User's Guide for Windows with Stata, SAS, and R

Table of Contents

1.0   Introduction

StatTag is user-friendly software that integrates statistical code with document preparation in Microsoft Word. StatTag facilitates reproducible research by connecting Word documents, such as a manuscript, to associated statistical code. Word documents prepared with StatTag are reproducible dynamic documents: statistical results in the document can be automatically updated if either statistical code or data change. In addition, StatTag allows statistical code to be edited directly from Microsoft Word.

StatTag is provided as a free Word plug-in written in C#. Once installed, StatTag is accessible from the Word toolbar. This user's guide covers use of StatTag within a Windows environment for Microsoft Word partnered with Stata (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP), SAS (SAS. 2002-2012. SAS Institute Inc: Release 9.4. Cary, NC), and R (R Foundation for Statistical Computing. 2015. R version 3.1.3. Vienna, Austria) statistical software.

2.0   Setup

For use with all statistical software, the StatTag plug-in must be installed. For some software, additional steps are required.

Setup Instruction			
Install the StatTag Plugin	Steps 1-3	Steps 1-3	Steps 1-3
Enable the Stata Automation API[1]	Steps 4-8		

Install the StatTag Plug-In:

1. Download the StatTag setup.exe file.

2. When prompted, click "Run" and follow the InstallShield Wizard.

3. Open Microsoft Word. If StatTag has installed successfully, your Word toolbar will include a "StatTag" tab that will look like this:
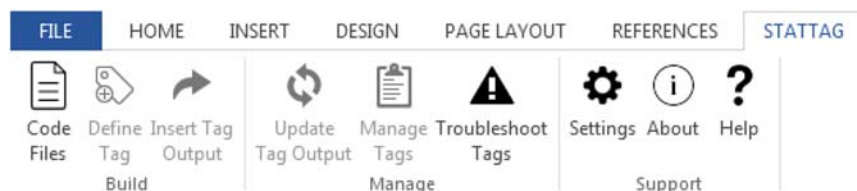
Enable the Stata Automation API:

4. Select the "StatTag" tab on the top tool bar.

5. Select the "Settings" icon

6. Under "Stata executable location," enter the file path for Stata on your computer. This may be something like C:\Program Files (x86)\Stata14\StataSE-64.exe.

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[1] http://www.stata.com/automation/
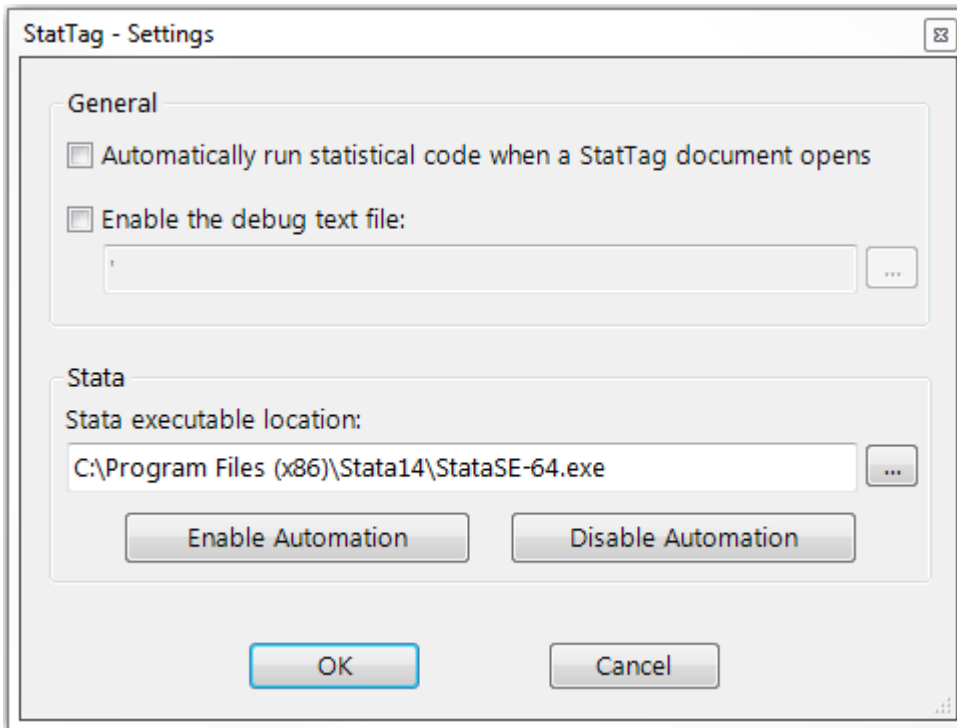
Tip: To locate the file path of your Stata program, open Stata, and type 'sysdir' in the command line. This returns the installation pathway. Open the folder in Windows Explorer to verify the pathway and identify the name of your Stata executable (.exe) file.

7. After the file path has been set, click 'Enable Automation' to allow StatTag and Stata to communicate via the Stata Automation API. **You must click 'Enable Automation' in order for StatTag to work.**

8. Click 'OK' to return to the main screen.

Note: You must install the StatTag plug-in first, before enabling the Stata Automation API. Both installation of the StatTag plug-in and enabling the Stata Automation API require administrator access on your computer. The Stata Automation Application Program Interface (API) allows StatTag and Stata to exchange information. StatTag sends 'calls' to Stata to execute statistical code, and Stata in turn sends back the results of the code to be inserted in the Word document. You only have to do this step on initial installation of StatTag. Updates to StatTag will not require re-enabling Stata Automation.

3.0   Basics of StatTag

The StatTag program will link any code file written for Stata (.do), SAS (.sas), or R (.R) with your Word document, will run the code file from Word, and will insert any tagged results. We recommend that you begin with a code file that already contains your working statistical code and generates the results of interest. With StatTag, it is possible to write your statistical code directly from Word, but not as convenient as writing your code files in the statistical program's editor.

There are three main steps to using StatTag:

1. Connect a Word document to files containing statistical code (i.e. .do, .sas, or .R file).

2. Annotate the code files to tag results, tables, or figures that are of interest.

3. Instruct StatTag where to insert those results within the Word document itself.

Note: This guide uses example code files to explain the use of StatTag. The example code files are distributed with the program, along with raw data and a Word document ready for tags to be embedded. To follow along with the User Guide, open the Word document.

3.1 Build

The three steps above are accomplished using the first three icons listed on the StatTag toolbar: *Code Files*, *Define Tag*, and *Insert Tag Output*. These three icons comprise the *Build* section of the StatTag toolbar. They allow the user to: (1) link statistical code to the Word document; (2) tag results, tables, and figures within the statistical code; and (3) identify where those tagged results should be inserted in to the Word document.

