

ACE 562
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***Lecture 1: Introduction to Econometrics and
Applied Research***

by
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Required Readings:

Griffiths, Hill and Judge. “Why is Econometrics Necessary?” Ch. 1 and “Economic Data Sources, Guidelines for Choosing a Research Project and Writing a Research Report,” Ch. 26 in *Learning and Practicing Econometrics*

Diebold. "Statistical Graphics for Forecasting," Ch. 3 in *Elements of Forecasting* (readings packet)

What is Econometrics?

There is a rich and ever-changing menu of important economic problems

Economic theory helps to solve problems by:

- Identifying important variables
- Illustrating interdependencies between economic variables

Economic theory is a rich source of statements like:

- As income increases, the demand for a normal good increases
- The competitive firm will reduce its output in response to a fall in market price
- In a competitive market, quantity demanded and price are inversely related

While certainly useful, economic theory is not sufficient to address most real-world economic problems

Economic theory, at best, only indicates the direction of change between variables

- Real world problems almost always require prediction of the size of change
- e.g. How much will the farm price of beef increase as average consumer income increases \$100 per week?

There is an overwhelming need for quantitative measurement of economic relationships

Measurement requires the use of economic data to describe what has happened in the past

Challenge: How to combine economic theory with the information supplied by economic data to estimate the relationships needed to solve economic problems?

Definitions of Econometrics

...study of the methods and procedures that can be used to determine numerical values for economic relationships

--- Johnson *et. al.*

...quantitative analysis of actual economic phenomena based on the concurrent development of theory and observation, related by appropriate methods of inference

---Samuelson, *et. al.*

...aims at a conjunction of economic theory and actual measurements, using the theory and techniques of statistical inference as a bridge pier

---Haavelmo

...blends economic theory, statistics, mathematics, and research philosophy to measure economic relationships

---Johnson *et. al.*

...what econometricians do
---Goldberger

Role of Econometrics in Agricultural and Consumer Economics

Emphasis on applied research

Econometrics plays an important role in applied research

Generally, assumed that economic theory plays a dominant role in applied research by providing framework within which relationships are identified and measured

- “Classical Methodology”
- Some controversy on this issue
- Other methodologies have been developed (and debated!)

Format for Applied Econometric Research

1. Problem Definition
2. Literature Review
3. Economic Model Specification
4. Statistical Model Specification
5. Data Collection
6. Selection of Econometric Software Package
7. Descriptive Statistical Analysis
8. Estimation of Statistical Model Parameters
9. Hypothesis Testing
10. Prediction or Policy Evaluation
11. Prepare Report and/or Presentation

1. Problem/Hypothesis Definition

All research begins with a [problem or question!!](#)

Often begins with general directive from a decision-maker in government or business

- Minister of Agriculture needs to know supply response for grain production to determine appropriate price policy
- Public official wants to know sensitivity of food consumption to income changes in order to analyze the need for food subsidies
- President of grain export firm inquires about the import demand function for major consuming countries
- Chief analyst for a market advisory firm is interested in the relationship between corn ending stocks and the price of corn

Research questions also are raised purely by intellectual curiosity

“a continuum of research questions”

intellectual curiosity



basic research

decision-makers



applied research

Problem definition is often the most difficult step in applied econometric research

- Mixture of skill, extensive reformulation of problem, knowledge of existing literature, and luck required to transform a general question into a researchable question or hypothesis
- No simple “recipes”
- Graduate students often find more frustration in this stage than any other
- Ladd, G. “Artistic Tools for Scientific Minds.” *American Journal of Agricultural Economics*. 61(1979):1-11.

2. Literature Review

Must review and understand previous studies related to problem

- New research must build upon findings of earlier studies
- No need to re-invent the wheel!

