Introduction to STATA

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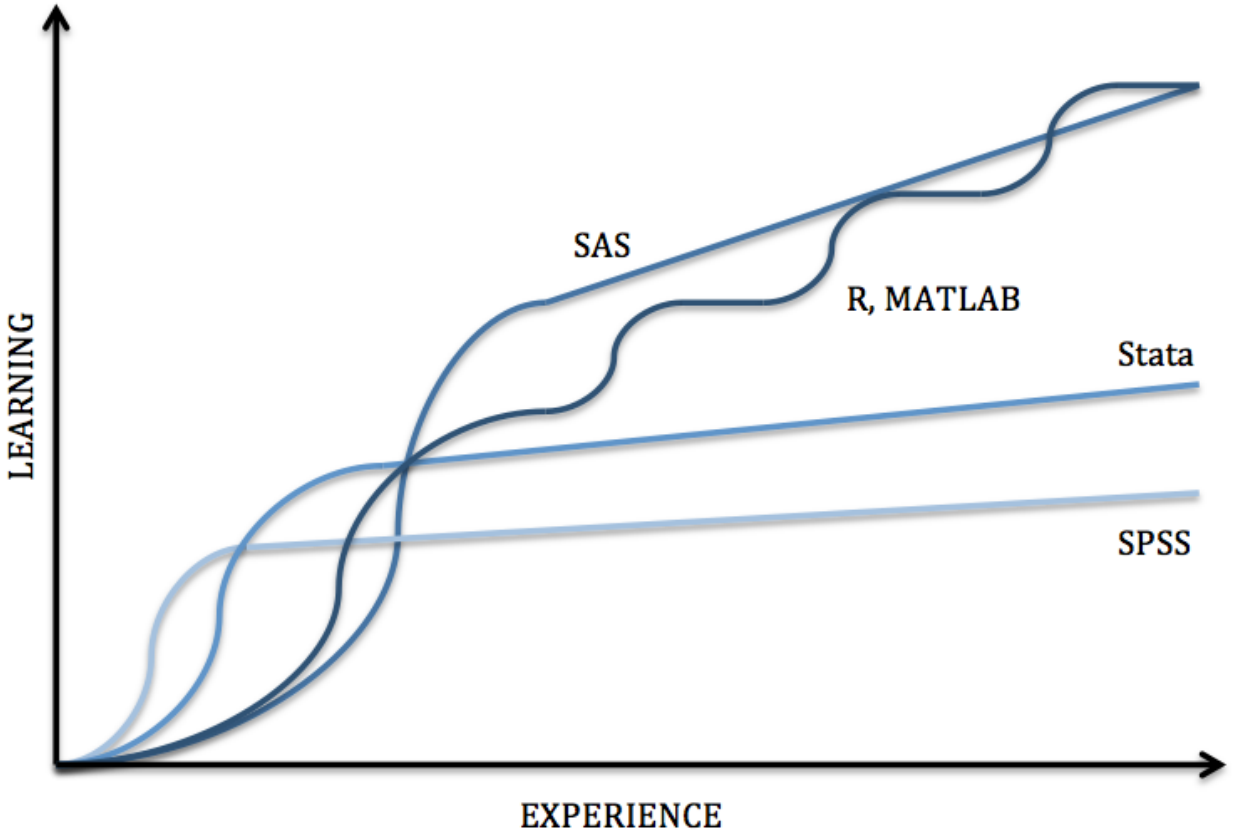
STATA for Health Economics

- A survey conducted to IHPME health economics students suggested the following research interests
  - Working with data
    - Common tasks: reading in data, creating new variables, data subsets, etc.
  - Applied econometrics
    - Common tasks: descriptive analysis, regression analysis, etc.
  - Economic Evaluation
    - Common tasks: model building (Markov, Microsim, etc.), sensitivity analysis, etc.

Outline

- Why use STATA?
- Reading/Cleaning data
- Regression Analysis
- Post-estimation Diagnostic Checks
- Other Topics in STATA
  - Do File and applied example
  - Mata and applied example
- STATA Resources

Learning Curves of Various Software Packages



Source: https://sites.google.com/a/nyu.edu/statistical-software-guide/summary

Summary of Various Statistical Software Packages

Software	Interface*	Learning Curve	Data Manipulation	Statistical Analysis	Graphics	Specialties
SPSS	**Menus** & Syntax	Gradual	Moderate	Moderate Scope Low Versatility	Good	Custom Tables, ANOVA & Multivariate Analysis
Stata	Menus & **Syntax**	Moderate	Strong	Broad Scope Medium Versatility	Good	Panel Data, Survey Data Analysis & Multiple Imputation
SAS	Syntax	Steep	Very Strong	Very Broad Scope High Versatility	Very Good	Large Datasets, Reporting, Password Encryption & Components for Specific Fields
R	Syntax	Steep	Very Strong	Very Broad Scope High Versatility	Excellent	Packages for Graphics, Web Scraping, Machine Learning & Predictive Modeling
MATLAB	Syntax	Steep	Very Strong	Limited Scope High Versatility	Excellent	Simulations, Multidimensional Data, Image & Signal Processing

* The primary interface is bolded in the case of multiple interface types available.

Source: https://sites.google.com/a/nyu.edu/statistical-software-guide/summary

Why STATA?

- Moderate learning curve
- Widely used in economics and other social sciences
- Feature rich for analyzing various types of data (survey data, panel data, etc.)
- Wide array of free, user-written routines to expand the scope of STATA's capabilities
- Support for export of regression results to tables through packages such as "estout" (STATA 16 or older) and/or Tables feature (STATA 17)

STATA Purchasing options (from UofT)