Code File

The *Build* toolbar enables linking one or more code files with your Word document. The first step to using StatTag is to connect your Word document with your statistical code. Note that it is possible to connect multiple code files to one Word document, and you may use code files from Stata, SAS or R in a single document. To link a code file:

1. Click on "*Code Files*"

2. A new dialog box will open. Select "Add File". A Windows Explorer box will open, allowing you to navigate to the appropriate code file. This should be a .do, .sas, or .R file.
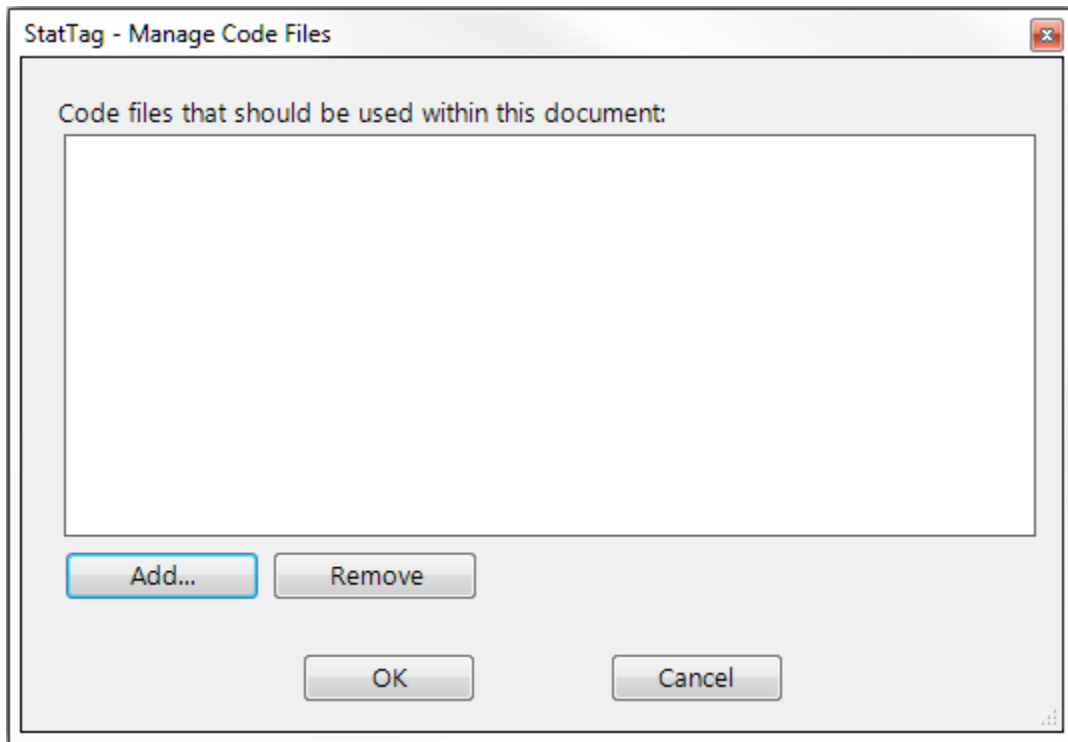
3. Locate the statistical code file and click "Open".

4. After clicking "Open", the file will appear in the selection window, and the default program will be chosen to run the code in. For example, if a do file is selected, Stata will be chosen by default.

5. Click "OK".

Note: You can connect multiple source code files to a single Word document.

Define Tag

After a code file has been linked, the options to *Define Tag* and *Insert Tag Output* become available and are no longer grayed out. Once you have connected your statistical code file to your Word document, you are ready to create tags.

Tags in your code file(s) identify numbers, tables, figures, or verbatim output (i.e. raw output from the statistical program console) that you would like to embed in your Word document. Tags can be inserted through StatTag, using the following instructions, or for the more advanced user, can be directly written into your code files using a text editor of the user's choice. Tags are specifically formatted text that Stata, SAS, or R interpret as comments, but allows StatTag to pull results into Word.
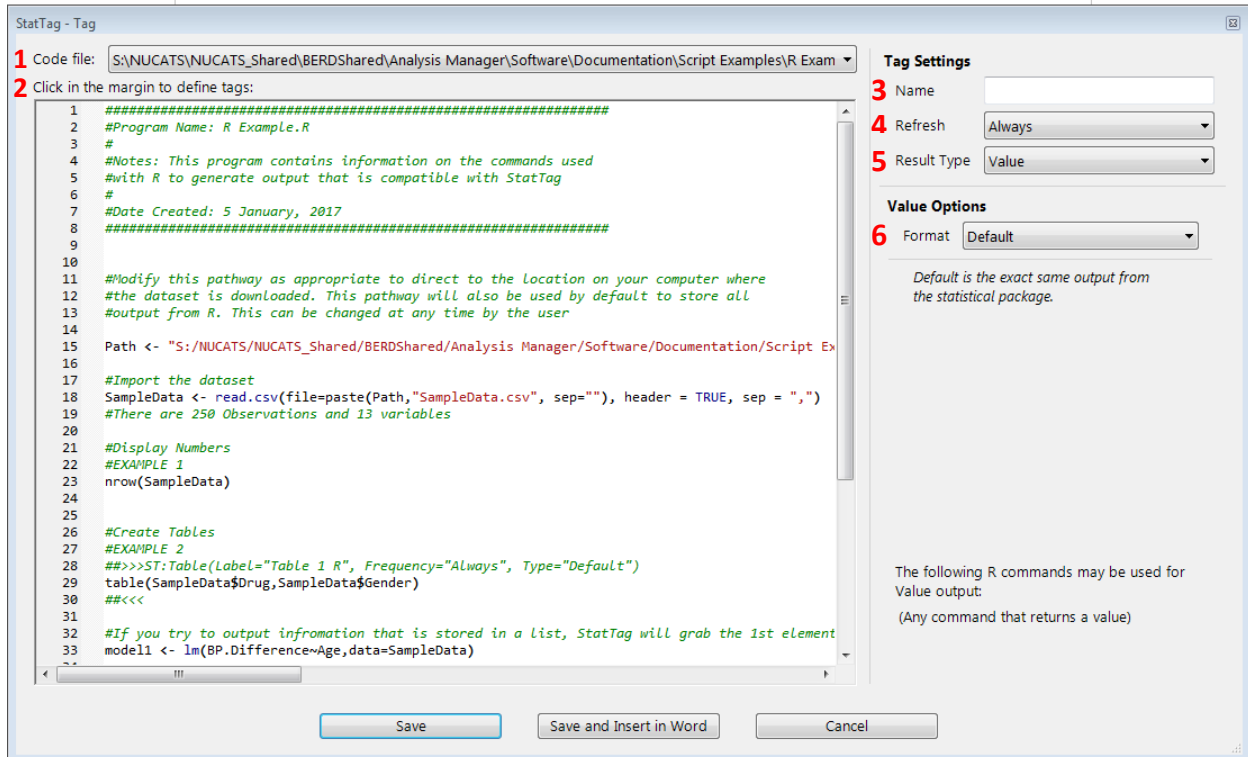
In the following example, we create a tag for a single value. Section 4 covers additional information on creating tags for tables, figures, and verbatim output and the corresponding commands that must be present in your statistical code.

