Introduction to R

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Outline

• Why use R?
• R Basics
• R for Database Management
  – Reading-in data, merging datasets, reshaping, recoding variables, sub-setting data, etc.
• R for Statistical Analysis
  – Descriptive Analysis, Regression Based Approaches
• R Studio
• R 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

<table>
<thead>
<tr>
<th>Software</th>
<th>Interface*</th>
<th>Learning Curve</th>
<th>Data Manipulation</th>
<th>Statistical Analysis</th>
<th>Graphics</th>
<th>Specialties</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPSS</td>
<td>Menus &amp; Syntax</td>
<td>Gradual</td>
<td>Moderate</td>
<td>Moderate Scope Low Versatility</td>
<td>Good</td>
<td>Custom Tables, ANOVA &amp; Multivariate Analysis</td>
</tr>
<tr>
<td>Stata</td>
<td>Menus &amp; Syntax</td>
<td>Moderate</td>
<td>Strong</td>
<td>Broad Scope Medium Versatility</td>
<td>Good</td>
<td>Panel Data, Survey Data Analysis &amp; Multiple Imputation</td>
</tr>
<tr>
<td>SAS</td>
<td>Syntax</td>
<td>Steep</td>
<td>Very Strong</td>
<td>Very Broad Scope High Versatility</td>
<td>Very Good</td>
<td>Large Datasets, Reporting, Password Encryption &amp; Components for Specific Fields</td>
</tr>
<tr>
<td>MATLAB</td>
<td>Syntax</td>
<td>Steep</td>
<td>Very Strong</td>
<td>Limited Scope High Versatility</td>
<td>Excellent</td>
<td>Simulations, Multidimensional Data, Image &amp; Signal Processing</td>
</tr>
</tbody>
</table>

* 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
Goals of Today’s Talk

• Provide an overview of the use of R for database management
  – By doing so, we can hopefully lower the learning curve of R, thereby allowing us to take advantage of its “very strong” data manipulation capabilities

• Provide an overview of the use of R for statistical analysis
  – This includes descriptive analysis (means, standard deviations, frequencies, etc.) as well as regression analysis
  – R contains a wide number of pre-canned routines that we can use to implement the method we’d like to use
Part I
R Basics
R version 3.2.2 (2015-08-14) -- "Fire Safety"
Copyright (C) 2015 The R Foundation for Statistical Computing
Platforms: x86_64-apple-darwin13.4.0 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type "license()" or "licence()" for distribution details.

Natural language support but running in an English locale.

R is a collaborative project with many contributors.
Type "contributors()" for more information and
"citation()" on how to cite R or R packages in publications.

Type "demo()" for some demos, "help()" for on-line help, or
"help.start()" for an HTML browser interface to help.

Type "q()" to quit R.

[GNU GPL v3.0 (2015-08-14) x86_64-apple-darwin13.4.0]
[Workspaces restored from /Users/adrian/Library/RData/autosave]
[History restored from /Users/adrian/Library/RData/R_history]

>
Programming Language

• Programming language in R is *object oriented*
  – Roughly speaking, this means that data, variables, vectors, matrices, characters, arrays, etc. are treated as “objects” of a certain “class” that are created throughout the analysis and stored by name.
  – We then apply “methods” for certain “generic functions” to these objects

• Case sensitive (like most statistical software packages), so be careful
Classes in R

• In R, every object has a *class*
  – For example, character variables are given the class of *factor* or *character*, whereas numeric variables are *integer*

• Classes determine how objects are handled by generic functions. For example:
  – the mean(x) function will work for *integers* but not for *factors* or *characters* - which generally makes sense for categorical (with more than two categories) and ordinal variables)
Packages in R

• Functions in R are stored in *packages*
  
  – For example, the command for OLS (lm) is accessed via the “stats” package, which is available in R by default
  
  – Only when a package is *loaded* will its contents be available. The full list of packages is *not* loaded by default for computational efficiency
  
  – Some routines in R are not installed (and thus loaded) by default, meaning that we will have to install packages that we will need beforehand, and then load them later on
Packages available (and loaded) in R by default