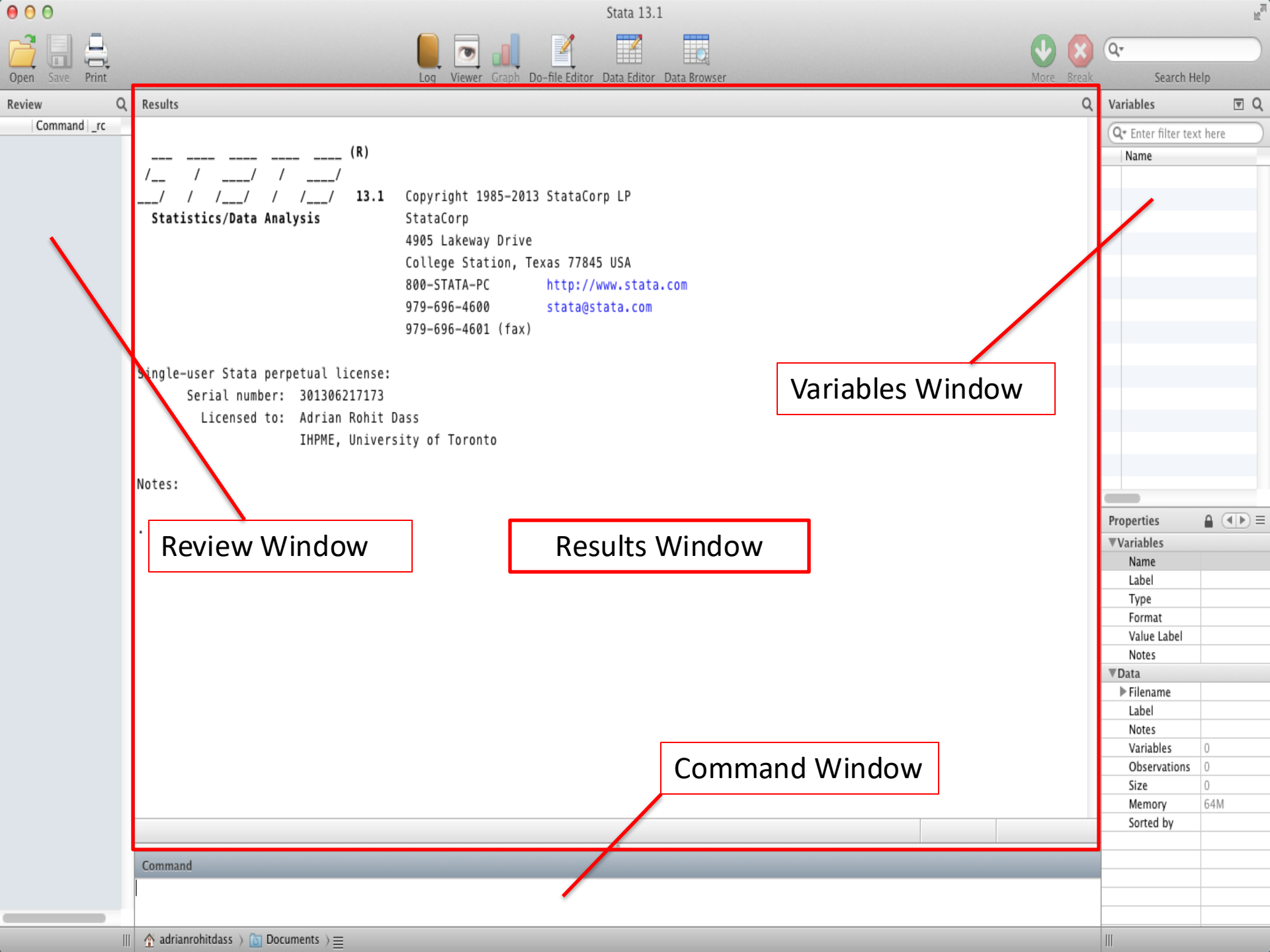
For details, please see here:

https://onesearch.library.utoronto.ca/ic/stata-gradplan-u-t

Reading/Cleaning data

STATA Basics

- Contains a menu and syntax based interface
- Prior programming experience is not required, but can be helpful (especially with the syntax based *.do* files)
- Case sensitive, so be careful:
  I.e.
  - regress y x results will result in a successful OLS estimation (if everything else is right)
  - Regress y x results will in an error message


Stata 13.1
Open
Save
Print
Log
Viewer
Graph
Do-file Editor
Data Editor
Data Browser
More
Break
Search Help
Review
Command
_rc
Results
(R)
13.1
Copyright 1985-2013 StataCorp LP
Statistics/Data Analysis
StataCorp
4905 Lakeway Drive
College Station, Texas 77845 USA
800-STATA-PC
http://www.stata.com
979-696-4600
stata@stata.com
979-696-4601 (fax)
Single-user Stata perpetual license:
Serial number: 301306217173
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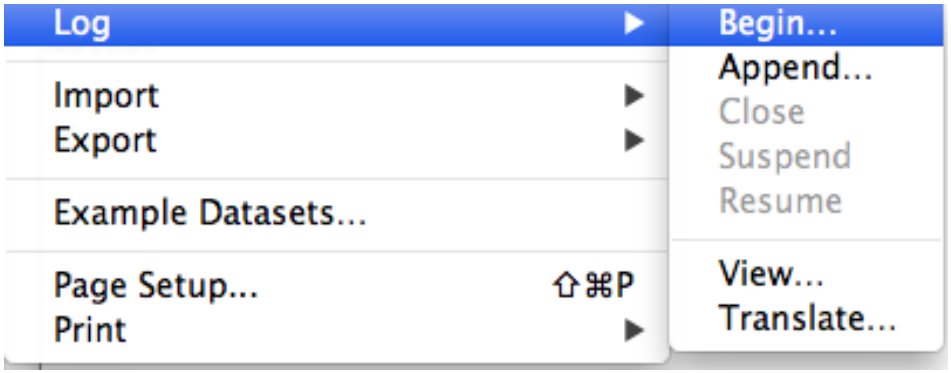
IHPME, University of Toronto
Notes:
Variables Window
Review Window
Results Window
Command Window
Variables
Enter filter text here
Name
Properties
Variables
Name
Label
Type
Format
Value Label
Notes
Data
Filename
Label
Notes
Variables 0
Observations 0
Size 0
Memory 64M
Sorted by
Command
adrianrohitdass
Documents

Starting a Log File

This should generally be your *first* step when using Stata

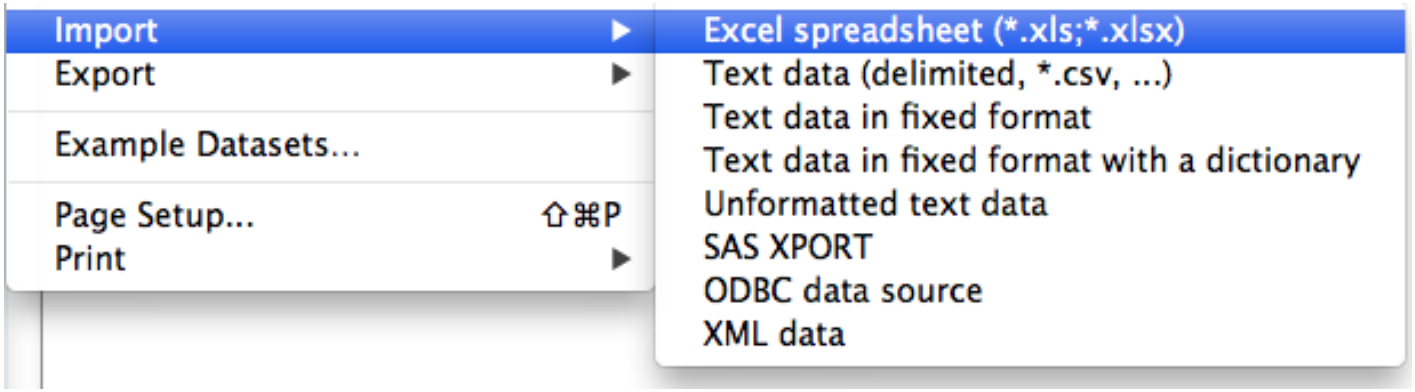
- Menu:
  - File → Log → Begin:



  - Stata will prompt you to name the file. Pick a creative name (E.g: logfile1), then click ok
  - At this point, Stata will record everything you do (importing data, running commands, regression output, etc)
- Syntax:
  - log using filename [, append replace [text|smcl] name(logname)]

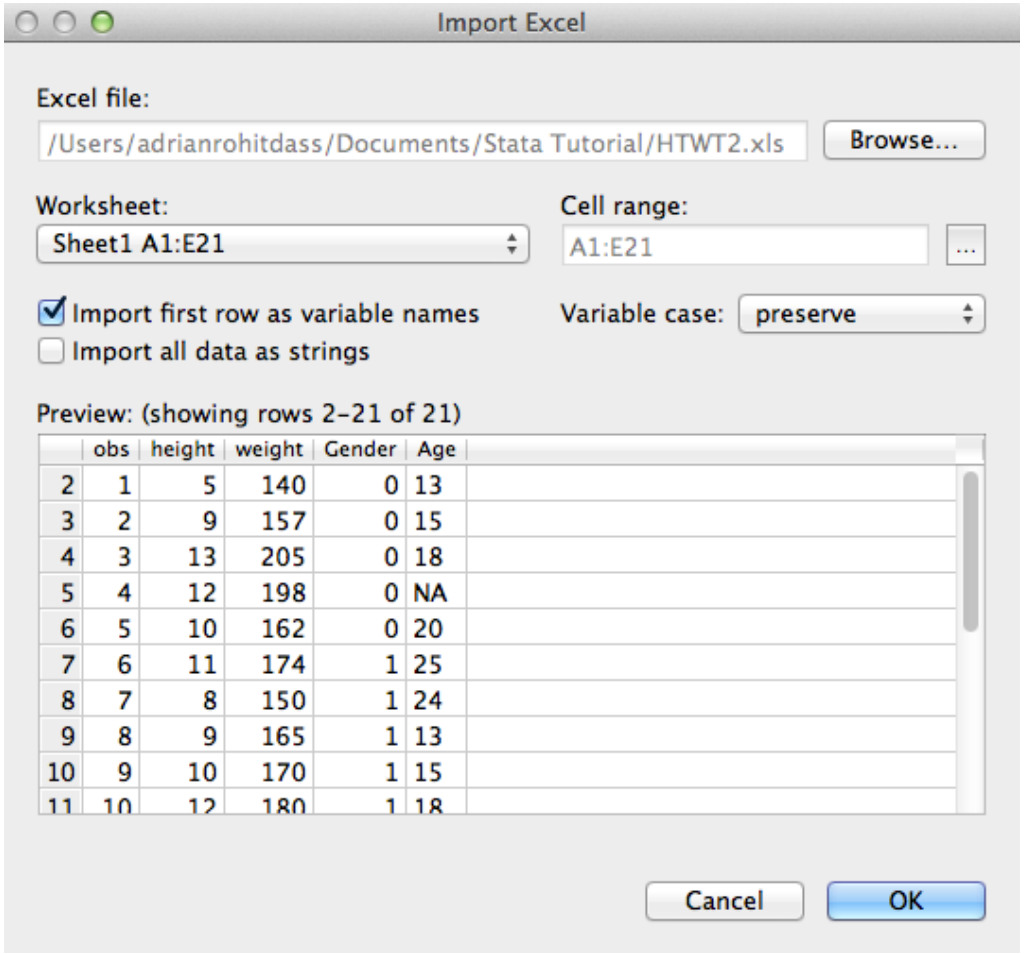
Importing Data into Stata

- Menu
  - File → Import → Choose appropriate option:



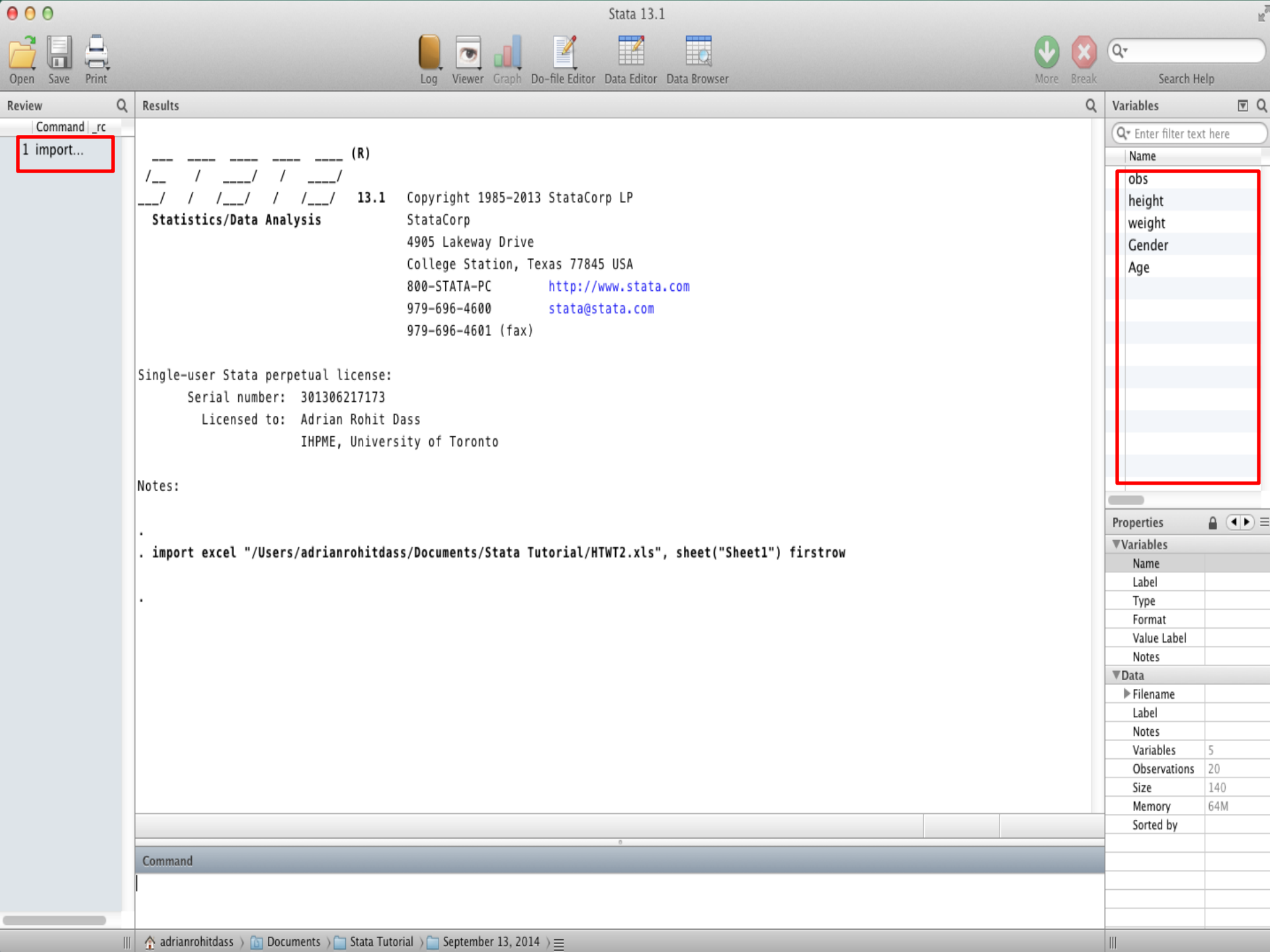
  - .csv (Comma Separated) is a common option, but .xls (Microsoft Excel Format) and other formats are compatible too
- Syntax
  - import excel [using] *filename [, import excel options]*
  - For .csv files, command changes to import *delimited*