To create a tag through StatTag:

1. Click "*Define Tag*"

2. The linked statistical code will open in a new dialog box.

3. The dialog box has the following components:
    (1) Code File
        i. If you have only 1 code file linked to your Word document, this will be automatically selected in the drop down menu
        ii. If you have 2 or more code files linked to your document, use the drop down menu to select the code file you are using to make the new tags.
    (2) Text editor showing the statistical code
        i. The statistical code may be edited directly though StatTag. Any changes you make are made to the file itself and saved immediately.
    (3) Name
        i. The tag name is the unique name of the result of interest, and should only be used once within each code file to identify a result. StatTag will warn you if you try to use a tag name more than once.

      ii. The tag name can contain any string of characters including special characters and spaces.

(4) Refresh

      i. "Always" is the default selection. The results within the Word document will be updated automatically by StatTag every time the statistical code runs. The statistical code is run whenever a tag is added, removed, or updated, and when the Word file is opened.

      ii. "On Demand" may also be selected. The results within the Word document will be updated only when you instruct StatTag to update them (using "Update Tag Output" icon, see Section 3.2). This is particularly useful for code that takes a long time to run, or when inserting many tags into a document.

(5) Result Type

      i. This section informs StatTag if the tag will be a value, figure, table, or verbatim output and how the data should be managed.

      ii. More information on tags for tables, figures and verbatim output is provided in Section 4.

(6) Format

      i. Formatting options are specific to the type of result inserted.

      ii. More information on formatting is provided in Section 5.

4. Enter a tag name for your new tag. For this example, we will create a new tag called "Total N", which will insert the total number of participants in the example study.

5. Use the text editor window to locate the statistical result of interest.

Note: StatTag recognizes different keywords in Stata, SAS, and R. Use of these commands is discussed in detail in Section 4.

Type			
Numeric Values	display	%put	Any command that returns a value
Tables	matrix list	ODS CSV	Any command that returns a data frame, matrix, vector or list
Figures	graph export	ODS PDF	pdf, win.metafile, png, jpeg, bmp, postscript
Verbatim	Any Code	Any Code	Any Code

6. Highlight the line of code containing the `display,` `%put` or R command. **To highlight, click between the line number and the start of the line of code. Clicking in this margin will highlight the line of code in purple.**

