Regression Analysis III: Advanced Methods

Syllabus - Summer 2015

Instructor:
Dave Armstrong
Department of Political Science
University of Wisconsin - Milwaukee
e: dave@quantoid.net
Office Hours: 1:30PM-2:30PM M-F (or by appointment)
Course website: http://www.quantoid.net/ICPSRReg3.html

1 Overview and Course Objectives

The Regression III course takes a considerably different form than the first two regression courses at the Summer Program. This course will hopefully prepare you for the things you will encounter when you (attempt to) publish quantitative work with linear models. Initial linear model classes focus on the assumptions and theoretical considerations of linear models and generally walk you through estimation and interpretation. Good courses also deal with diagnostics, though these often get less time than they should. Further, it is not always obvious what violations of these assumptions will lead to in practical terms. This course will provide you with a systematic approach to assessing, fixing and presenting your linear model results. Though we focus almost exclusively on the linear model (we will allude to nonlinear models occasionally), the logic we follow will be helpful in dealing with nonlinear models as well.

This is a class that deals exclusively with observational data - those not collected in experimentally controlled environments. As such, we will spend little time on ANOVA and no time at all talking about concerns that are specific to the analysis of experimental data.

2 Requirements

This course is a practical, data-analytic extension of what you learned in your department's linear models class or the Regression II class at the ICPSR Summer Program. As such, I assume you are familiar with the types of things taught in these courses - Gauss-Markov assumptions, properties of OLS estimators, and statistical inference for linear model coefficients. While I assume this knowledge exists, I will spend time reviewing these ideas briefly in class. If you are not sure where you belong in the series of linear models courses at the Summer Program, please see me or the Summer Program director and we will make sure you end up the most appropriate class.

I recently experimented with allowing participants to use either Stata or R and found, from student evaluations, and from both R and Stata users that the support for both pieces of software was both distracting and unnecessary. Stata users found that it was reasonably easy to pick up R for the purposes of the course. Further, Some of the specific software used in the course does not exist (or exist in the same useful way) in Stata. I found that the implementation in Stata often required some programming (loops, macros, etc...) and that was a threshold many participants did not want to cross. Thus, R will be the only officially supported software. That said, I have Stata code for many of the examples in class and would be happy to share with interested participants. If you want to use this course as an opportunity to strengthen your R skills, but have little familiarity with that software, you should take the R workshop that I teach in the first three weeks of the first session.

If you're one of those "glutton-for-punishment" types, you may also find it useful to learn LaTeX. LaTeXis a system for typesetting documents. People find it most useful for typesetting documents that are heavy on mathematical notation, but this is just the tip of the iceberg. LaTeXhas its own bibliographic software (BibTeX) and will automatically build (and re-build) tables of contents, lists of figures and lists of tables. It also automatically numbers (and re-numbers when necessary) tables, figures and equations, changing appropriately formed references to those objects when table, figure or equation numbers change. Best of all, common LaTeXtypesetting engines are free (see `http://www.latex-project.org/ftp.html` for links to the software appropriate for your OS). Everything I present in class is written in LaTeX; specifically, the slides are all made with a package called "Beamer". There are some nice literate programming tools (Sweave and StatWeave) that integrate LaTeX, R and Stata as well. Further, there are those who see LaTeXas a sort of secret handshake for nerds. So, if you want to be one of the "cool" kids, then you should definitely try it; everyone else is doing it.

3 Course Text(s)

No one text effectively presents all of the material that will be covered in this course. That said, much of the material is covered (and covered well) in:

Fox, John. (2015) Applied Regression Analysis and Generalized Linear Models. *3rd ed.* Thousand Oaks, CA: Sage Publications, Inc.

Fox, John and Sanford Weisberg. (2011) An R Companion to Applied Regression. *2nd ed.* Thousand Oaks, CA: Sage Publications, Inc.

The R Companion is a great book for those currently learning R. I would highly recommend getting the recently update and expanded second edition. This is widely recognized as one of the best ways for Social Scientists to get into R. The Applied Regression book

is a great general purpose regression book. Much of what we talk about will be covered in other regression books. If you've got a particular favorite, then it might be worth supplementing your reading from your chosen regression book with pieces from the Fox book that are not covered by your favorite. Some books that I think are pretty good (depending on your orientation toward visualization, etc...) are:

Gujarati, Damodar N. (2002) Basic Econometrics. *4th ed.* New York: McGraw Hill/Irwin.

Wooldridge, Jeffrey M. (2005) Introductory Econometrics. *3rd ed.* Mason, OH: Southwestern.

Cook, R. Dennis and Sanford Weisberg. (1999) Applied Regression Including Computing and Graphics. New York: Wiley & Sons, Inc.

We will also use a number of other books and articles to deal with more specialized issues. These are listed below (along with the appropriate chapters/pages) for the classes in which we use them.