Importing Data into STATA (Microsoft Excel (.xls))



	obs	height	weight	Gender	Age
2	1	5	140	0	13
3	2	9	157	0	15
4	3	13	205	0	18
5	4	12	198	0	NA
6	5	10	162	0	20
7	6	11	174	1	25
8	7	8	150	1	24
9	8	9	165	1	13
10	9	10	170	1	15
11	10	12	180	1	18

Once happy with settings, click ok


Stata 13.1
Open
Save
Print
Log
Viewer
Graph
Do-file Editor
Data Editor
Data Browser
More
Break
Search Help
Review
Command
_rc
1 import...
Results
(R)
13.1
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Statistics/Data Analysis
StataCorp
4905 Lakeway Drive
College Station, Texas 77845 USA
800-STATA-PC
http://www.stata.com
979-696-4600
stata@stata.com
979-696-4601 (fax)
Single-user Stata perpetual license:
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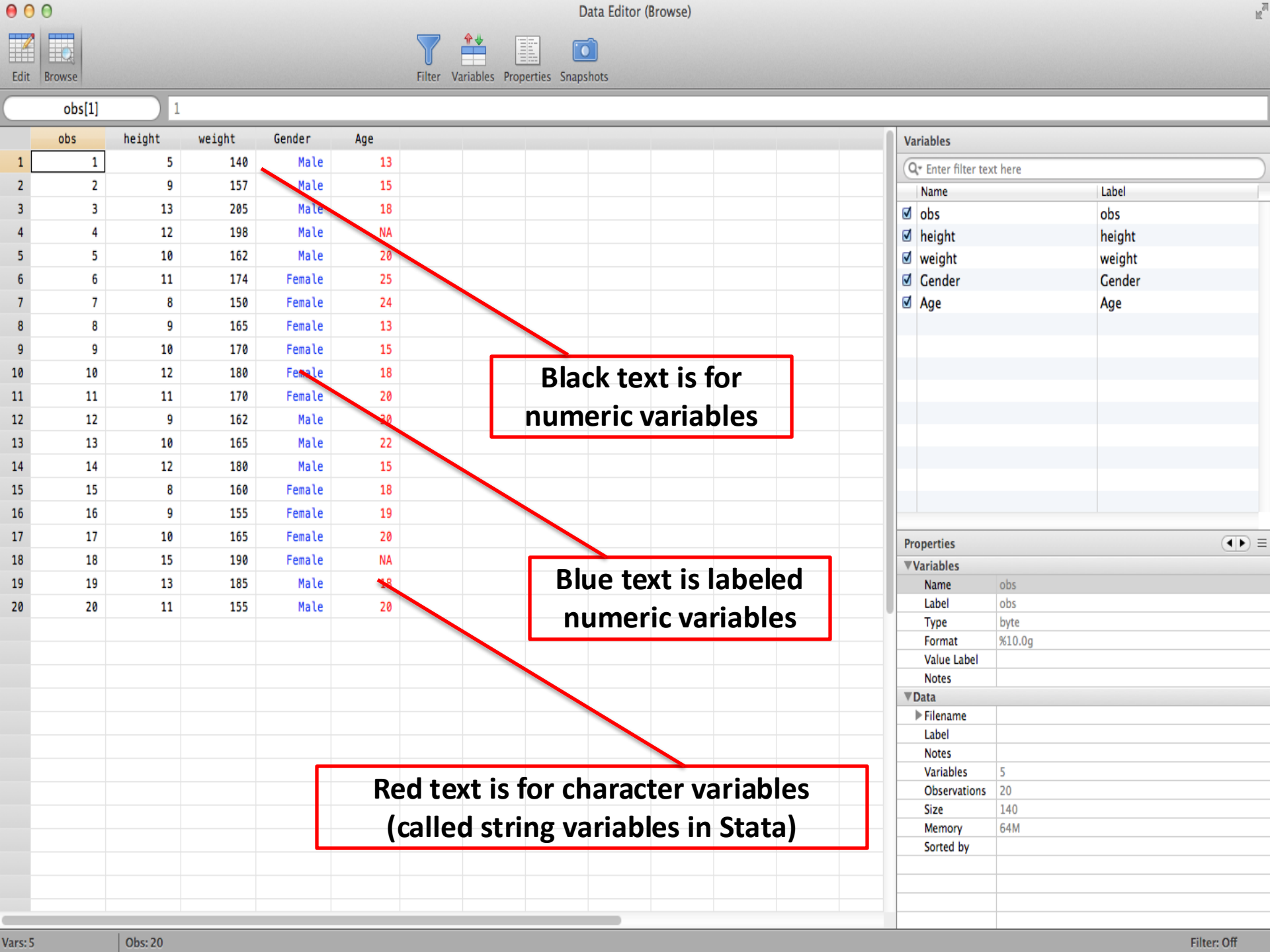
IHPME, University of Toronto
Notes:
. import excel "/Users/adrianrohitdass/Documents/Stata Tutorial/HTWT2.xls", sheet("Sheet1") firstrow
.
Command
Variables
Enter filter text here
Name
obs
height
weight
Gender
Age
Properties
Variables
Name
Label
Type
Format
Value Label
Notes
Data
Filename
Label
Notes
Variables 5
Observations 20
Size 140
Memory 64M
Sorted by
adrianrohitdass
Documents
Stata Tutorial
September 13, 2014

Starting off

Type describe to obtain some useful information about your dataset:

```
Contains data
  obs:            20
 vars:             5
 size:           140
-------------------------------------------------------------------------------
              storage   display    value
variable name   type    format     label      variable label
-------------------------------------------------------------------------------
obs             byte    %10.0g                obs
height          byte    %10.0g                height
weight          int     %10.0g                weight
Gender          byte    %10.0g                Gender
Age             str2    %9s                   Age
-------------------------------------------------------------------------------
Sorted by:
     Note:  dataset has changed since last saved
```