Tip: You can select multiple lines, but as best practice, select only the line(s) containing the result of interest.
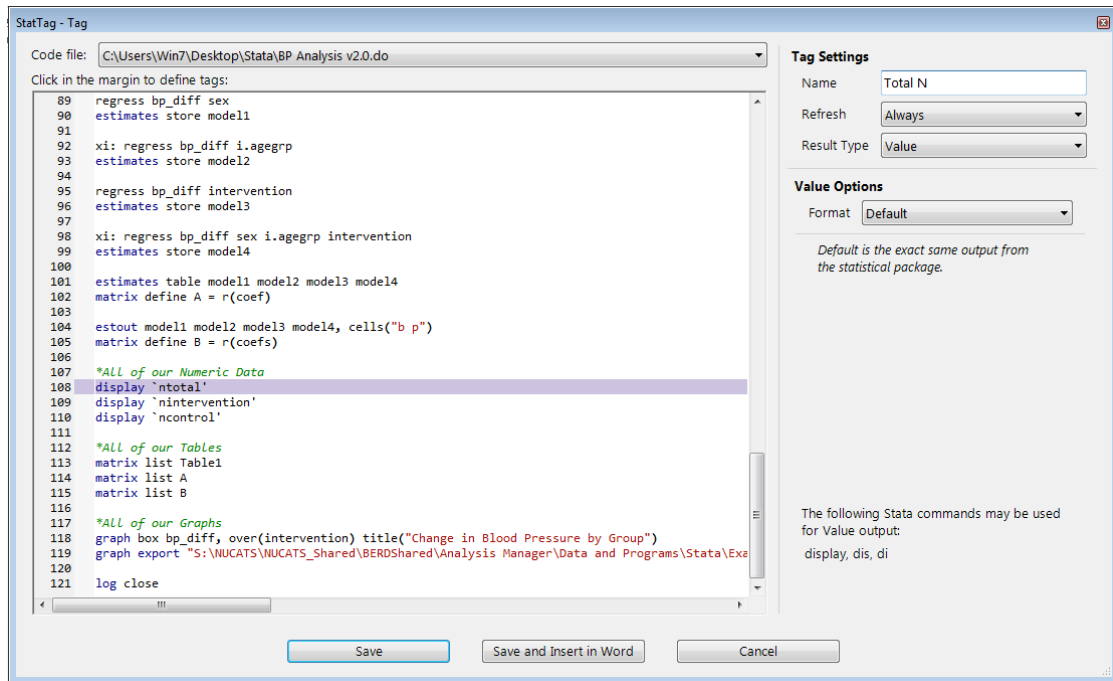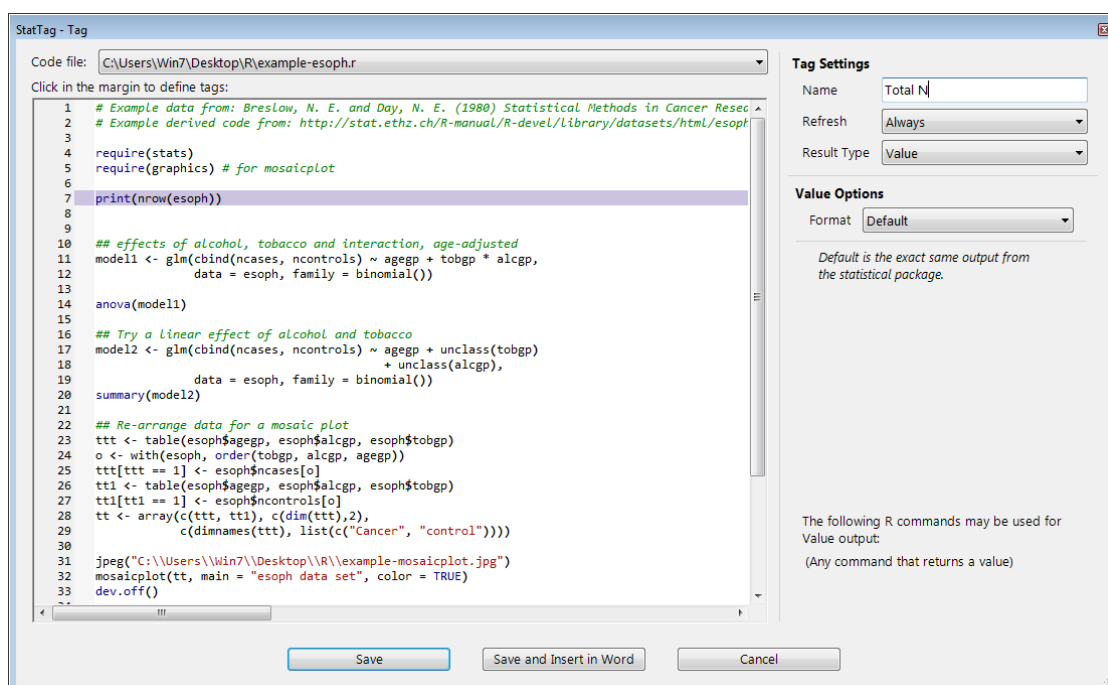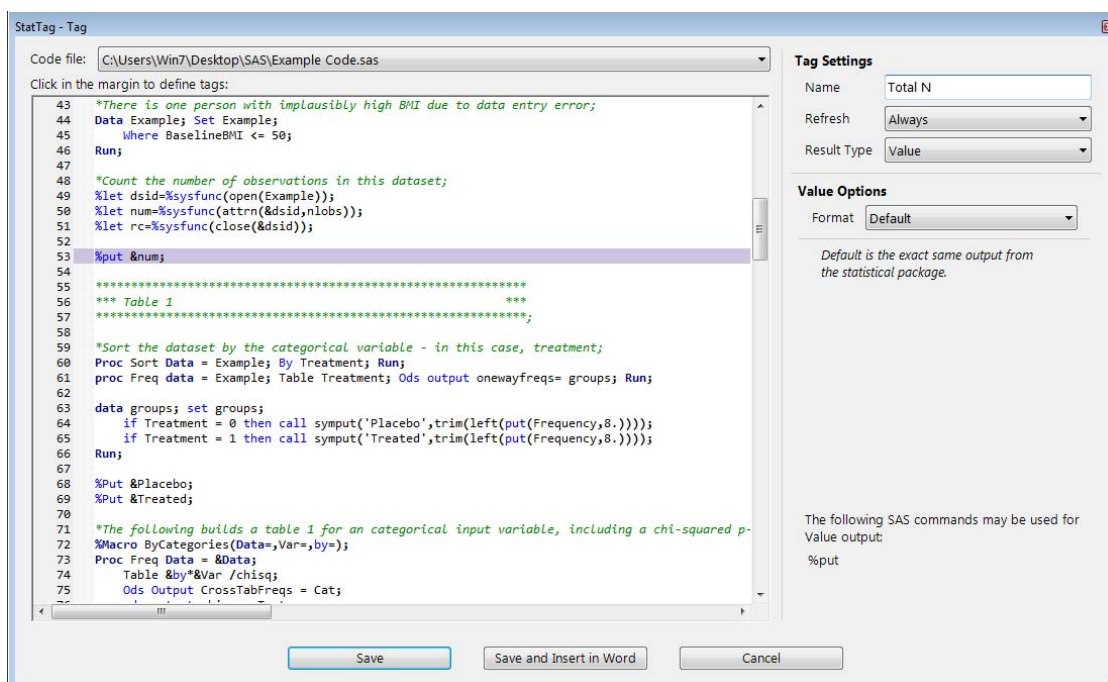
7. If your selection of code does not include a recognized keyword, StatTag will print an error in the top right of the text editor.
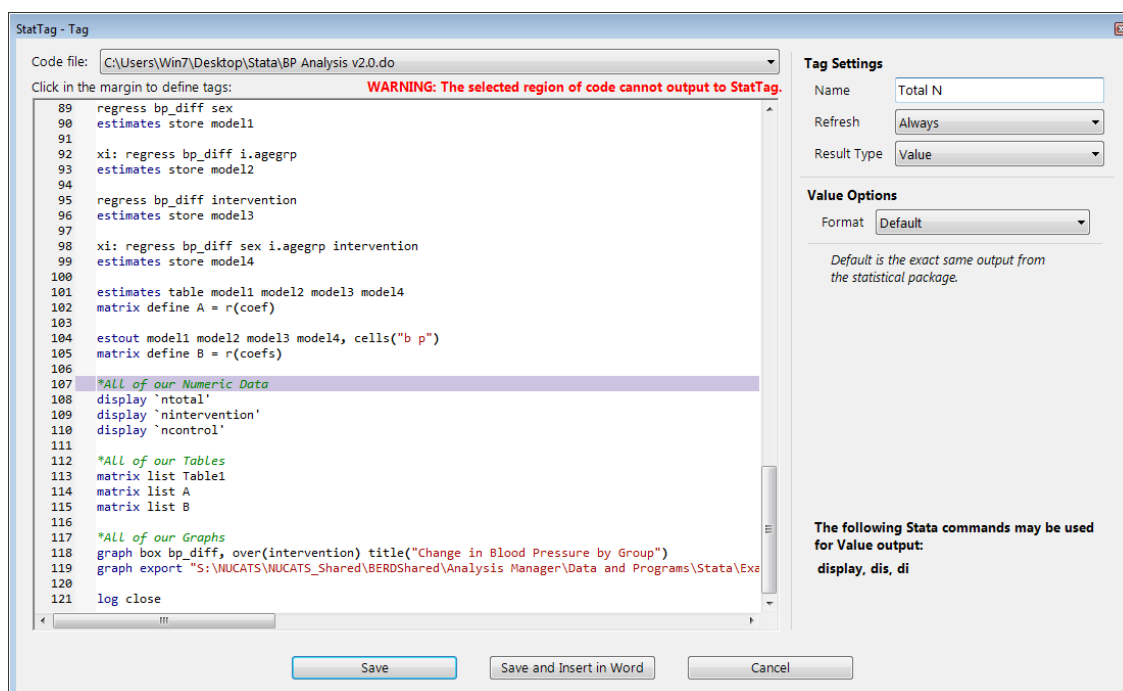
Tip: If you get a warning that the section of code you have highlighted cannot output to StatTag, double check the instructions in the selection pane. These will tell you what commands you should highlight.