Literature search requires laborious "detective" work

Bibliographic and citation databases are essential resources

- *Ingenta and Uncover Web*: access to over 20,000 journal tables of contents
(<http://www.ingenta.com/>)
- *EconLit*: economic journals, books and working papers - CDROM or library access at UI
(<http://www.library.uiuc.edu/resource/first.htm>)
- *Social Science Citation Index*: citations to articles in social sciences
(<http://www.library.uiuc.edu/resource/webscien.htm>)

3. Economic Model Specification

Next step is to specify a relevant theoretical economic model

- e.g. Production theory, demand theory, financial theory

Economic model is crucial because it

- identifies variables to include in the analysis
- often predicts direction of relationship between variables

We can think of an economic model as a

- Screening device to sift out what is important
- Roadmap for the analysis

Economic models often are expressed initially in implicit mathematical form

For example

$$Q_w^d = f(P_w)$$

where Q_w^d is the quantity demanded for wheat and P_w is the price of wheat

Comparative statics tell us theoretical direction of change

$$\frac{dQ_w^d}{dP_w} < 0$$

NOTE: Economic models in implicit form are not sufficient for testing hypotheses about key parameters or predicting economic outcomes

4. Statistical Model Specification

A statistical model is based on the observation that economic relations are not exact

- Omission of the influence of innumerable chance events
- Measurement error
- Randomness in human behavior

Add a random error component to the economic model

$$Q_w^d = f(P_w) + e$$

e is known as the error term and it has well-defined probabilistic (stochastic) properties

To complete the specification of the statistical model, the explicit form of the mathematical relationship between the variables must be specified,

$$Q_w^d = \beta_1 + \beta_2 P_w + e$$

- The β 's are unknown constants, called parameters, that tie the relevant variables into an equation
- Linear functional form is widely assumed
- We will use only a linear model in this class

Adding a random error and functional form converts an economic into a statistical model, which gives a basis for statistical inference and economic prediction

Problem: Economic theory does not usually specify the functional form of the equation or empirical definition of variables

Variables such as “consumption”, “price”, and “income” are meaningful in a theoretical model

Statistical model requires variables to be precisely specified in observable terms

Usually, a number of choices are available

Price of pork

- Retail or farm-level?
- National average or specific location?
- Whole animal or processed parts?
- Grade?

No hard and fast rules (tough choices!)

Depends on the objectives of research and results of experimentation with alternative definitions

5. Data Collection

Many sources of data

- US Department of Agriculture is the source for much of data used by agricultural and consumer economists
- Internet resources are becoming more useful

Must understand how data are generated

- Gardner, B. “How Data We Make Can Unmake Us: Annals of Factology.” *American Journal of Agricultural Economics*. 74(1992):1067-1075
- ...*econometricians are often accused of using sledgehammers to crack open peanuts while turning a blind eye to data deficiencies.*

--- Peter Kennedy

Use a worksheet format to input data (often already in this form)

Check for errors!!

6. Selection of Econometric Software Package

This step is usually never discussed in econometrics or research methods courses

In practice, most students simply use the software available in department or the favorite of a professor

If alternatives are available, choice criteria usually are:

- Speed
- User-friendliness
- Latest econometric features

Does it matter which software you use?

From a numerical accuracy standpoint, **YES**

Computers are exceedingly precise and can make mistakes with exquisite precision.

Econometric software has bugs.

---McCullough and Vinod

Numerical accuracy references:

McCullough, B.D. and H.D. Vinod. "The Numerical Accuracy of Econometric Software." *Journal of Economic Literature* 37(1999):663-665.

McCullough, B.D. and B. Wilson. "On the Accuracy of Statistical Procedures in EXCEL97." *Computational Statistics and Data Analysis* 31(1999):27-37.

McCullough, B.D. "Econometric Software Reliability: Eviews, LIMDEP, TSP and SHAZAM." *Journal of Applied Econometrics* 14(1999):191.

McCullough, B.D. "Benchmarking Numerical Accuracy: A Review of RATS v4.2." *Journal of Applied Econometrics* 12(1997):181-190.

Some research suggests exercising care in using EXCEL and other spreadsheet programs for statistical analysis; may want to check results using an econometric package with known numerical accuracy

7. Descriptive Analysis

This step is often overlooked, due to inexperience or laziness!