4 Software

One of R's main virtues from the grad-student point of view is that the base package and all of the add-ons (called packages in R) are free. You can download the base package of R from the Comprehensive R Archive Network (CRAN) website `http://www.cran.r-project.org`. As of this writing, the most recent version is 3.1.2. R is updated a couple of times per year so you'll have to look back here periodically for updates. We will be using a number of user-contributed packages that we will discuss as they become relevant.

4.1 Related Software

A good text editor is invaluable when using R and LaTeX. TeXWorks is a good, free editor for LaTeXthat works in most environments, including Windows and Mac(`http://www.tug.org/texworks/`). RStudio is a free IDE (Integrated Development Environment) for R that includes a nicely-featured text editor (`http://www.rstudio.org/`). There are a couple of pay options that are good general-purpose text editors for Mac and Windows that integrate nicely with LaTeXand R (as well as a bunch of other languages) - WinEDT (`http://www.winedt.com/`), for Windows and TextMate (`http://macromates.com/`) are my favorites, but there are many other options as well.

5 Course Schedule

Each entry represents a single topic. Readings are designated either as suggested (∗) or supplemental (−). For most of you, this is not the only class you are taking and as the weeks fly by, your time will undoubtedly be too limited to read everything indicated in the syllabus. However, this should serve as a nice reference to which you can return if the intricacies of a particular topic have faded from your memory.

1. Preliminary Material (Tuesday, June 23)

   Readings:
   ∗ Fox (2015), Chapters 1 & 2
   ∗ Fox and Weisberg (2011), Chapters 1 & 2
   − Venables and Ripley (2002), Chapters 1-3

2. OLS I: The Basics of Least Squares Regression (Wednesday, June 24)

   (a) Least-squares fit
   (b) Properties of the least-squares estimator
   (c) Statistical inference
   (d) Regression in matrix form

   Readings:
   ∗ Fox (2015), Chapters 5, 6 & 9
   ∗ Fox and Weisberg (2011), Chapter 4
   ∗ Gill (1999)
   ∗ Clarke (2005)
   − Gelman and Stern (2006)
   − Lewis-Beck and Skalaban (1990), Achen (1990), King (1990)

3. OLS II: Effective Presentation (Thursday-Friday, June 25-26)

   (a) Factors and contrasts; quasi-variances and graphical displays
   (b) Interactions and effect displays
   (c) Standardization and relative importance

   Readings:
   ∗ Armstrong (2011)
   ∗ Firth (2003)
   ∗ Berry, Golder and Milton (2012)
   ∗ Brambor, Clark and Golder (2006)
   ∗ Silber, Rosenbaum and Ross (1995)
   − Braumoeller (2004)
   − Firth and Menzes (2004)
   − Kam and Franzese (2007)

4. Lab I: (Monday, June 29)

   (a) Factors and contrasts

   (b) Interactions

   (c) Relative Importance

5. Linearity: Diagnostics, Transformations and Polynomials (Tuesday, June 30)

   (a) Diagnosing linearity through residual plots

   (b) Fixing non-linearity with data transformations and polynomials

   (c) Linearity and ordinal variables

   Readings:
   ∗ Fox (2015) Chapters 4 & 12 (Sections 12.3-12.5)
   ∗ Fox and Weisberg (2011) Chapter 3
   ∗ Jacoby (1999)
   – Cook and Weisberg (1999) Chapter 16
   – Box and Tidwell (1962)
   – Breiman and Friedman (1985*a*,*b*), Pregibon and Vardi (1985), Buja and Kass (1985), Fowlkes and Kettering (1985)

6. Non-Linearity, Smoothing and Splines (Wednesday, July 1)

   (a) Nonparametric Smoothing - Lowess

   (b) Inference for regression smoothers

   (c) Regression Splines

   Readings:
   ∗ Fox (2015) Chapters 17 & 18
   – Fox (2000*b*,*a*)
   ∗ Keele (2008) Chapters 2 & 3

7. Generalized Additive Models (Thursday, July 2)

   (a) Estimation and Backfitting

   (b) Degrees of freedom

   (c) Cross-validation for smoothing parameters

   (d) Diagnostics

   Readings:

   * Fox (2000*a*)
   * Keele (2008) Chapters 4-6
   – Wood (2006)
   – Hastie and Tibshirani (1990)

8. Lab II: (Friday, July 3)

   (a) Non-linearity transformations

   (b) Polynomials

   (c) Smoothers and splines

9. Re-sampling Techniques and Regression (Monday, July 6)

   (a) Bootstrapping and Jackknifing

   (b) Cross-validation

   Readings:
   * Fox (2015) Chapter 21
   * Stone (1974)
   – Efron and Tibshirani (1993)
   – Davison and Hinkley (1997)
   – Ronchetti, Field and Blanchard (1997)