8. Use the formatting window to make any changes to the way in which the result is displayed. By default, the result will be displayed as it is in the statistical program. For example, our selections to `display` `ntotal'`, `%put` &num and `print(nrow(esoph))` will insert these numbers to the Word document using the default formatting from Stata, SAS and R respectively.

9. Click either "Save" or "Save and Insert in Word". If "Save" is chosen, the tag will be saved, as will any edits to the statistical code. If "Save and Insert in Word" is selected, the tag will be saved, the statistical code will run, and the result will be inserted at the location of the cursor in your Word document.

10. Use the "*Define Tag*" icon as often as needed to create tags for all of your statistical results. (In the next section, we have also defined "Intervention N" and "Control N," following the steps above).

Insert Tag Output

Tags can be inserted at the point of the cursor when they are defined, using the "Save and Insert in Word" option. They can also be inserted after they are created through the "Insert Tag Output" icon. Tags can be inserted more than once, and the results will be updated collectively

throughout the text. Tags are always inserted at the location of the cursor, although they can be copied and pasted elsewhere once inserted.

> **Tip:** Once a tag is inserted into a Word document, double clicking on the tag will open the tag window, from which you can modify the characteristics of the tag (name, when to run) or the associated statistical code.

To insert a saved tag:

1. Click "*Insert Tag Output*"

2. All saved tags will be shown in a new window by their tag name and the code file in which they have been saved. Select one or more tags by clicking on the checkbox next to the tag name.
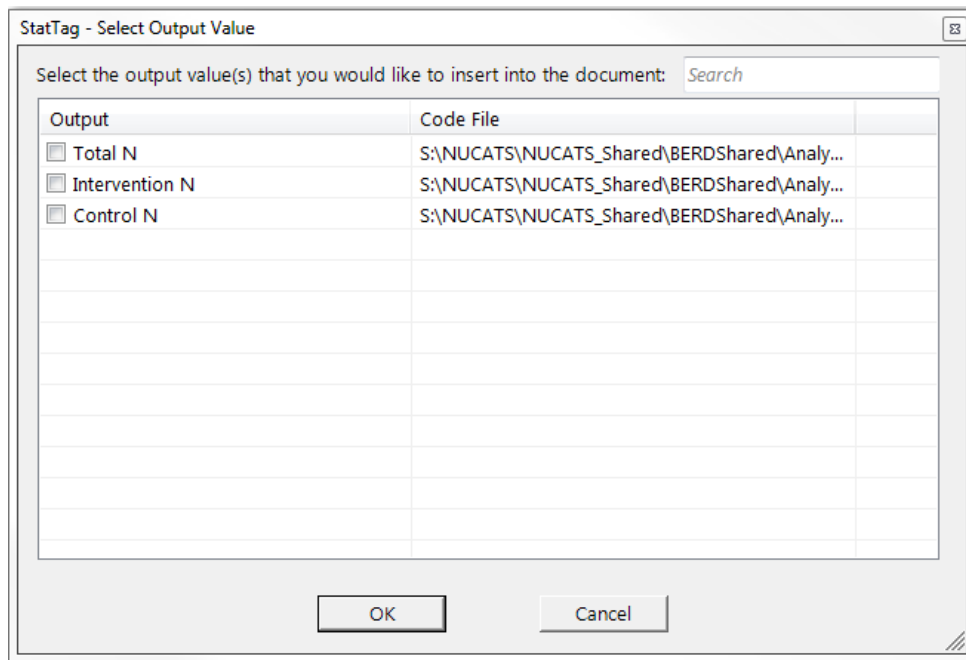
3. Click "OK" to insert the output. Upon clicking "OK" the statistical code will run and the result will be inserted in to the document.
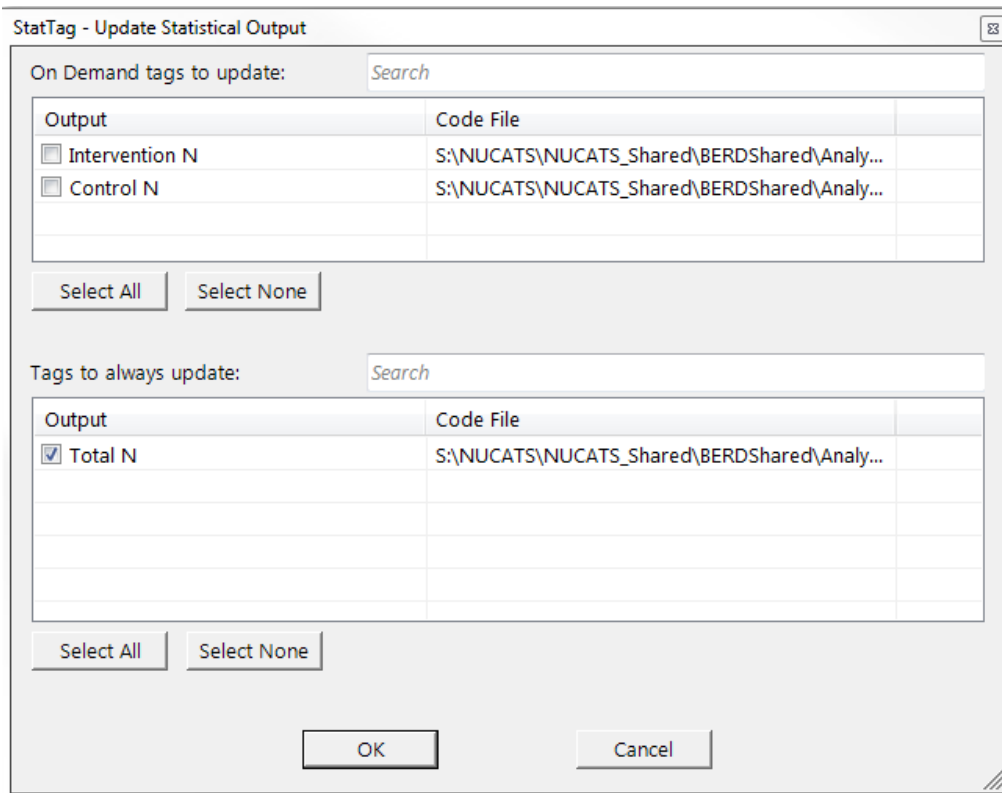
3.2   Manage

The second portion of the StatTag toolbar consists of the *Manage* icons. These icons allow the user to manage tags after they have been created and inserted using the *Build* icons. The *Manage* icons include Update Tag Output, Manage Tags, and Troubleshoot Tags. These icons allow the user to manually update results; add, edit or delete saved tags; and troubleshoot any issues with inserted tags.