<table>
<thead>
<tr>
<th>Package</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>base</td>
<td>Base R functions (and datasets before R 2.0.0).</td>
</tr>
<tr>
<td>compiler</td>
<td>R byte code compiler (added in R 2.13.0).</td>
</tr>
<tr>
<td>datasets</td>
<td>Base R datasets (added in R 2.0.0).</td>
</tr>
<tr>
<td>grDevices</td>
<td>Graphics devices for base and grid graphics (added in R 2.0.0).</td>
</tr>
<tr>
<td>graphics</td>
<td>R functions for base graphics.</td>
</tr>
<tr>
<td>grid</td>
<td>A rewrite of the graphics layout capabilities, plus some support for interaction.</td>
</tr>
<tr>
<td>methods</td>
<td>Formally defined methods and classes for R objects, plus other programming tools, as described in the Green Book.</td>
</tr>
<tr>
<td>parallel</td>
<td>Support for parallel computation, including by forking and by sockets, and random-number generation (added in R 2.14.0).</td>
</tr>
<tr>
<td>splines</td>
<td>Regression spline functions and classes.</td>
</tr>
<tr>
<td>stats</td>
<td>R statistical functions.</td>
</tr>
<tr>
<td>stats4</td>
<td>Statistical functions using S4 classes.</td>
</tr>
<tr>
<td>tcltk</td>
<td>Interface and language bindings to Tcl/Tk GUI elements.</td>
</tr>
<tr>
<td>tools</td>
<td>Tools for package development and administration.</td>
</tr>
<tr>
<td>utils</td>
<td>R utility functions.</td>
</tr>
</tbody>
</table>

Source: https://cran.r-project.org/doc/FAQ/R-FAQ.html

For database management, we usually won’t need to load or install any additional packages, although we might need the “foreign” package (available in R by default, but not initially loaded) if we’re working with a dataset from another statistical program (SPSS, SAS, STATA, etc.)
Packages in R (Continued)

• To load a package, type `require(packagename)`
  – Ex: To load the foreign package, I would type `require(foreign)` before running any routines that require this package

• To install a package in R:
  – Type `install.packages("packagename")` in command window
  – For example, the package for panel data econometrics is `plm` in R. So, to install the `plm` package, I would type `install.packages("plm")`.
    • Note that, although installed, a package will not be loaded by default (i.e. when opening R). So, you’ll need `require(package)` at the top of your code (or at least sometime before the package is invoked).
  – Some packages will draw upon functions in other packages, so those packages will need to be installed as well. By using `install.packages(" "), it will automatically install dependent packages
Some Basic Operations in R

• Q: If x = 5, and y = 10, and z = x + y, what is the value of z?
• Let’s get R to do this for us:

```r
> x = 5
> y = 10
> z = x + y
> z
[1] 15
```

• In this example, we really only used the ‘+’ operator, but note that ‘-’, ‘/’, ‘*’, ‘^’, etc. work the way they usually do for scalar operations
Some Basic Operations in R

• Now suppose we created the following vectors:

  \[
  \begin{array}{c}
  \text{A} = \\
  1 \\
  2 \\
  3 \\
  \end{array}
  \quad \quad \quad
  \begin{array}{c}
  \text{B} = \\
  2 \\
  4 \\
  6 \\
  \end{array}
  \]

• What is A + B?

  \[
  \begin{array}{c}
  \text{A} = \text{c}(1,2,3) \\
  \text{B} = \text{c}(2,4,6) \\
  \text{Z} = \text{A} + \text{B} \\
  \text{Z} \\
  \end{array}
  \]

  \[
  \begin{array}{c}
  \text{Z} \\
  \text{[1]} \ 3 \ 6 \ 9 \\
  \end{array}
  \]

• Note that with vectors, ‘+’, ‘-’, ‘/’, ‘*’, ‘^’ perform element-wise calculations when applied to vectors. So, vectors need to be the same length.

