

Econometrics

Lecture 1

Nathaniel Higgins

JHU SAIS

- Class
 - Mondays from 6p to 8p in Rome 102
- Office hours
 - By appointment
- My Contact Info
 - nhiggins@jhu.edu
- Course website
 - <http://www.nathanielhiggins.com>
 - (Not a fan of Blackboard, but we'll use it if we have to)
- TA: Robert Tenorio (rtenori2@jhu.edu)
 - TA session time: Thursdays from 4:45-5:45p in the computer lab
 - TA office hours are Tuesdays from 6-8p in ???

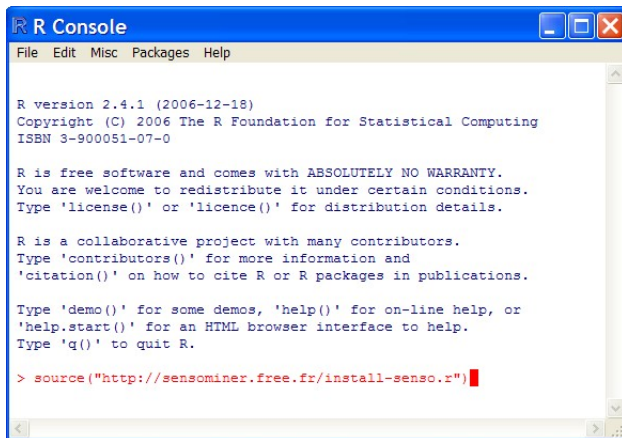
- Required

- Wooldridge, Jeffrey M. (2013). *Introductory Econometrics: A Modern Approach, 5e*. Mason, OH: South-Western CENGAGE Learning.
- R: I recommend installing two versions of R on your machine:
 - 1 R Studio <https://www.rstudio.com/>
 - 2 The standard R GUI <http://www.r-project.org/>
- I also really like Tinn-R as an editor with the standard GUI
- **Team Leada R Bootcamp:**
<https://www.teamleada.com/courses/r-bootcamp>

- Recommended

- KENNEDY, PETER (2008). *A Guide to Econometrics (6th Edition)*. Malden, MA: Blackwell Publishing.

R will be the in-class software



```
R R Console
File Edit Misc Packages Help

R version 2.4.1 (2006-12-18)
Copyright (C) 2006 The R Foundation for Statistical Computing
ISBN 3-900051-07-0

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.

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.

> source("http://sensominer.free.fr/install-senso.r")
```

How you will be evaluated

- Problem sets (approx. 6), dropping lowest grade
 - Throughout semester; not all of the same length, but equally weighted for your grade
 - NOT meant as an explicit exam-prep — exam questions will be written exclusively by me, while homework questions will come from me + book + Leada
- Mid-term exam on/around class 8
- Replication project
 - Due on final exam day
- Final exam date tbd, but targeting last class

Weight	Assignment
15%	Problem Sets
25%	Mid-term exam
30%	Final Exam
30%	Replication Project

Grade	Interpretation	Numerical
A	Outstanding	4.00
A-	Excellent	3.67
B+	Very good	3.23
B	Good	3.00
B-	Pass	2.67
C+	Low Pass	2.33
C	Minimal Pass	2.0
D	Failure	0.0

What you will learn

- Will learn first to be a *consumer* of empirical research
 - Will learn to understand the assumptions on which empirical analyses are based (and so understand which ones you are willing to believe, and which ones make you queasy)
 - Will learn what to be skeptical of
 - Will learn to interpret empirical models and estimation strategies
- Will learn to be a *producer* of basic empirical analysis
 - Learn to use R to manipulate data and produce basic econometric results
 - Learn to use R as a programming language

Assignment details: Replication project

- One grade is subtracted for every day late (A goes to an A-, etc.). Due on day of exam at 12a.
- Update the results of a scholarly article
- Everyone will work on the same paper. 95 % sure it will be:

Horowitz, J. "The Income Temperature Relationship in a Cross-Section of Countries and its Implications for Predicting the Effects of Global Warming." *Environmental and Resource Economics* 44, no. 4 (2009): 475-493.

