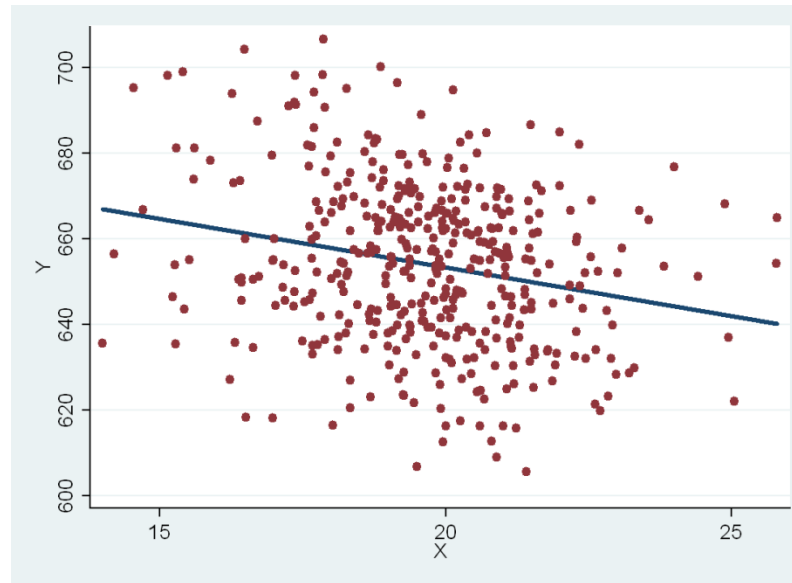


EC3303: Econometrics I



Kelvin Seah

AY 2022/2023, Semester 1

What is Econometrics?

Why Study Econometrics?

Some recent positions for graduates with econometric skills in Singapore...

Some Uses of Econometrics in the Real World

Economists make use of econometric tools to make predictions/ forecasts and to measure causal effects...

E.g. 1: Econometrics at Work in Retail



Target ask its econometrician an odd question:

“If we wanted to figure out if a customer is pregnant, even if she didn’t want us to know, can you do that?”

People’s shopping habits are ingrained. But when people are going through a major life event, their shopping habits become flexible.

Result:

- Identified 25 products linked with pregnancy (e.g. lotions, vitamin supplements, soap, cotton balls, hand sanitizers).
- Estimate a “pregnancy prediction” score.
- Even estimate a person’s due date to within a small window.

Link: http://www.nytimes.com/2012/02/19/magazine/shopping-habits.html?pagewanted=all&_r=0

E.g. 2: Data Analysis in Sports

- Data Analysis for Baseball.



Faced with a limited budget but want a competitive team?

Economic Questions and Data

In this lecture, we will examine:

- Examples of economic questions
- The types of data available to answer them
- The two main challenges we will face:
 - Identifying **causal effects**
 - Running a **randomized controlled experiment**

Question 1: How much do cigarette taxes reduce smoking?

- Smoking is a major public health concern. One tool for cutting consumption is to increase taxes on cigarettes.
- If we want to reduce smoking by a certain amount, say 20%, by raising taxes, then we need to know the **price elasticity** to calculate the price increase necessary to achieve this reduction. But what is the price elasticity of demand for cigarettes?
- To answer the question, you need data that can relate cigarettes taxes to cigarettes consumption.



Question 2: What is the return to education?

- Suppose you want to decide whether to drop out of university. Also suppose your only concern is the income you earn in the future.
- This is a quantitative question: how does another year of education change your future earnings?
- To answer this question, you need data that can relate earnings to years of education.

Question 3: Will reducing the number of modules make students happier?

Ask NUS Economists

Undergrads and the 3am e-mail

Why happiness, including that of students, warrants study

Georgios Georgiou

For The Straits Times

Q Are undergraduates in Singapore happier than the average Singaporean?

A Ask any teacher whether they have received e-mails from students at 3 in the morning and chances are, they would say "yes".

As an educator myself, I always wonder what is keeping these students up and forcing them to e-mail their teacher. It should be emphasised that in my line of work (teaching), very rarely are these e-mails about urgent matters.

The authors just happen to be up at that time, apparently studying. Why are these students still studying at 3am, instead of sleeping?

Could the answer be related to the amount of responsibilities university students have to shoulder?

Since 2012, under the auspices of the United Nations, researchers have been surveying individuals from different countries and tracking their happiness levels on a scale from 0 to 10.

The results have been published from 2012 to this year in an (almost) yearly publication called the World Happiness Report (WHR), which ranks countries based on their average happiness scores.

It may come as a surprise that economists study happiness and not just money, but the so-called "happiness economics" has become popular in recent years through the work of prominent economists such as Amartha Sen, Jouni Paavola and Jeffrey Sachs.



are particularly affluent as well, also manifest relatively low happiness levels. In fact, even lower than Singapore's.

This serves as a frame of reference, but what I am more interested in is understanding the happiness of Singapore's university students.

I collected happiness responses

The fact that the students' happiness is lower than the population average is disconcerting because research has shown that young people are supposed to be happier

uncertainty. In particular, the difference between the national average and the students' average ranged from 0.3 to 1.1 points on the 10-point happiness scale.