- May be too easy to go straight to econometric modeling with modern computers and econometric packages
- Need to get a “feel” for the data

Calculate descriptive statistics, such as mean, standard deviation, range, etc.

Despite all of our powerful developments in computer and statistical technology, the [human eye](#) is in many respects a more powerful tool

Sometimes this form of analysis is called [exploratory data analysis](#)

The classic book in this area:

Tukey, J.W., *Exploratory Data Analysis*. Addison-Wesley Publishing Co.: Reading, MA, 1977.

The Power of Graphics

- Graphics helps us summarize and reveal patterns in data
 - Time series plots to understand basic trends
 - Scatterplots to gain basic sense of relationships
- Graphics helps us identify anomalies and errors in data
- Graphics facilitates and encourages comparisons

**“If the math fails, draw a picture!”
---P. Newbold**

8. Estimation of Statistical Model Parameters

The example statistical model is,

$$Q_w^d = \beta_1 + \beta_2 P_w + e$$

where β_1 and β_2 are the unknown parameters of the model

Since, the numerical values of the economic parameters are unknown, they must be estimated using a sample of economic data and an estimation technique

A primary concern of econometrics is discovering the "best" procedure for using the sample economic data to estimate the parameter values

Least squares regression is most widely-used estimation method

9. Hypothesis Testing

After obtaining numerical estimates of statistical model parameters, we will likely want to test specific hypotheses about the numerical estimates

- May be important to know if $\beta_2 < 0$ or $\beta_2 < -1$

We must take into account the element of chance in hypothesis testing since we are dealing with a parameter estimates

- Use standard techniques of statistical inference
- Inference is concerned with the relation between the sample estimates and the true population parameters
- Must understand the concept of sampling distributions!!
- t -tests, F -tests, etc.

10. Prediction or Policy Evaluation

Prediction: Forecast future values of the left-hand side variable

- Quantity demanded for wheat in 2004

Policy: Answer “what-if” questions important to particular policy debates

- Impact on quantity demanded for wheat if price increases due a drought

11. Preparation of Report and/or Presentation

Typical format of research report or paper:

- Statement of the problem
- Review of the literature
- Economic model
- Statistical model
- Data
- Estimation and inference procedures
- Empirical results and conclusions
- Possible extensions and limitations of the study
- Acknowledgements
- References

Some helpful references on writing papers:

Brorsen, B.W. "Observations on the Journal Publication Process." *North Central Journal of Agricultural Economics* 9(1987):315-321.

Hamermesh, D.S. "The Young Economist's Guide to Professional Etiquette." *Journal of Economic Perspectives* 8(1992):153-163.

The Chicago Manual of Style: The Essential Guide for Writers, Editors and Publishers, 14th Edition. Chicago: University of Chicago Press, 1993.

Troyka, L.Q. *Simon and Schuster Handbook for Writers, 5th Edition.* Upper Saddle River, NJ: Prentice-Hall, Inc., 1999.

Elements of Graphical and Tabular Style

Effectiveness of report or presentation is dramatically improved with well-developed graphics and tables

- Producing a good graph or table is like producing good writing...it is a craft that takes discipline and practice
- Poor graphics and tables can destroy the effectiveness of reports and presentations

Three keys to good graphics and tables

1. Know your audience and your goals
2. Show the data and appeal to the viewer
3. Revise and edit, again and again

Showing the data

Avoid distortions that mislead a viewer

Use common scales in graphics or table formats in multiple comparisons

Minimize non-data ink (ink used to depict anything other than data points)

Avoid chart and table "junk"

- Elaborate shadings
- Grids
- Decoration
- Un-necessary axes
- Three dimensional perspective

Appealing to the viewer

Most important, make graphics and tables self-contained

- Should meet the "[stand-alone test](#)": a knowledgeable viewer should be able to understand the graphic or table without consulting the accompanying text, if any

Clearly indicate variables graphed on the horizontal and vertical axes and their respective [units](#)

Clearly [label](#) rows and columns of tables and respective units

[Short](#) but descriptive titles

[Source](#) of data clearly indicated

Avoid mnemonics and abbreviations