10. Outliers and Influential Data: Diagnostics (Tuesday, July 7)

    (a) Outliers, leverage and influential data

    (b) Hat values, standardized residuals, Cook's D

    Readings:
    * Fox (2015) Chapter 11
    * Fox and Weisberg (2011) Chapter 6 (pp 101-201)
    * Cook and Weisberg (1999) Chapter 15
    – Jasso (1985, 1996), Kahn and Udry (1986)

11. Robust Regression (Wednesday, July 8)

    (a) Breakdown point, influence function and various types of robust regression

    (b) M-estimation (and extension) and iterative re-weighted least squares

    (c) Diagnostics for outliers revisited

    (d) Robust GLMs

    Readings:
    ∗ Andersen (2008)
    ∗ Fox (2015) Chapter 19
    − Cantoni and Ronchetti (2001)
    − Rousseeuw and Leroy (1987)

12. Non-constant error variance and collinearity: Diagnostics and Fixes (Thursday, July 9)

    (a) Residual plots

    (b) ML transformations of Y

    (c) Weighted least squares

    (d) Heteroskedastic linear regression

    (e) Robust standard errors

    Readings:
    ∗ Fox (2015) Chapters 12 & 13
    ∗ Fox and Weisberg (2011) Chapters 3 & 6
    ∗ Long and Ervin (2000)
    ∗ King and Roberts (2014)
    − Harvey (1976)
    − Cribari-Neto (2004), Cribari-Neto, Souza and Vasconcellos (2007), Cribari-Neto and da Silva (2011)

13. Lab III (Friday, July 10)

    (a) Outliers and Robust Regression

    (b) Heteroskedasticity

14. Critiques of the Linear Regression Model (Monday, July 13)

    (a) How important are the assumptions behind OLS Regression?
    (b) How should we appropriately use regression models?
    (c) The importance of sampling to inference.

    Readings:

    * Berk (2003)

15. Model Selection (Tuesday, July 14)

    (a) Theoretical issues in model searching and post-data model construction
    (b) Model selection criteria and multi-model inference.
    (c) Subset selection models

    Readings:
    * Fox (2015) Chapter 22
    * Leamer (1983)
    * Burnham and Anderson (2004)
    * Leamer and Leonard (1983)
    * Box (1976), Box and Hunter (1962)
    – Freedman (1991*b*,*a*), Berk (1991), Blalock (1991), Mason (1991)
    – Miller (2002), Breiman (1992), Breiman and Spector (1992)

16. Finite Mixture Models (Wednesday, July 15)

    Readings:
    * Imai and Tingley (Forthcoming)
    * Grün and Leisch (2008)
    * Grün and Leisch (2007)

17. Missing Data and Multiple Imputation (Thursday, July 16)

    (a) Whats the problem with missing data?

    (b) When can we fix it?

    (c) How do we impute the data and use those imputations?

    Readings:
    * Fox (2015) Chapter 20
    * Mcknight et al. (2007)
    * Cranmer and Gill (2013)
    * Resseguier, Giorgi and Paoletti (2011)
    – Allison (2001)
    – Schafer (1997)
    – Rubin (1987)

18. Lab IV (Friday, July 17)

    (a) Mixture Models

    (b) Missing Data and Multiple Imputation

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Search inside document. Lecture 4: Transformations. Regression III: Advanced Methods. William G. Jacoby Michigan State University. Goals of the lecture. â€¢ The Ladder of Roots and Powers. â€¢ Changing the shape of distributions. â€¢ Transforming for Linearity. 2.Â On Regression Analysis of the Relationship Between Age and Blood Cholesterol on Blood Pressure. Uploaded by. IJSTR Research Publication. Air pollutant yield-loss assessment for four vegetable crops.pdf. Uploaded by. Shakeel Khan. Cervical Cancer Vaccine - Eco No Metrics Project. Lecture 16: Generalized Additive Models Regression III: Advanced Methods Bill Jacoby Michigan State University Goals of the Lecture Introduce Additive Models.Â Poisson Regression Analysis We have so far considered situations where the outcome variable is numeric and Normally distributed, or binary. In clinical work one often. More information. Dimensionality Reduction: Principal Components Analysis. Dimensionality Reduction: Principal Components Analysis In data mining one often encounters situations where there are a large number of variables in the database. Longitudinal Analysis. Empirical Modeling of Social Science Theory: Advanced Topics. Introduction to the R Statistical Computing Environment. Statistics and Data Analysis I: Introduction. Regression Analysis III: Advanced Methods. Pagination. Next page Next â€º. TOEFL IELTSGMATGRESATACTPTEESL Grammar Practice Speaking Practice Writing Submit essays. Contact UsDisclaimer Videos Forums Search My idols My bookmarks. The Regression III course takes a considerably dierent form than the rst two re-gression courses at the Summer Program. This course will hopefully prepare you for the things you will encounter when you (attempt to) publish quantitative work with linear models. Initial linear model classes focus on the assumptions and theoretical consider-ations of linear models and generally walk you through estimation and interpretation.