  In R, \text{c}() is used to combine values into a vector or list. Since we have a list of values, we need to use it here.
Working with Matrices in R

• A matrix with typical element \((i,j)\) takes the following form:

\[
\begin{array}{ccc}
(1,1) & (1,2) & (1,3) \\
(2,1) & (2,2) & (2,3) \\
(3,1) & (3,2) & (3,3)
\end{array}
\]

• Where \(i = \) row number and \(j = \) column number

• In R, the general formula for extracting elements (i.e. single entry, rows, columns) is as follows:
  – matrixname[row #, column #]

• If we leave the terms in the brackets blank (or leave out the whole bracket term) R will spit out the whole matrix
• Example: Suppose we had the following matrix:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

• To create this matrix in R, type:
  > `matrix = matrix(c(1, 2, 3, 4, 5, 6, 7, 8, 9), nrow=3, ncol=3)`

• Extract the element in row #2, column #3
  > `matrix[2,3]`
  8

• Extract the second row
  > `matrix[2,]`
  2 5 8

• Extract the last two columns
  > `matrix[,c(2,3)]`
  4 7
  5 8
  6 9

Since we have a list of columns, we need to use `c()` here
Example: Suppose now we had the following vector, with typical element ‘i’:

\[
\begin{array}{c}
1 \\
2 \\
3 \\
\end{array}
\]

- Extract the third element of the vector
  \[
  \text{vector}[3] = 3
  \]
- Suppose the 2\textsuperscript{nd} element should be 5, not 2. How do we correct this value?
  \[
  \text{vector}[2] = 5
  \]
  \[
  \text{vector} = 1, 5, 3
  \]
But wait a minute...

• Q: If this is a tutorial on the use of R for database management/statistical analysis, then why are we learning about vectors/matrices?

• A: The way we work with data in R is very similar/identical to how we work with vectors/matrices
  – This is different from other statistical software packages, which may be a contributing factor to the “high” learning curve in R

• The importance of vector/matrices operations will become more clear as we move
Part II

R for Database Management
Capability of R with Different Types of Data

• Feature rich software for analyzing various types of data:
  – Cross-sectional data: A collection of individuals (persons, countries, etc.) in one time period. Quite common form of micro-data, like surveys.
  – Time Series Data: Many points in time, but for one individual entity. Usually in aggregated form, like rates or percentages.
  – Panel Data: Combination of cross-sectional and time series data. Ex: survey of the same individuals over many years, or aggregate data on murder rates for each province in Canada over many years.

• R has routines for analyzing virtually any type of data
Reading Data into R

What format is the data in?
• Data from Comma Separated Values File (.csv)
  – Package: utils
  – Formula: read.csv(file, header = TRUE, sep = ",", quote = "\\", dec = ".", fill = TRUE, comment.char = "", ...)  
• Data from Excel File (.xlsx)
  – Package: xlsx
  – Formula: read.xlsx(file, sheetIndex, sheetName=NULL, rowIndex=NULL, startRow=NULL, endRow=NULL, colIndex=NULL, as.data.frame=TRUE, header=TRUE, colClasses=NA, keepFormulas=FALSE, encoding="unknown", ...)  
• Data from STATA (.dta)
  – Package: foreign
  – read.dta(file, convert.dates = TRUE, convert.factors = TRUE, missing.type = FALSE, convert.underscore = FALSE, warn.missing.labels = TRUE)  

Other Formats: See package “foreign”
https://cran.r-project.org/web/packages/foreign/foreign.pdf
Reading Data into R

Examples:

• CSV file with variable names at top
  – `data = read.csv("C:/Users/adrianrohitdass/Documents/R Tutorial/data.csv")`

• CSV file with no variable names at top
  – `data = read.csv("C:/Users/adrianrohitdass/Documents/R Tutorial/data.csv", header=F)`

• STATA data file (12 or older)
  – `require(foreign)`
  – `data = read.dta("C:/Users/adrianrohitdass/Documents/R Tutorial/data.dta")`

• STATA data file (13 or newer)
  – `require(readstata13)`
  – `data = read.dta13("C:/Users/adrianrohitdass/Documents/R Tutorial/data.dta")`
## Comparison and Logical Operators