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 - 2 A **.R-file** containing commands that, when run on *my machine* will create all the results in your main document

Assignment details: Replication project

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 - 1 A Word or PDF document (produced with LaTeX, etc.) that is the core of the project (**main document**)
 - 2 A **.R-file** containing commands that, when run on *my machine* will create all the results in your main document
 - 3 The **source data** that the .R-file (text file) references in order to create the results in your paper

Assignment details: Replication project

- Main document
 - Short document (on the order of 10 pages or *LESS*, including all tables)
 - Replicate all tables in original article, but with your new data
 - Tables will look professional (they should look like the table in the original article)
 - Each table/calculation in the work you are replicating will appear in your paper and, while the tables need not be *identical* in format, your tables should display the results in a manner that is clean and easy-to-compare with the original
 - Have a look at an issue of the *American Economic Review* to see what professional tables should look like
 - Not necessary to reproduce graphics, but doing so might help you to ensure that you understand the data
 - Paper will explain your results, how they were obtained, and the assumptions necessary to obtain them; good idea to highlight any parts of the original paper that you think are strengthened or weakened by your new analysis.

Assignment details: Replication project

- Code (R-file)
 - An R-file (file with extension of “.R”) that produces results as they appear in your main document (verbatim!)
 - This file is nothing but a series of commands; the commands work with data that you will provide as part of the project
 - Code must work on an anonymous machine (more on this later)
- Data
 - You must assemble the data needed so that your programs call the data that you provide to me
 - Document where you obtained data (in the main document)

Assignment details: Problem sets

- Six-ish (more depending on how quickly we move through topics)
- Use R to complete some of them; some of them require paper-and-pencil work
 - Turn these in electronically as .R files
 - Use commands to execute the exercise
 - Answer the narrative parts of the questions using comments (“# comment”)
- Will drop the lowest score
- **Therefore no late problem sets will be accepted**
- All problem sets are due before class in my/Robert's email inbox

Assignment details: Mid-term

- This is a regular old exam — boring, I know
- Just to keep you on track
- We will have a review to get you prepared (likely outside of regular class time)
- Exam on/about class 8

Assignment details: Final

- Cumulative exam
- Given during class
- You will have the class period to complete the work; the final will not be longer than the mid-term

What metrix is

- Econometrics is the combination of statistics (based on probability theory) and model-building (based on economic theory), with a very healthy dose of data assembly and cleaning.
- That probably doesn't mean much to you yet (it wouldn't mean much to me if I was in your shoes)

- Theory of random variables
- We assume we know how a random variable is *distributed*
- Knowing the distribution of a random variable allows us to say how likely getting a particular value (or range of values is)
 - x represents a coin flip (discrete random variable)
 - x represents temperature (continuous random variable)

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 - x represents a coin flip (discrete random variable)
 - x represents temperature (continuous random variable)
- Say something about: the values x takes on, central tendency, variance
- Statistics also offers us some basic tools to describe how multiple variables relate to each other (or “move together”), e.g. basic correlation analysis
- But there are limits to this type of analysis . . .

Model building

- Create a model of behavior
- Combine observations of random and non-random stuff
- We assume that we know something about the *structure* of the behavior, even if we don't know the magnitudes of the relationships

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 - If we believe ... “when taxes go up, GDP goes down, but GDP decreases at a decreasing rate”
 - $gdp = \beta_0 + \beta_1 \text{taxes} + \beta_2 \text{taxes}^2 + u$

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- The model is the *structure* we use to interpret data

- Let's look at an example from my own research

What can we do with Econometrics/Stata?

My research

- One of my research areas is referred to as “discounting” (time preferences)
 - Do people prefer money now or money later?
 - By how much do they prefer it?

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or . . .

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 - Simple question will help you to think about the usual direction of this preference:
 - Would you rather have \$100 now, or \$100 next year?
or . . .
 - How much interest would I have to pay you for you to give me \$100 now

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- *The APR necessary to get a person to forgo money today* is one way to express how much a person prefers money now to money later, in a way that is consistent over different lengths of time

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 - 1 If somebody offers you 5% APR on \$100 principal for one year you get:
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- How to calculate same APR for one year with *daily* compounding . . .