It is important to note that these numbers include responses of exchange students, many of whom originate from Nordic countries, famous for their extremely high

stressing about grades, and so on.

Another could be that undergraduates simply have higher expectations about life in general and so report lower happiness levels.

If indeed, the responsibilities of university education cause lower happiness levels in students, then this may be a matter that universities

The lower happiness levels among students could be that university education comes with elevated responsibilities or it could be that these students

- Suppose you are the provost
- You know that reducing the number of modules will affect student happiness...but by how much?

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- To answer this question, you need data that can relate student happiness to the number of modules read by students...

Question 4: What is the *quantitative* effect of reducing class size on student achievement?



THE STRAITS TIMES

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ODS OLIVER DENTAL SURGERY If you are missing a single tooth or a whole bunch of teeth - **Think minidental implants** Click to find out more.

SDP calls for smaller class sizes in education policy paper

Question 4: What is the *quantitative* effect of reducing class size on student achievement?

- Proposals to reduce class size are often the center of policy debate in the public education system (including in NUS!)
- Reducing class size costs money. A decision maker must weigh the costs against the benefits.
- To answer this question, you need data that can relate class size to learning in schools.

www.straitstimes.com/singapore/education/are-smaller-class-sizes-worth-the-trouble

Question 5: What will be the rate of inflation next year?

- This question is of interest to everyone: investors, the government, MAS, and You!
- We are not interested in the nominal returns on our investments, but the real returns.
- So we will be interested in knowing the inflation rate, for say next year.
- To answer this question we need data that can relate past inflation rates to future rates.

Question 5: What will be the rate of inflation next year?

- To answer this question we need data that can relate past inflation rates to future rates.

Singapore's Inflation Rate Over the Years

Year	CPI (annual % change)
.	.
.	.
.	.
2010	2.8
2011	5.3
2012	4.5
2013	2.4
2014	1.0

Source: World Bank, World Development Indicators

Two Important Concepts: Causal Effects and Randomized Controlled Experiments

- The first four questions concern **causal relationships** between variables.
- An action is said to *cause* an outcome if the outcome is the direct result, or consequence, of that action.
- Is it straightforward to estimate causal effects? The general answer is NO, unless we are allowed to conduct **experiments**.

Causal Effects and Randomized Controlled Experiments

- Suppose a plant scientist wants to measure the effect of fertilizer on soybean yield.
- Parallel worlds
- He could conduct an experiment as follows:
- He plants many plots of soybeans. Each plot is attended identically with one exception: some plots (**treatment group**) get 100g of fertilizer per square metre, while the rest (**control group**) get none.

Causal Effects and Randomized Controlled Experiments

- Whether a plot gets fertilized is determined randomly by a computer (like a coin flip).
 - i.e. the treatment is randomly assigned.
- At the end of the season, the harvest from each plot is weighed.
- The difference between average yields per square meter of the treated and untreated plots gives the causal effect, because by design, it is solely due to the application of the fertilizer.

Randomized Controlled Experiments

Does tuition help academic learning?

- How would you design an experiment to study this?
 - randomly assign subjects from the population into two groups at the beginning of the year. In one group, students receive tuition. In the other, students don't.
 - At the end of the semester, administer a test to all students.
 - If average test scores are significantly better in the 1st group than in the 2nd, then tuition is effective.
 - Converse is true.
 - Might differences in test scores between both groups be confounded by differences in their characteristics? No. Randomisation will ensure that the composition of students in both groups are similar so that any differences must be due solely to tuition.

<http://www.straitstimes.com/opinion/kids-with-tuition-fare-worse>

Randomized Controlled Experiment

- *Randomized*: subjects from the population are **randomly** assigned into treatment and control groups.
- *Controlled*: having a control group permits measurement of the treatment effect.

What about Economic Experiments?

- In economics, it is often NOT possible / feasible to perform randomized controlled experiments.
- Experiments are rare, since they may be unethical, impossible to perform satisfactorily, or expensive.
- Think about the returns to education question: would you like your education to be randomly assigned?
- Can we have an experiment to estimate the impact of parental smoking on the health outcomes of children under 12?

Experimental vs. Observational Data

- Experimental data comes from experiments designed to evaluate the policy/treatment effect (e.g., use of fertilizer).
- Observational data is obtained by observing actual behavior outside of an experimental setting.
- The economic data available to economists are almost always, observational.

Observational Data

- Estimating causal effects using observational data can be challenging.
- Think about the fertilizer example. In practice, we have to observe behaviours of farmers (e.g. whether or not they use fertilizer) and yields and see how these are related to estimate how fertilizer use affects yield.
- Can we conclude that the observed difference between the average yields of farmers who use fertilizers and farmers who don't provides us with an estimate of the treatment effect of fertilizer use?