<table>
<thead>
<tr>
<th>Operator</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>=</td>
<td>Assign a value</td>
<td>x = 5</td>
</tr>
<tr>
<td>==</td>
<td>Equal to</td>
<td>sex ==1</td>
</tr>
<tr>
<td>!=</td>
<td>Not equal to</td>
<td>LHIN != 5</td>
</tr>
<tr>
<td>&gt;</td>
<td>Greater than</td>
<td>income &gt;5000</td>
</tr>
<tr>
<td>&lt;</td>
<td>Less than</td>
<td>healthcost &lt; 5000</td>
</tr>
<tr>
<td>&gt;= or &lt;=</td>
<td>Greater than or equal to</td>
<td>income &gt;= 5000</td>
</tr>
<tr>
<td></td>
<td>Less than or equal to</td>
<td>healthcost &lt;= 5000</td>
</tr>
<tr>
<td>&amp;</td>
<td>And</td>
<td>sex==1 &amp; age&gt;50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
</tr>
</tbody>
</table>
Referring to Variables in a Dataset

• Suppose I had data stored in “mydata” (i.e. an object created to store the data read-in from a .csv by R). To refer to a specific variable in the dataset, I could type

\[ \text{mydata$\text{varname} } \]

Name of Dataset

Name of Variable in dataset

‘$’ used in R to extract named elements from a list
Creating a new variable/object

• No specific command to generate new variables (in contrast to STATA’s “gen” and “egen” commands) but may involve a routine depending on what’s being generated
  – $x = 5$ generates a 1x1 scalar called “x” that is equal to 5
  – $\text{data}\$age = \text{year} – \text{data}\$dob$ creates a new variable “age” in the dataset “data” that is equal to the year – the person’s date of birth (let’s say in years)
Looking at Data

• Display the first or last few entries of a dataset:
  – Package: `utils`
  – First few elements of dataset (default is 5):
    • `head(x, n, ...)`
  – Last few elements of dataset (default is 5):
    • `tail(x, n, ...)`

• List of column names in dataset
  – Package: `base`
  – Formula: `colnames(x)`
Missing Values

Missing Values are listed as “NA” in R

- Count number of NA’s in column
  \[ \text{sum(is.na(x))} \]

- Recode Certain Value’s as NA (i.e. non responses coded as -1)
  \[ x[x==-1] = \text{NA} \]
Renaming Variables (Columns)

A few different ways to do this:

- To rename the ‘ith’ column in a dataset
  
  \[ \text{colnames(data)}[i] = \text{“My Column Name”} \]

- Can be cumbersome – especially if don’t know column # of the column you want to rename (just it’s original name)

- Alternative:
  
  \[ \text{colnames(data)}[\text{which}(\text{colnames(data)} == \text{‘R1482600’})] = \text{‘race’} \]

Grabs column names from specified dataset

Look-up that returns the column #

New column name
Subsetting Data

• Subsetting can be used to restrict the sample in the dataset, create a smaller data with fewer variables, or both
• Recall: extracting elements from a matrix in R
  • `matrixname[row #, column #]`
• What’s the difference between a matrix and a dataset?
  – Both have row elements
    • Typically the individual records in a dataset
  – Both have column elements
    • Typically the different variables in the dataset
• If we think of our dataset as a matrix, then the concept of subsetting in R becomes a lot easier to digest
Subsetting Data (Continued)

Examples:

• Restrict sample to those with age >=50
  > datas1 = data[data$age >=50,]

• Create a smaller dataset with just ID, age, and height
  > Include = c("ID", "age", "height")
  > datas2 = data[,Include]

• Create a smaller dataset with just ID, age, and height; with age >=50
  > Include = c("ID", "age", "height")
  > datas3 = data[data$age>=50,Include]
Recoding Variables in R

• Usually done with a few lines of code using comparison and logical operators
• Ex: Suppose we had the following for age:
  > data$age = [19, 20, 25, 30, 45, 55]

• If we wanted to create a categorical variable for age (say, <20, 20-39, 40-59), we could do the following:
  > data$agecat[data$age <20] = 1
  > data$agecat[data$age >=20 & data$age <40] = 2
  > data$agecat[data$age >=40 & data$age <60] = 3
  > data$agecat
  > [1, 2, 2, 2, 3, 3]
Merging Datasets

Suppose we had the following 2 datasets:

<table>
<thead>
<tr>
<th>Data1</th>
<th>Data2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id</td>
<td>Age</td>
</tr>
<tr>
<td>1</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>63</td>
</tr>
<tr>
<td>3</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>69</td>
</tr>
<tr>
<td>5</td>
<td>52</td>
</tr>
</tbody>
</table>

Our first dataset contains some data on age and income, but not health care costs to the public system. Dataset 2 contains this data, but was not initially available to us. It also doesn’t have age or income.