- If somebody offers you 5% APR on \$100 principal for one year you get:

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- $\frac{0.05}{365}$ interest on the total new principal (including your day-one earnings) after the second day, etc. ...
- See Excel example

- So what is APR (for the purposes of this digression)?

- So what is APR (for the purposes of this digression)?
- A consistent way to express the equivalence between an amount of money *now* and an amount of money *later* (at some specified point in the future)
- \$100 now is worth \$105.13 in one year at an APR of 5%

$\$100 \text{ now} = \$105.13 \text{ in one year at } 5\%$

- \$100 now is worth \$103.77 in nine months at an APR of 5%

$\$100 \text{ now} = \$103.77 \text{ in nine months at } 5\%$

- Somebody with a *discount rate* of 5% sees these amounts as equivalent

$$\begin{aligned} \$100 \text{ now} &= \$103.77 \text{ in nine months} \\ &= \$105.13 \text{ in one year} \end{aligned}$$

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- more.

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- The higher the discount rate, the more/less people prefer money now?
- more.higher discount rate \equiv more impatient

My research

Why I care about discount rates

- Some of the largest conservation programs in the U.S. are managed by the USDA
- Why? Because a very large amount of privately owned land is farmland and ranchland
- The USDA manages a host of programs meant to set-aside land for a period of time (to take it out of active cultivation or active use)
- Doing so has a host of environmental benefits
 - Reducing erosion
 - Providing habitat for migratory birds
 - etc.
- The government contracts with private landowners — govt. pays an annual rental rate (often for a period of 10-15 years) and in exchange the landowners agree to, e.g. plant native grasses on their land

- Suppose that instead of offering landowners annual payments, the government offered landowners a single up-front payment
- If the landowners are (on average) more impatient than the government, then the government can save money by offering landowners money up front instead of annually
- Everybody can be better off — the government saves money, and the landowners get a payment schedule that they prefer
- All this will make more sense after you see the numbers

My research

An experiment

- Based on this premise, an experiment was conducted
- We want to know: what are farmers' discount rates?

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- Start with a sample of 291 farmers
- Split the farmers into one of three treatments

	Now payment	Later payment	Implied APR
Treatment 1			
Treatment 2			
Treatment 3			

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- We want to know: what are farmers' discount rates?
- Start with a sample of 291 farmers
- Split the farmers into one of three treatments

	Now payment	Later payment	Implied APR
Treatment 1	\$405	\$430	8%
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Treatment 3			

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Treatment 2	\$405	\$463	18%
Treatment 3			

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- Split the farmers into one of three treatments

	Now payment	Later payment	Implied APR
Treatment 1	\$405	\$430	8%
Treatment 2	\$405	\$463	18%
Treatment 3	\$405	\$498	28%

An experiment

Results

- Think of what the responses mean
- If you offer somebody the choice between \$405 now and \$430 in nine months and they choose \$430, what does that imply?

An experiment

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- If you offer somebody the choice between \$405 now and \$430 in nine months and they choose \$430, what does that imply?
- It implies that their discount rate is *at most* 8% (but it could be much lower)

An experiment

Results

- Think of what the responses mean
- If you offer somebody the choice between \$405 now and \$430 in nine months and they choose \$430, what does that imply?
- It implies that their discount rate is *at most* 8% (but it could be much lower)
- If they choose \$405, it implies that their discount rate is *at least* 8% (but it could be much higher)

An experiment

Results

- So what do you think happened?

Now choices	Total choices	% choosing now

An experiment

Results

- So what do you think happened?

	Now choices	Total choices	% choosing now
\$430			

An experiment

Results

- So what do you think happened?

	Now choices	Total choices	% choosing now
\$430		68	

An experiment

Results

- So what do you think happened?