Use fertilizer



Higher yield

Does not use fertilizer



Lower Yield

Observational Data

- Probably not. Because farmers who use fertilizers and farmers who don't may be quite different.
- Farmers who use fertilizers may be more tech-savvy or may care about yields more, for instance.
- And these farmers may use more advanced equipment or provide their plants with more inputs, leading to greater yields.
- So the observed difference in yields between the two groups of farmers may be reflecting these other differences as well.
- These other differences or factors contaminate estimation of the causal effect of fertilizers and are called *confounding factors*.

Observational Data

- Observational data are often collected using surveys (such as MOE's GES), or from administrative records (such as those maintained by IRAS)



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What is the causal effect of an honours degree on earnings?

6,897 fresh graduates and 830 follow-up graduates from NUS were surveyed in November 2021 and the overall response rates obtained were 74.6% and 69.4% respectively.

NUS: 2021 GES Employment Rates¹ and Salaries of Graduates by Bachelor Degree

Degree	Proportion of Graduates in the Labour Force who were		Basic Monthly Salary ⁴		Gross Monthly Salary ⁵			
	Employed ²	In Full-Time Permanent Employment ³	Mean	Median	Mean	Median	25 th Percentile	75 th Percentile
Faculty of Arts & Social Sciences								
Bachelor of Arts	91.4%	70.0%	\$3,405	\$3,200	\$3,600	\$3,200	\$2,850	\$4,100
Bachelor of Arts (Hons)	88.8%	68.3%	\$3,619	\$3,500	\$3,731	\$3,650	\$3,400	\$3,983
Bachelor of Social Sciences	92.5%	78.2%	\$3,757	\$3,531	\$3,850	\$3,600	\$3,400	\$4,100

Does this mean an honours helps one to earn \$400 more per month, on average?

Data: Sources and Types

Whether data are observational or experimental, data sets come as three main types:

- **Cross sectional data:** data on multiple entities – workers, firms, students, etc. – for a single time period.
- **Time series data:** data for a single entity, collected at multiple time periods.
- **Panel data:** data on multiple entities, in which each entity is observed for two or more time periods.

Data: Cross sectional

Student ID	Homework	Midterm	Final	Gender	Height
A0749524	98.25	81	88	M	201
A0769875	100	86	87	M	168
A0727632	99.5	96	92	F	152
A0751427	99.75	88	94	F	169
A0737778	0	36	55	M	175
A0725622	95.5	78	92	F	170
A0744743	96.5	74	78	M	180
A0767022	98	84	87	M	162
A0756043	97.5	86	94	F	161
A0719011	98.5	80	88	F	158
A0728885	99.25	95	92	F	170
A0705437	36.25	70	79	M	175
A0714969	92.5	94	56	F	160

Homework, Midterm, Final Grades, Gender, and Heights (in cm) of 13 hypothetical students in an EC3303 class.

Data: Time Series

Year	GDP per capita	Fertility Rate	Total Population
2005	29869.63	1.26	4265800
2006	31514.37	1.28	4401400
2007	32982.98	1.29	4588600
2008	31832.71	1.28	4839400
2009	30700.47	1.22	4987600
2010	34758.4	1.15	5076700
2011	36154.01	1.2	5183700
2012	36482.65	1.29	5312400
2013	37491.08	1.19	5399200

GDP per capita (2005 USD), Fertility Rate, and Total Population Count for Singapore for the years 2005-2013.

Source: World Bank, World Development Indicators

Data: Panel (Longitudinal)

State	Year	Unemp. Rate	Income	Beer tax	Miles driven	Mortality rate
AL	1982	14.4	10544	1.539	7234	0.0002128
AL	1983	13.7	10732	1.789	7836	0.0002348
AZ	1982	9.9	12309	0.215	6810	0.0002499
AZ	1983	9.1	12693	0.206	6587	0.0002267
AR	1982	9.8	10267	0.65	7209	0.0002384
AR	1983	10.1	10433	0.675	7176	0.0002396
CA	1982	9.9	15797	0.107	6859	0.0001862
CA	1983	9.7	15970	0.103	7216	0.0001807
CO	1982	7.7	15082	0.215	7743	0.0002174
CO	1983	6.6	15131	0.206	7656	0.0002051

Unemployment Rates, Average Incomes (USD), Beer Tax, Miles Driven, and Mortality Rates for 5 U.S. states for 2 years, 1982 and 1983.

The Road Ahead

In this course, we will be concerned with:

- Learning methods to estimate causal effects with observational data.
- Working primarily with cross sectional data, though in the later part when we cover fixed effects, we will also learn a little about panel data (EC3304 Econometrics II will introduce time series analysis and forecasting)
- Applying the methods to real world data using STATA software and interpreting the results.

Announcement

- I have posted a supplementary lecture on statistics, along with this lecture. The lecture is titled “Supplementary Review of Statistics” and can be found in the usual Multimedia” folder of LumiNUS. The lecture slides can be found in the usual “Files” → “Lecture Notes” folder of LumiNUS.
- I highly encourage you to view this lecture, especially if your knowledge of statistics and probability is stale.
- Even if your knowledge of statistics and probability is fresh, I encourage you to go through the supplementary lecture quickly, so you can be familiarized with the notation used for this course.