The common element between the two datasets is “ID”, which uniquely identifies the same individuals across the two datasets.

Note that, for some reason, individual 5 does not have a reported health care cost.
Merging Datasets (Continued)

• Command: merge
  – Package: base

• For our example:
  – Datam = merge(Data1, Data2, by="id", all=T)

– Resulting Dataset

<table>
<thead>
<tr>
<th>Datam</th>
<th>Id</th>
<th>Age</th>
<th>Income</th>
<th>Health Care Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>55</td>
<td>49841.65</td>
<td>188.1965</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>63</td>
<td>46884.78</td>
<td>172.2420</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>65</td>
<td>45550.87</td>
<td>102.8355</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>69</td>
<td>26254.15</td>
<td>150.2247</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>52</td>
<td>22044.73</td>
<td>NA</td>
</tr>
</tbody>
</table>
Part II

R for Statistical Analysis
Descriptive Statistics in R

• Mean
  – Package: base
  – Formula: \texttt{mean(x, trim = 0, na.rm = FALSE, ...)}

• Standard Deviation
  – Package: stats
  – Formula: \texttt{sd(x, na.rm = FALSE)}

• Correlation
  – Package: stats
  – Formula: \texttt{cor(x, y = NULL, use = "everything", method = c("pearson", "kendall", "spearman"))}
Descriptive Statistics (Example)

• Suppose we had the following data column in R (transposed to fit on slide):
  – Vector = [5,5,6,4]

• What is the mean of the vector?

• In R, I would type
  > mean(Vector)
  > 5
Descriptive Statistics (Example)

- Suppose now we had the following:
  - Vector = [5,5,6,4,NA]
- What is the mean of the vector?
- In R, I would type
  > mean(Vector)
  > NA
- Why did I get a mean of NA?
  - Our vector included a missing value, so R couldn’t compute the mean as is.
- To remedy this, I would type
  > mean(Vector, na.rm=T)
  > 5
Tabulations R

• Tabulations of categorical/ordinal variables can be done with R’s `table` command:
  – Package: `base`
  – Formula: `table(..., exclude = if (useNA == "no") c(NA, NaN), useNA = c("no", "ifany", "always"), dnn = list.names(...), deparse.level = 1)`

Ex: Table Sex Variable, with extra column for missing values (if any)

```r
> mytable = table(pdata$sex, exclude=NULL)
> mytable

Female  Male  <NA>
17540  18396   0
```
Graphing Data in R

• Basic plot in R
  – Package: graphics
  – Formula: plot(x, y, ...)

Example:

plot(lmdata$height, lmdata$weight, main = "Plot of Height and Weight", xlab="Height ",ylab="Weight", col=2)
Resulting Graph

Plot of Height and Weight
Ordinary Least Squares

- The estimator of the regression intercept and slope(s) that minimizes the sum of squared residuals (Stock and Watson, 2007).
  - Package: stats
  - Formula: \texttt{lm(formula, data, subset, weights, na.action, method = "qr", model = TRUE, x = FALSE, y = FALSE, qr = TRUE, singular.ok = TRUE, contrasts = NULL, offset, ...)}

Examples:

Regression of “weight” on “height” using dataset “lmdata”

\texttt{ols = lm(weight~height, data=lmdata)}

Online Help File
Ordinary Least Squares

Example: OLS regression of Weight on Height (Univariate Analysis)

```r
# Linear Regression Model Example
> lmdata = read.csv("/Users/adrianrohidass/Google Drive/Introduction to R/Examples Using Data/ex1.csv")
> ols = lm(weight ~ height, data = lmdata)
> summary(ols)

Call:
  lm(formula = weight ~ height, data = lmdata)

Residuals:
   Min     1Q Median     3Q    Max
-18.5451 -3.9467 -0.6108  3.1763 18.7007

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) 103.3971   9.3421   11.068 1.83e-09 ***
height       6.3771    0.8837    7.216 1.03e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 8.502 on 18 degrees of freedom
Multiple R-squared:  0.7431, Adjusted R-squared:  0.7289
F-statistic: 52.07 on 1 and 18 DF,  p-value: 1.031e-06
```
Post-Estimation