Update Tag Output

Tags are either updated "Always" when the statistical code is run (when new tags are defined, removed, or modified, and when the document is opened), or "On Demand" when the user instructs StatTag to update the results. To change how tags are updated, or to update the tags "On Demand":

1. Click on *"Update Tag Output "*

2. A new dialog box is opened. Tags are shown in either the "On Demand" window or the "Always" window, depending on how they have been defined in the statistical code.

3. To update the inserted results from any tags that have been defined as "On Demand," select the tags by checking the box next to the tag name.

4. To update the inserted results from any tags that have been defined as "Always," select the tags by checking the box next to the tag name. By default, all of these tags will be selected.

5. Click "OK" to run the statistical code, and update the selected results.

Manage Tags

Once saved, all tags will be listed in the *Manage Tags* dialog box. From this dialog box, the user can change how tags are formatted and updated, or can remove them entirely. To manage tags:

1. Click "*Manage Tags*"

2. All saved tags will be shown in a dialog box by their tag name with information about how they have been defined. From this dialog box, new tags can be defined, and existing tags can be edited or removed.

Remove	Run In	Type	Name	When to Run	
☐	Stata	Value	Total N	Always	Edit
☐	Stata	Value	Intervention N	On Demand	Edit
☐	Stata	Value	Control N	On Demand	Edit

StatTag - Manage Tags

Available tag(s):   Search

Define New Tag   Remove Checked Tag(s)

OK   Cancel
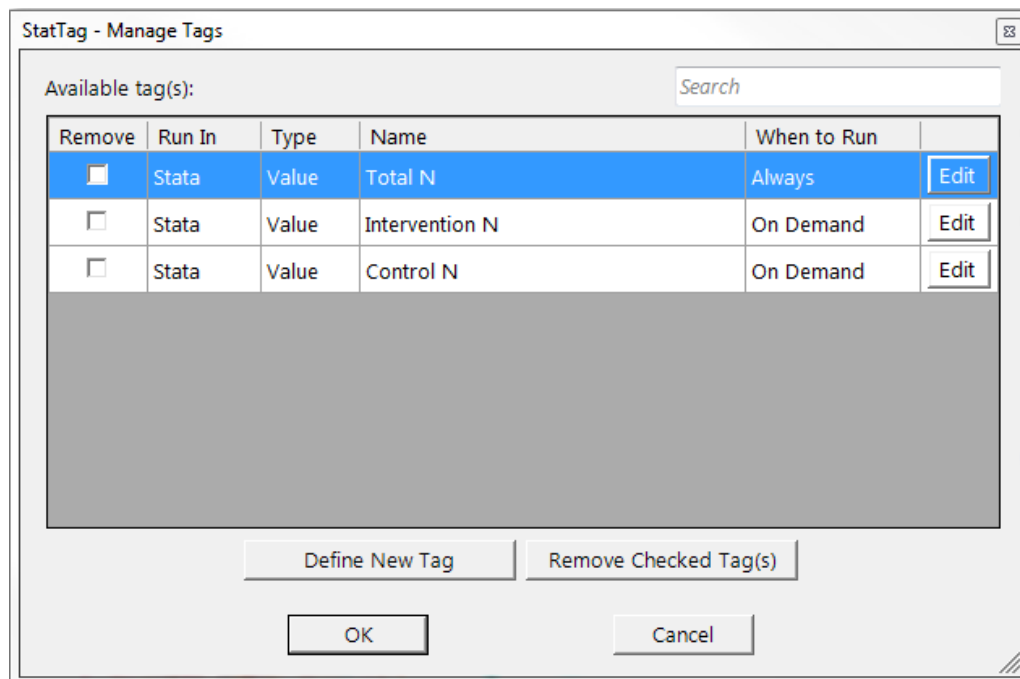
3. To define a new tag, click the "Define New Tag" button at the bottom of the dialog box. This will open the statistical code, and follow the "Define Tag" process described above. Defining new tags will insert new tag notation in your statistical code.

4. To edit a tag, click the "Edit" button on the right of the window. This opens the statistical code, showing the highlighted tag. The options for this tag can be edited through the dialog box.

Note: Tag properties can be edited either through the dialog box using the clickable and selectable tag properties options or by editing the tag itself through either the statistical program or a text editor. Do not try to modify the tag text from within Word.

5. To remove a tag, check the boxes next to each tag you wish to remove. Then click "Remove Checked Tag(s)".

Note: Removing tags will delete the tag notation in your statistical code. Removing tags will not delete inserted text, tables or figures from your Word document. However, those results will no longer be tagged. They will not be updated when code is rerun or the document is open.

6. Click "OK" to permanently save any changes you have made within your statistical code.

Troubleshoot Tags

There are two troubleshoot options provided: (1) linking unlinked tags, and (2) removing duplicate tags. Tags can become unlinked if the statistical code is unlinked from the Word document, or if the statistical code is edited outside of StatTag and the notations are modified. For example, code could become unlinked if the code file (.do, .sas or .R) is moved to new location without changing the code file path in StatTag. Tag names can be duplicated within statistical code if the code is edited outside of StatTag and a tag name is inadvertently duplicated. To troubleshoot either issue:

1. Click "*Troubleshoot Tags*"

2. A new window will open showing any unlinked tags and any duplicated tags in separate tabs.

3. If there are unlinked tags, they will be shown in the first tab.
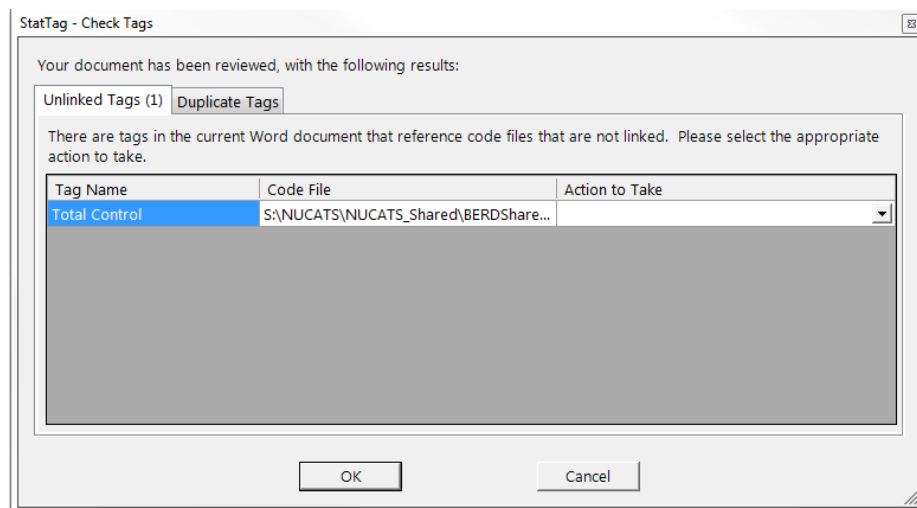
4. The drop down menu "Action to Take" shows three options for each tag:
    (1) Link the tag to a code file currently linked to the Word document
    (2) Remove the tag from the document
    (3) Link the missing code file