To look at your data, type browse


Data Editor (Browse)
Edit
Browse
Filter
Variables
Properties
Snapshots
obs[1]
1
obs height weight Gender Age
1 5 140 Male 13
2 9 157 Male 15
3 13 205 Male 18
4 12 198 Male NA
5 10 162 Male 20
6 11 174 Female 25
7 8 150 Female 24
8 9 165 Female 13
9 10 170 Female 15
10 12 180 Female 18
11 11 170 Female 20
12 9 162 Male 20
13 10 165 Male 22
14 12 180 Male 15
15 8 160 Female 18
16 9 155 Female 19
17 10 165 Female 20
18 15 190 Female NA
19 13 185 Male 18
20 11 155 Male 20
Black text is for numeric variables
Blue text is labeled numeric variables
Red text is for character variables (called string variables in Stata)
Variables
Enter filter text here
Name Label
obs obs
height height
weight weight
Gender Gender
Age Age
Properties
Variables
Name obs
Label obs
Type byte
Format %10.0g
Value Label
Notes
Data
Filename
Label
Notes
Variables 5
Observations 20
Size 140
Memory 64M
Sorted by
Vars: 5
Obs: 20
Filter: Off

Convert Character variable to Numeric

Make use of Stata's destring command:

destring [varlist] , {generate(newvarlist)|replace} [destring_options]

Eg:

destring age, replace ignore(NA)

Changing Existing variables: **rename**

- Command: **rename**

- changes the name of an existing variable

- Example, rename variable ‘ZGMFX10A’ as ‘height’ **rename** ZGMFX10A height

Working with Labels

label give descriptions to variables or data sets

- To label the dataset in memory:
- **label data** "National Population Health Survey"

- To label a variable:
- **label var** healthstat "Self-Reported Health Status"

- To label different numeric values the variable may take:
- **label define** vlhealthstat 1 "Excellent" 2 "Very Good" 3 "Good" 4 "Fair" 5 "Poor"
- **label values** healthstat vlhealthstat

Obtaining basic summary statistics

- Summarize command: Use to obtain basic summary statistics of 1 or more variables (mean, standard deviation, min, max, etc.)

summarize [varlist] [if] [in] [weight] [, options]

```
. summarize weight height

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         20       169.4    16.32692       140        205
      height |         20       10.35    2.207046         5         15
```

- Correlate command: Creates a matrix of correlation or covariance coefficients for 2 or more variables

correlate [varlist] [if] [in] [weight] [, correlate_options]

```
. correlate  height weight
(obs=20)

             |   height   weight
-------------+------------------
      height |   1.0000
      weight |   0.8620   1.0000
```

tabulate

- command: **tabulate**

- Calculates and displays frequencies for one or two variables

- Syntax:

- **tabulate** varname [if] [in] [weight] [, options]

```
. tab KEYSEX
```

KEYSEX	Freq.	Percent	Cum.
Male	4,599	51.19	51.19
Female	4,385	48.81	100.00
Total	8,984	100.00	

More detailed descriptives

- Use tabstat command

tabstat varlist [if] [in] [weight] [, options]

```
tabstat earnings, s(sum)
```

variable	sum
earnings	**6.7**

- The example above calculates the sum of the variable, but you could specify other statistics as well (median, range, etc.). If you don't specify a particular statistic at the end, then *tabstat* will generate the mean

Creating a new variable: **generate**

- command: **generate**

- Syntax:

- **generate** newvar = exp [if exp] [in range]

- Example:

- **generate** age_sq=age*age

- Notes:

Can type generate or gen for short

Changing Existing variables: **replace**

- Command '**replace**' changes the contents of an existing variable

- Syntax:

  replace oldvar = exp [if exp] [in range]

- **replace** can be using in many circumstances, including
  - Creating binary and categorical variables
  - Fixing values

Ex: Replace responses coded as "no response" (-1 in this case) with missing values

replace variable = . if variable == -1

Create a Binary Variable

- To create a binary variable (0 / 1):

- Generate a variable equal to 0 for all observations
- Replace it to be 1 for selected observations

- Example, create a binary variable for people with income over $80,000:

```
gen highinc=0
replace highinc=1 if hh_inc>80000
```

Recode Variable

- command: recode
- Syntax:

- recode varlist (rule) [(rule) ...] [, generate(newvar)]

- Example

recode sah (1 2 = 1) (3 = 2) (4 5 = 3), gen(sahrecode)

Exploring Missing Values

- Missing values are given by "." in STATA
- To count the number of missing values in all variables in dataset, use user-written command **tabmiss**
  - To install, type findit tabmiss in command window
  - To use, type **tabmiss**
- Important Note: you can use "findit" to install other user written commands, as well as help files for commands in STATA
- Can also use **tab** var, m (one variable)

Saving data

If you've imported data into STATA from a spreadsheet, text file, etc., you may want to save it as a STATA dataset.

- This is particularly useful for large datasets, as STATA can generally read its own datasets faster than importing raw data

- Menu: go File → Save (will give you an option to replace the data if it already exists)
- Syntax: **save** [filename] [, save_options]

Graphing/Plotting Data

- Two-way scatter plot

twoway scatter yvar xvar

- Two-way line plot

twoway line yvar xvar

- Two-way scatter plot with linear prediction from regression of y on x

twoway (scatter yvar xvar) (lfit yvar xvar)

- Two-way scatter plot with linear prediction from regression of y on x with 95% CI

twoway (scatter yvar xvar) (lfitci yvar xvar)

Regression Analysis

Fitting a Linear Model To The Data

General notation:

regress depvar [indepvars] [if] [in] [weight] [, options]

Where:

Y is our *dependent* variable
X is our *independent* variable(s)
Note: You may type “reg” instead of “regress”

Fitting a Linear Model To The Data

Stata Output:

Follows notation (reg *Y X*)

```
. reg weight height
```

Source	SS	df	MS
Model	3763.76056	1	3763.76056
Residual	1301.03944	18	72.2799688
Total	5064.8	19	266.568421

Number of obs	= 20
F(1, 18)	= 52.07
Prob > F	= 0.0000
R-squared	= 0.7431
Adj R-squared	= 0.7289
Root MSE	= 8.5018

weight	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
height	6.377093	.8837324	7.22	0.000	4.520441	8.233746
_cons	103.3971	9.3421	11.07	0.000	83.77006	123.0241

Post Estimation

Post Estimation

- Obtaining residuals

predict residuals, residuals

NB: The “residuals” after predict is just the name you want to give to the residuals. You can change this if you want to