	Now choices	Total choices	% choosing now
\$430	59	68	86.8%

An experiment

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	Now choices	Total choices	% choosing now
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An experiment

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An experiment

Results

- So what do you think happened?

	Now choices	Total choices	% choosing now
\$430	59	68	86.8%
\$463	44	67	65.7%

An experiment

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- So what do you think happened?

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An experiment

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- So what do you think happened?

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An experiment

Results

- So what do you think happened?

	Now choices	Total choices	% choosing now
\$430	59	68	86.8%
\$463	44	67	65.7%
\$498	44	73	60.3%

An experiment

Results

- So what do you think happened?

	Now choices	Total choices	% choosing now
\$430	59	68	86.8%
\$463	44	67	65.7%
\$498	44	73	60.3%
Total	147	208	70.7%

An experiment

What can we learn from these results?

- A substantial majority of farmers in the sample have discount rates over nine months (approximately the time between when the experiment was conducted — June — and the next growing season) that *exceed* 28%

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- A substantial majority of farmers in the sample have discount rates over nine months (approximately the time between when the experiment was conducted — June — and the next growing season) that *exceed* 28%
- Any idea what the government's borrowing costs over nine months are?

An experiment

What can we learn from these results?

- A substantial majority of farmers in the sample have discount rates over nine months (approximately the time between when the experiment was conducted — June — and the next growing season) that *exceed* 28%
- Any idea what the government's borrowing costs over nine months are?
- Essentially zero

An experiment

What can we learn from these results?



Home > Institutional > Announcements, Data & Results > Latest Auction Data > Recent Bill Auction Results

Recent Bill Auction Results

Security Term	Issue Date	Maturity Date	Discount Rate %	Investment Rate %	Price Per \$100	CUSIP
13-WEEK	02-02-2012	05-03-2012	0.050	0.051	99.987361	9127953N9
26-WEEK	02-02-2012	08-02-2012	0.075	0.076	99.962083	9127955Y3
4-WEEK	01-26-2012	02-23-2012	0.020	0.020	99.998444	912795Z38
13-WEEK	01-26-2012	04-26-2012	0.040	0.041	99.989889	9127955K3
26-WEEK	01-26-2012	07-26-2012	0.070	0.071	99.964611	9127954B4
4-WEEK	01-19-2012	02-16-2012	0.015	0.015	99.998833	912795Z20
13-WEEK	01-19-2012	04-19-2012	0.025	0.025	99.993681	9127955J6
26-WEEK	01-19-2012	07-19-2012	0.060	0.061	99.969667	9127955X5
4-WEEK	01-12-2012	02-09-2012	0.000	0.000	100.000000	9127953C3
13-WEEK	01-12-2012	04-12-2012	0.010	0.010	99.997472	9127955H0
26-WEEK	01-12-2012	07-12-2012	0.050	0.051	99.974722	9127955W7
52-WEEK	01-12-2012	01-10-2013	0.105	0.107	99.893833	9127955V9
4-WEEK	01-05-2012	02-02-2012	0.000	0.000	100.000000	912795Y88
13-WEEK	01-05-2012	04-05-2012	0.015	0.015	99.996208	9127953H2
26-WEEK	01-05-2012	07-05-2012	0.055	0.056	99.972194	9127955U1
4-WEEK	12-29-2011	01-26-2012	0.000	0.000	100.000000	912795Y70
13-WEEK	12-29-2011	03-29-2012	0.025	0.025	99.993681	9127955F4



An experiment

What can we learn from these results?