5. If there are duplicated tags, they will be shown in the second tab.
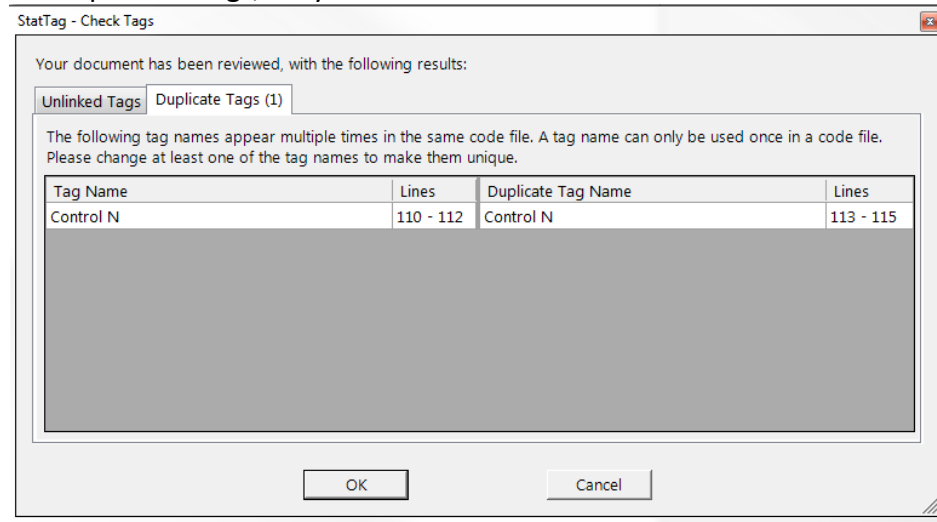
6. The dialog box shows the duplicated tags and the lines in the statistical code in which they occur. Use the "*Manage Tags*" icon to resolve any duplicates – for example, by removing or renaming a duplicate tag. If duplicates are not resolved, the tag output in the Word document will reflect output corresponding to the latest occurrence of the tag in the statistical code.

3.3   Support

Settings ⚙

The Settings window controls aspects of StatTag's operation. The first option either enables or disables StatTag to automatically run your statistical code when a Word document with embedded code files is opened. This is disabled by default, but when enabled by checking the box, will execute the statistical code and refresh the results of all tags set to run "Always".

The second option enables or disables StatTag to capture information about the StatTag plug in. This is disabled by default, but if you encounter errors and would like to request assistance please do the following: (1) enable the debug file, by checking the box, which will write a plain text file to your computer; (2) run your program to generate the errors, and; (3) send the debug file to StatTag@northwestern.edu.

If you are using Stata, the Settings dialog will contain the location of your Stata executable file. See page 4 for more information about configuring Stata.

About ⓘ

The About icon will open a window containing the version number of StatTag that you are using, and information regarding citation, usage, and licenses related to StatTag.

Help ❓

The Help icon will open the User Guide from within Word. If you need additional help or support, email StatTag@northwestern.edu or visit the StatTag website at http://sites.northwestern.edu/stattag/ to interact with the user community.

4.0   Tag Structure and Syntax

Four types of results can be tagged.

Type			
Numeric Values	`display`	`%put`	Any command that returns a value
Tables	`matrix list`	`ODS CSV`	Any command that returns a data frame, matrix, vector or list
Figures	`graph export`	`ODS PDF`	pdf, win.metafile, png, jpeg, bmp, postscript
Verbatim	`Any Code`	`Any Code`	Any Code

In order to return results from your statistical analysis to Word, your results must be created and either printed to the results window of your statistical program or to file through one of the above commands, and encapsulated in a tag. Other lines in your statistical code should not be encapsulated by tags, as they may cause errors. Examples of all commands referenced below can be found in the accompanying sample files for each statistical program.

4.1   Values

Values are returned to StatTag and then inserted into Word with the `display` (Stata) or `%put` (SAS) commands, or R commands that return a number. The `display` and `%put` commands are used in Stata and SAS code respectively to print strings or scalar values to the results window. They will not return data in any other format, such as a matrix or table.

The `display` command is typically used in Stata code with the return command to retrieve stored results, or with local or global macro variables.

The `%put` command is typically used in SAS code to store values or strings as local macro variables.

R commands that return a single value (e.g., `print`) may be used. If the value returned has more than one element (such as a vector), only the first element will be used.

4.2 Tables

Tables are returned to Word with the `matrix list` (Stata) or `ODS CSV` (SAS) commands, or R commands that return a collection of values.

The `matrix list` command is used in Stata code to print a matrix to the results window. The `matrix list` command is typically used after creation of a matrix with the `mkmat`, `matrix define`, `estout`, or `estimates table` commands.

The `ODS CSV` command is used in SAS code to redirect output to a location on file, instead of the results window. The file location is used by StatTag to pull in the results of interest.

R commands that return a collection of values (data frame, matrix, vector, or list) can be used as table results by StatTag.

4.3 Figure

Figures are returned to Word with the `graph export` (Stata), `ODS PDF` (SAS), `pdf, win.metafile, png, jpeg, bmp,` or `postscript` (R) commands.

The `graph export` command is used in Stata code to save a graph or figure to file outside of Stata, the location of which is specified by the user. StatTag will retrieve the file to insert into Word. The `graph export` command expects a pathway and file name to be specified along with the file format, and the replace option to overwrite an existing file as required. The command will export the last graph rendered in Stata.

The `ODS PDF` command is used in SAS code to save results of other commands to a pdf file outside of SAS, the location of which is specified by the user. StatTag will retrieve the file to insert into Word. The `ODS PDF` command expects a pathway and file name to be specified. The command will export any contained output that would be otherwise printed in the results window.

The `pdf, win.metafile, png, jpeg, bmp` and `postscript` commands are used by R to save a graph or figure to a file outside of R, the location of which is specified by the user. StatTag will retrieve the file to insert into Word.