- Obtaining fitted values

predict fittedvalues, xb

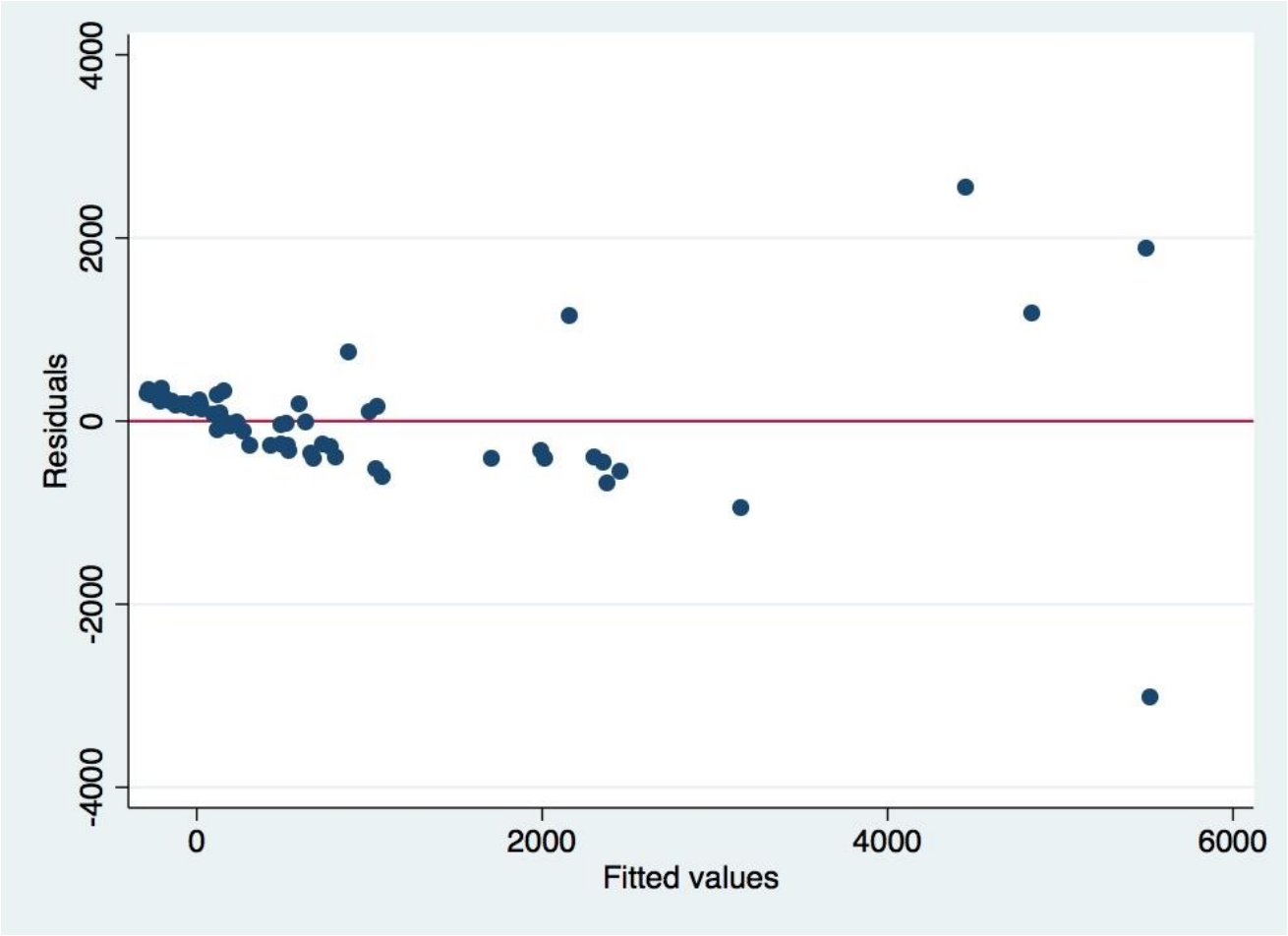
Residual Diagnostic and Heteroskedasticity testing

- OLS regression assumes homoskedasticity for valid hypothesis testing. We can test for this after running a regression
- Examine residual pattern from the residual plot

  rvfplot, yline(0)
- Heteroskedasticity test

  estat hettest

RVF Plot


Residuals
4000
2000
0
-2000
-4000
0
2000
4000
6000
Fitted values

Test for Heteroskedasticity

```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of VOL

         chi2(1)      =   171.05
         Prob > chi2  =   0.0000
```

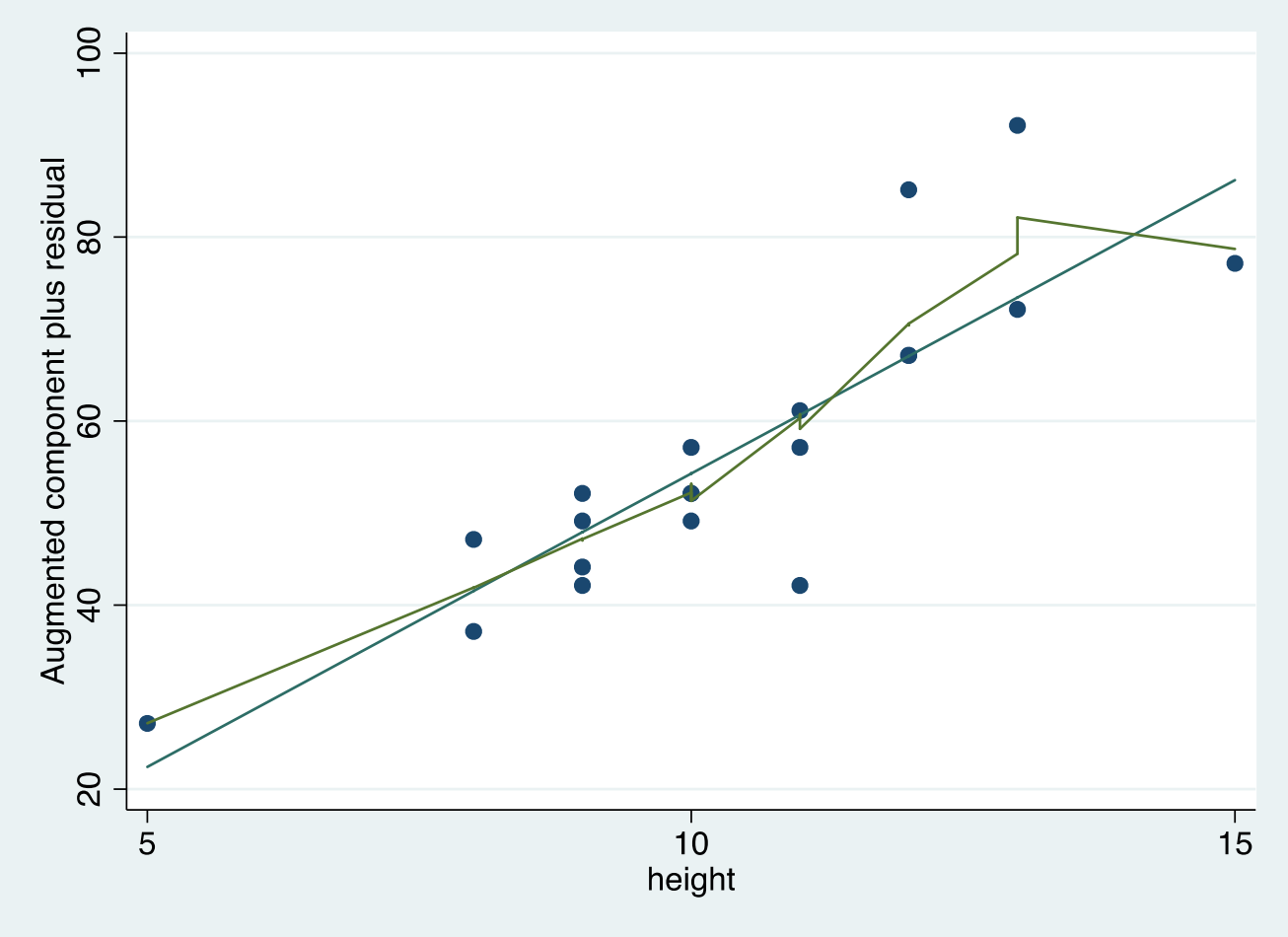
Reject the null (no heteroskedasticity) in favour of the alternative (there is heteroskedasticity of some form).