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Recent Bill Auction Results

Security Term	Issue Date	Maturity Date	Discount Rate %	Investment Rate %	Price Per \$100	CUSIP
13-WEEK	02-02-2012	05-03-2012	0.050	0.051	99.987361	9127953N9
26-WEEK	02-02-2012	08-02-2012	0.075	0.076	99.962083	9127955Y3
4-WEEK	01-26-2012	02-23-2012	0.020	0.020	99.998444	912795Z38
13-WEEK	01-26-2012	04-26-2012	0.040	0.041	99.989889	9127955K3
26-WEEK	01-26-2012	07-26-2012	0.070	0.071	99.964611	9127954B4
4-WEEK	01-19-2012	02-16-2012	0.015	0.015	99.998833	912795Z20
13-WEEK	01-19-2012	04-19-2012	0.025	0.025	99.993681	9127955J6
26-WEEK	01-19-2012	07-19-2012	0.060	0.061	99.969667	9127955X5
4-WEEK	01-12-2012	02-09-2012	0.000	0.000	100.000000	9127953C3
13-WEEK	01-12-2012	04-12-2012	0.010	0.010	99.997472	9127955H0
26-WEEK	01-12-2012	07-12-2012	0.050	0.051	99.974722	9127955W7
52-WEEK	01-12-2012	01-10-2013	0.105	0.107	99.893833	9127955V9
4-WEEK	01-05-2012	02-02-2012	0.000	0.000	100.000000	912795Y88
13-WEEK	01-05-2012	04-05-2012	0.015	0.015	99.996208	9127953H2
26-WEEK	01-05-2012	07-05-2012	0.055	0.056	99.972194	9127955U1
4-WEEK	12-29-2011	01-26-2012	0.000	0.000	100.000000	912795Y70
13-WEEK	12-29-2011	03-29-2012	0.025	0.025	99.993681	9127955F4



An experiment

What can we learn from these results?

- If ...
 - 1 the government can borrow at essentially zero interest and ...

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 - ① the government can borrow at essentially zero interest and ...
 - ② folks prefer money now to money later, then ...
- The government can save money by paying folks now instead of later
- This does not necessarily come at the cost of reducing the welfare of farmers — presumably the farmers want the money now rather than later for some good reason

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- Suppose that farmers on average had a discount rate of exactly 8% over nine months

An experiment

What can we learn from these results?

- Suppose that farmers on average had a discount rate of exactly 8% over nine months
- The government could either pay a farmer \$405 now or \$430 in nine months
- It costs the government less to pay the farmer \$405 now, since the government can borrow money at very low interest rates. I.e. the government saves almost exactly \$25
- If the average farmer has a higher discount rate, the government saves more

Econometrics

What we have done so far

- So, how much money do you think the government could save?
- We would like to know the average discount rate (adr) to help give us a better idea
- We can infer something about the adr by looking at the raw results of the experiment

	Now choices	Total choices	% choosing now
\$430	59	68	86.8%
\$463	44	67	65.7%
\$498	44	73	60.3%
Total	147	208	70.7%

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- Model the probability of choosing *now*

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$$Pr_N = \frac{\left[\frac{1}{\left(1 + \frac{\delta}{365}\right)^{14}} * 405 \right]^\mu}{\left[\frac{1}{\left(1 + \frac{\delta}{365}\right)^{14}} * 405 \right]^\mu + \left[\frac{1}{\left(1 + \frac{\delta}{365}\right)^{270}} * \textit{laterpayment} \right]^\mu}$$

Avg. discount estimation

	ALL
Discount rate (δ)	0.34*** (7.60)
Noise parameter (μ)	0.11*** (3.51)
Observations	208
Log likelihood	-119.8

Robust z-statistics in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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- The following two amounts are equally appealing:
\$405.00 now
\$520.75 later

- Probability basics
- Linear regression modeling with a single variable (OLS basics)
- Statistical inference and hypothesis testing
- Multivariate modeling
- Functional form, goodness of fit
- Dummy variables and treatment effects
- Binary dependent variables
- Endogeneity, omitted variables, etc. (problems with observational data)
- Two stage least squares and Instrumental variables
- Panel data
 - Fixed effects
 - Random effects (need to know GLS to know how this works)
- Time series (very basic)
- Heteroskedasticity

Homework

- Homework is due before class on 14 Sep
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- 1 Read all of appendices A and B. Read *at least* C.1 and C.2 of appendix C. Read more if you can push through. See me if you have difficulty.
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- 5 Do all of R Bootcamp at www.teamleada.com

Next time

- We will go over the homework
- We will begin material contained in chapters 1 and 2 (and some concepts from appendix C)