4.4   Verbatim

Verbatim results echo any printed output within the statistical program. Inserted output will be formatted text in a text box. The inserted text may be further formatted in Word.

Tagging code as verbatim in Stata will result in the insertion of any output printed to the Stata results screen.

Tagging code as verbatim in SAS will result in the insertion of any information printed to the SAS log screen.

Tagging code as verbatim in R will result in the insertion of any output printed to the R console.

4.5   Syntax

A tag always starts with `**>>>ST:Value(Label=" ", Frequency="",…)` and may contain additional information based on the type of tag (number, table, or figure) it identifies. The tag always ends with `**<<<.` Examples of tags for a numeric value, a table, a figure and verbatim output are listed below.

```
**>>>ST:Value(Label=" ", Frequency="", Type="")
code
**<<<

**>>>ST:Table(Label="", Frequency="", Type="", AllowInvalid=True, Decimals=0,
Thousands=False)
code
**<<<

**>>>ST:Figure(Label="", Frequency="")
code
**<<<

**>>>ST:Verbatim(Label="", Frequency="")
code
**<<<
```

If tags are made through StatTag, the text ("`***>>>   …. **<<<`") will be written into your statistical code by the plug-in. The Label, Frequency, Type and Table parameters are inserted with the opening and closing tags by StatTag. For the more advanced user, you can also directly

write tags into your statistical code. If written by hand in the statistical code, you must write both the opening and closing tags, and provide a tag name for each tag.

Note: Tags cannot be nested within each other. A tag should encapsulate exactly one keyword command (i.e. `display`, `matrix list,` `%put`, etc.)

5.0   Formatting tags

When a tag is created, its format should be specified accordingly. Options may be selected for either Values or Tables. There are no formatting options for Figures or Verbatim.

5.1   Values

Values can be formatted by default (per the exact statistical output), as a number with a specific number of decimal places, as a date/time combination, or as a percentage with a specific number of decimal places. Formatting is selected from the drop down list.

Tag Settings
Name   Total N
Refresh   On Demand
Result Type   Value
Value Options
Format   Default

Default is the exact same output from the statistical package.

5.2   Tables

Matrices and tables are inserted to Word through StatTag using different mechanisms depending on the statistical software used. In all cases, data are formatted using OpenXML prior to being inserted. By default, where data are blank or missing, a "." is returned in the particular cell. This behavior can be changed for either the document (document properties) or the user (user settings) so that the returned value is a missing character or another default character. Tables use field formatting, and text cannot currently be wrapped within a cell.

Tag Settings
Name   Table 1 R
Refresh   Always
Result Type   Table
Table Options
☐ Exclude row(s):
☐ Exclude column(s):
Enter the values or ranges to exclude, separated by commas: (e.g. 1, 3, 8-10)
Value Options
Format   Default
Default is the exact same output from the statistical package.

Currently, if any formatting is specified, the formatting is applied to the entire table. Formatting options include specification of the number of decimal places and inclusion of a comma separator for thousands places, which will be applied to all numerical data in the table.

Once inserted to Word, the dimensions (rows and columns) of a table should not be modified by removing or adding columns, as this will cause errors when updating the results. If you change the dimensions of a table, you should delete the table from Word and insert the table again. StatTag allows flexibility in importing tables to exclude rows and columns by number. Using these options, the headers, row names, or specific variables and data can be excluded.

> **Tip:** Data from individual cells in an inserted table can be copied elsewhere within the Word document text, and will retain their linkage to the original data. For example, if you wished to include a p-value in the text, copy the result from the table and paste into the text. When the table is updated, the value in the text will be updated as well.

5.3   Formatting after insertion

Once inserted, values and tables can be formatted using Word text formatting options, such as changing fonts, bolding, or italicizing. Updating the tags will not affect the applied formatting in Word.

Tags can also be copy and pasted, or cut and pasted to other parts of the text, and will retain their linkage to the statistical code. If your tag is copied or inserted in multiple locations, updates within your statistical code will update every instance of the tag within your text.

Tags can be deleted from the text. Deleting the tag from the text will not delete the tag syntax within your statistical code. To delete the syntax, use the "Remove tags" option in the Manage Tags dialog box.

6.0   Troubleshooting

Error	Solution
[NO RESULT]	StatTag returns this value when the plug-in does not capture any information from the statistical program. If your tag returns this result, complete these steps:
	1. Close the statistical program if it is open.
	2. Check to ensure the tag encapsulates a keyword command.
	3. Check to ensure the statistical code is running correctly. Run the code in the native software and check for any errors or warnings.
	4. Review any files created on disk to ensure they contain the expected output, and they are created each time the code is run.
My document takes a long time to update	Inserting and updating tables can take a long time. The default update option is "Always", in which case the statistical code is run each time any tag is inserted, removed, modified, and when the document is opened. Depending on the number and type of tags you have inserted, this process may be very long.

	Consider using the "On Demand" update option for your tables to reduce the amount of time the update takes.
Could not communicate with Stata	The Stata API must be enabled to insert and update tags. Check the Settings icon to ensure that (1) the correct pathway has been specified to your Stata.exe file, and (2) that the API has been enabled.
Warning is displayed when a tag is defined	If a red warning notice is given, you have not highlighted a keyword command in your code. Check to ensure you have selected the right option of Value, Table, or Figure, and you have highlighted a section of code containing the corresponding command.
Looping	Tags must be standalone, and should not be embedded within a loop.
Embedded Tags	Tags should not encapsulate other tags.
I don't see StatTag in the Toolbar	Check in your program files to ensure StatTag is installed. If installed, check the COM Add-ins after Word is launched. To do so, from the File menu in Word, open the Options menu, then the Add-ins menu. On the bottom of the menu, under Manage, ensure COM Add-ins is selected and click 'Go'. Ensure the box for StatTag is checked and click 'OK'.

7.0   Acknowledgements

StatTag was inspired in part by the Stata Automation Report project:

> Lo Magno, G.L. (2013). Sar: Automatic generation of statistical reports using Stata and Microsoft Word for Windows. The Stata Journal, 13(1); 39-64.

StatTag makes use of the following open source projects (licenses in Appendix I):

- Scintilla - http://www.scintilla.org/
- ScintillaNET - https://github.com/jacobslusser/ScintillaNET
- Json.NET - http://www.newtonsoft.com/json
- SASHarness - https://github.com/cjdinger/SasHarness
    - Hemedinger, C. (2013). Create Your Own Client Apps Using SAS® Integration Technologies. SAS Global Forum 2013. Paper 003-2013.
- R.NET - https://github.com/jmp75/rdotnet

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