Linearity testing

- OLS assumes a linear relationship between the Y and X's. We can test for this after a regression:
- Command:

acprplot var, lowess

ACPRPLOT Stata



Testing for multicollinearity

OLS regression assumption: independent variables are not too strongly *collinear*

Detection:

- Correlation matrix

correlate *varlist* (before regression)

- Variance Inflation Factor

vif (after regression)

Specification testing

- To see if there is omitted variables from the model, or if our model is miss-specified
- Syntax: **estat ovtest**

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of crime
       Ho:  model has no omitted variables
                  F(3, 44) =      6.45
                  Prob > F =      0.0010
```

Standard Errors

- Heteroskedasticity-robust standard errors
  - regress y x_1 x_2…x_n, vce(robust)
- Cluster robust standard errors
  - regress y x_1 x_2…x_n, vce(cluster *clusterid*)
- Bootstrapped standard errors
  - regress y x_1 x_2…x_n, vce(bootstrap)

Storing Estimation Results

- STATA can store the results of your regression via the estimates command:

  estimates store *name*
- This can be very useful in analyzing regression results after running multiple models
- estout package (needs to be installed) can be used to create tables from the regression results that can be exported from STATA. To install, type:
  ssc install estout, replace

http://repec.org/bocode/e/estout/esttab.html

Regression commands for other types of outcome variables

- Binary outcomes: probit or logit

(help probit; help probit postestimation)
(help logit; help logit postestimation)

- Ordered discrete outcomes: oprobit or ologit

(help oprobit; help oprobit postestimation)
(help ologit; help ologit postestimation)

- Categorical outcomes: mprobit or mlogit

(help mprobit; help mprobit postestimation)
(help mlogit; help mlogit postestimation)

Panel Data Econometrics

- Pooled Linear Regression

regress depvar [indepvars] [if] [in] [weight] [, options]

- Random Effects

xtreg depvar [indepvars] [if] [in] [, re RE_options]

- Fixed Effects

xtreg depvar [indepvars] [if] [in] [weight] , fe [FE_options]

Other Topics in STATA

Working With Do-Files

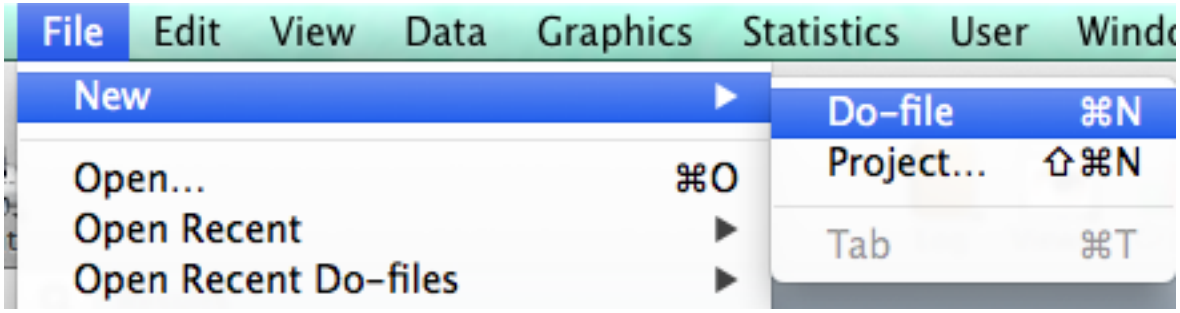
Motivation

Why bother?

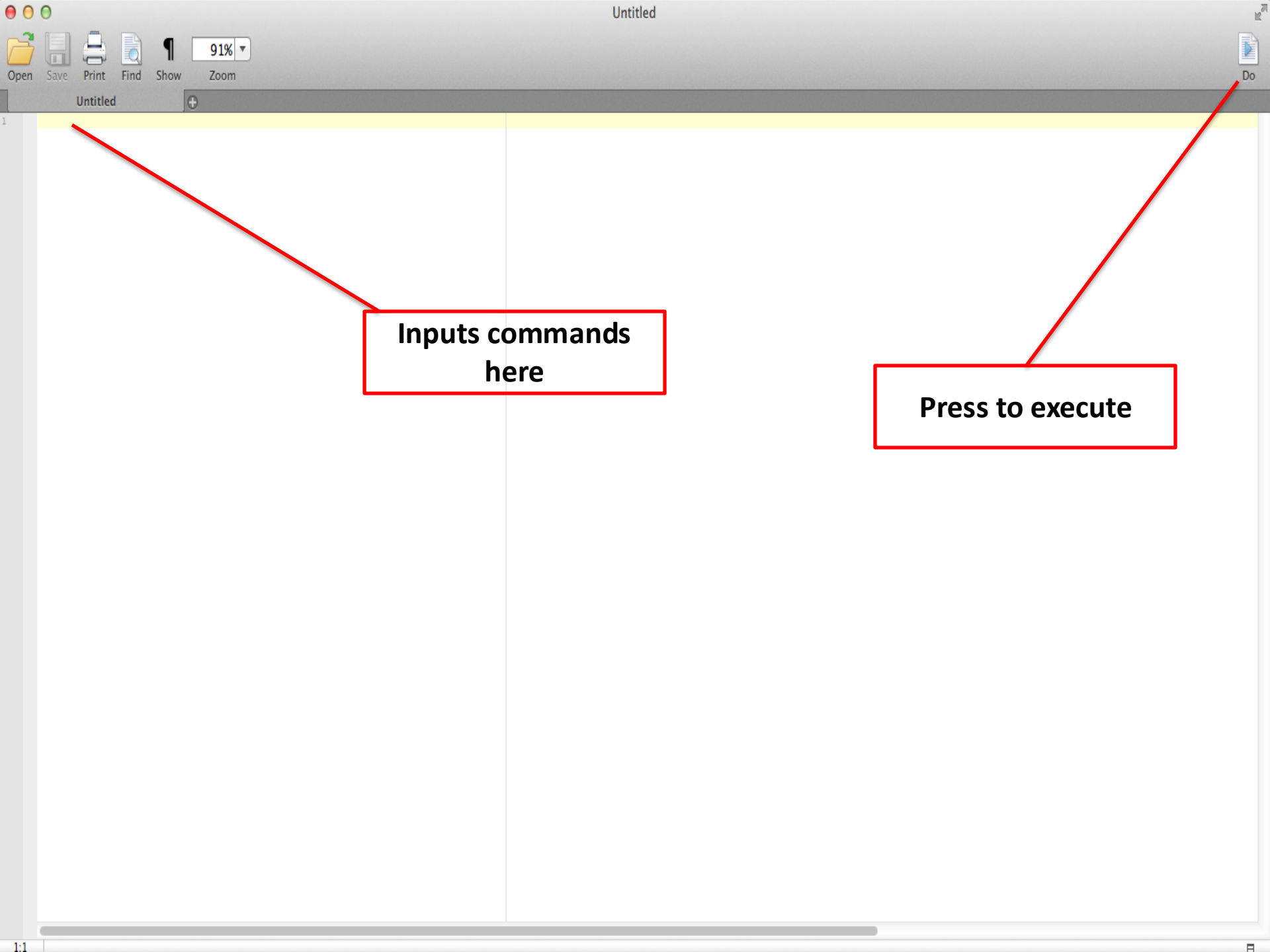
1) We can ovoid tediously running the same set of commands over and over again through the menu/command window
2) Creates a document listing *all* the commands we've run
3) Increases our productivity with STATA!

How to get to do file editor:

- File → New → Do-file



- Or "Do-file Editor" button at top (depending on which version of STATA you have)


Untitled
Open
Save
Print
Find
Show
91%
Zoom
Do
Untitled
Inputs commands here
Press to execute

Clean_panel

Open Save Print Find Show Zoom 91% Do

Clean_panel