Package: `lmtest`
- Breusch-Pagan test against heteroskedasticity.
  `bptest(formula, varformula = NULL, studentize = TRUE, data = list())`
- Ramsey’s RESET test for functional form.
  `resettest(formula, power = 2:3, type = c("fitted", "regressor", "princomp"), data = list())`

Package: `car`
- Variance Inflation Factor (VIF)
  `vif(model)`
Exporting Regression Results

Outputting regression results to look at, modify, or insert into document.

Package: *estout*

Formula: `esttab(t.value = FALSE, p.value = FALSE, round.dec = 3, caption = NULL,label = NULL, texfontsize = NULL, sig.levels = c(0.1, 0.05, 0.01), sig.sym=c("","",""), filename=NULL, csv=FALSE, dcolumn=NULL, table="table", table.pos="htbp", caption.top=FALSE, booktabs=FALSE, var.order=NULL, sub.sections=NULL,var.rename=NULL, resizebox=c(0,0),colInumber=FALSE, store="default")`

NB: This package was designed for LaTeX, but works with excel as well. To export to a .csv, be sure to have `csv = T`

Example:

`esttab(filename = "/Users/adrianrohitdass/Google Drive/Introduction to R/Examples Using Data/out", csv=T)`
Other Regression Models

• Generalized Linear Models
  – Package: glm

• Instrumental Variables
  – Package: AER
  – https://cran.r-project.org/web/packages/AER/AER.pdf

• Panel Data Econometrics
  – Package: plm
  – https://cran.r-project.org/web/packages/plm/vignettes/plm.pdf
Other Regression Models (Continued)

• Linear and Generalized Linear Mixed Effects Models
  – Package: lme4
  – [https://cran.r-project.org/web/packages/lme4/lme4.pdf](https://cran.r-project.org/web/packages/lme4/lme4.pdf)

• Quantile Regression
  – Package: quantreg
  – [https://cran.r-project.org/web/packages/quantreg/quantreg.pdf](https://cran.r-project.org/web/packages/quantreg/quantreg.pdf)
R Studio
What is R Studio?

From R Studio Website:

• An integrated development environment (IDE) for R. Includes:
  – A console
  – Syntax highlighting editor
  – Tools for plotting, history, debugging, and workspace history

• Can think of it as a more user friendly version of R

• Open Source Edition available free of charge

• For more information, see https://www.rstudio.com
Syntax Window

List of datasets/variables

Files, plots, packages, help, and viewer

Command/Results Window
Conclusions

• R has extremely powerful database management capabilities
  – Is fully capable of performing the same sort of tasks as commercial software programs
• R is very capable of statistical analysis
  – Is fully capable of calculating summary statistics and performing regression analysis right out of the box
  – Can install additional packages to perform other sorts of analysis, depending on the research question of the user
• R, and the additional packages available to enhance the use of R, are available free of charge
R Resources
R Online Resources

• A list of R packages is contained here: https://cran.r-project.org/web/packages/available_packages_by_date.html

• By clicking on a particular package, you’ll be taken to a page with more details, as well as a link to download the documentation.

• Typing help(topic) in R pulls up a brief help file with syntax and examples, but the online manuals contain more detail.
R Online Resources

UCLA Institute for Digital Research and Education

• List of topics and R resources (getting started, data examples, etc.) can be found here:

http://www.ats.ucla.edu/stat/r/
Other R Resources

   - Great reference for the applied researcher wanting to use R for econometric analysis. Includes R basics, linear regression model, panel data models, binary outcomes, etc.

2. CRAN Task View: Econometrics
   - A listing of the statistical models used in econometrics, as well as the R package(s) needed to perform them. Available at: https://cran.r-project.org/view=Econometrics
Thanks for Listening

Good luck with R!