```
clear
import excel "/Users/adrianrohitdass/Documents/Stata Tutorial/HTWT1 copy 2.xls", sheet("Sheet1") firstrow

//Rename Variables
rename R0000100 PUBID
rename R0536300 KEYSEX
rename R0536401 KEYBDATE_M
rename R0536402 KEYBDATE_Y
rename R1235800 CV_SAMPLE_TYPE
rename R1482600 KEYRACE_ETHNICITY
rename R2189400 smoke_1998
rename R2563300 income_1998
rename R3508500 smoke_1999
rename R3884900 income_1999
rename R4906600 smoke_2000
rename R5464100 income_2000
rename T6650500 VERSION_R15

//Shape Panel
reshape long smoke_ income_, i(PUBID) j(year)

//Run regression
reg weight height
```

18:23

Applied Example

- Analysis of Health Expenditure Data in Jones et al. (2013) *Chapter Three*
- The data covers the medical expenditures of US citizens aged 65 years and older who qualify for health care under Medicare.
  - Outcome of interest is total annual health care expenditures (measured in US dollars).
  - Other key variables are age, gender, household income, supplementary insurance status (insurance beyond Medicare), physical and activity limitations and the total number of chronic conditions.
- Data can be downloaded from here (mus03data.dta): https://www.stata-press.com/data/musr.html

Code From Applied Example

```
cd "/Users/Desktop/STATA Example" //Change Working Directory

log using "mylogfile.smcl", replace //start log file

clear //remove variables from STATA

use "mus03data.dta" //Load Data

describe //Description of data (output will remain in log file)

table posexp //Frequency table (output will remain in log file)

drop if posexp==0 //Remove individuals with $0 in health expenditures (following example)

*Regression*
reg totexp female income suppins phylim actlim totchr //Regression without age
eststo reg1 //Store results

reg totexp age female income suppins phylim actlim totchr //Regression with age (following example)
eststo reg2 //Store results

rvfplot, yline(0) //RVF Plot
graph export rvfplot.png, replace //Save plot in working directory

estat hettest //Heteroskedasticity test

esttab reg1 reg2 using "myresults.csv", cells(b(fmt(3)star) se(par)) stats (N r2) replace //export results

*Robust regression*
reg totexp female income suppins phylim actlim totchr, robust //Regression without age, HC robust
eststo robust1 //Store results

reg totexp age female income suppins phylim actlim totchr, robust //Regression with age (following example), HC robust
eststo robust2 //Store results

esttab robust1 robust2 using "myresultsrobust.csv", cells(b(fmt(3)star) se(par)) stats (N r2) replace //export results

log close //Close log file
```

mata

mata (continued)

What is mata?

“From STATA manual: Mata is a matrix programming language that can be used by those who want to perform matrix calculations interactively and by those who want to add new features to Stata.”

Source: https://www.stata.com/manuals/m.pdf

To start and stop a mata session:

```
. mata //start mata session
/*Insert STATA mata matrix commands here*/
end // end mata session
```

mata Example Functions

- Create general nxk matrix (named A) with same value across rows and columns

  A = J(n,k,val)
- Create matrix of any dimensions manually (named B)

  B = (0.95,0.05\0,1)
- Extract i*th* row

  A[i,]
- Extract jth column

  A[,j]
- Matrix multiplication

  *
- Element wise multiplication

  :*

For more commands, please see https://www.stata.com/manuals/m.pdf

Applied Example

Markov model with the following transitional probability matrix

H	S	D
0.9	0.08	0.02
0	0.8	0.2
0	0	1

Everybody in the model starts in H

Can we use mata and matrix algebra to solve for the second period health states?

Code for applied example

```
. mata

mata clear

A = J(2,3,0) // 2X3 matrix of 0s (Two time periods, 3 health states)
P = 0.9, 0.08, 0.02\0,0.8, 0.2\0,0,1 //3x3 transitional probability matrix

A[1,] = 1, 0, 0 //Initial health states

A[2,] = A[1,] * P //Health states in period 2

A //Display entire matrix

end
```

Conclusions

- Stata is a widely used software package for data manipulation and statistical analysis.
- Moderate learning curve with user friendly interface.
- Wide array of commands to fit econometric models, with possibility of adding user-written commands to expand functionality.
- Mata programming for working with matrices.

STATA Resources

STATA Online Resources

- STATA manuals are freely downloadable from the above site

http://www.stata-press.com/manuals/documentation-set/

- Typing help [topic] in the command window is also useful, but the online manuals generally contain more detail/examples

STATA Online Resources

UCLA Institute for Digital Research and Education

- List of topics and STATA resources can be found here:

http://www.ats.ucla.edu/stat/stata/webbooks/reg/default.htm

Other STATA Resources

- Jones, A.M., Rice, N., d'Uva, T.B., Balia, S. 2013. Applied Health Economics - Second Edition, Routledge Advanced Texts in Economics and Finance. Taylor & Francis
- Cameron, A.C., Trivedi, P.K. 2010. Microeconometrics Using Stata – Revised Edition, Stata Press books.
- Allison, P.D. 2009. Fixed Effects Regression Models, Quantitative Applications in the Social Sciences. SAGE Publications.
- Wooldridge, J. M. (2010). Econometric analysis of cross section and panel data. MIT press
  - Solutions manual (sold separately) contains STATA code and output

Thanks for Listening

Good luck with STATA!