**Friday exam 2**

**Due date: Monday, May 25, 2020**

Regression discontinuity design

1. A large city has a mental health court where mentally ill defendants can have their charges dismissed. But to get into mental health court, a defendant is first interviewed by a **single therapist**. This therapist uses a rigid interview guide to score each defendant’s mental illness severity on a scale of 1 to 100. Individuals whose score is 60 or higher are immediately placed into the mental health court, and individuals whose score is below 60 bypass mental health court and transition into traditional adjudication. You, the researcher, are interested in the effect that mental health court has on recidivism (i.e., re-committing a criminal offense). Use this information to answer the following questions.
   1. Your colleague says that to estimate the causal effect of mental health court on recidivism, simply compare the recidivism outcomes for people who went through mental health court to those who went through traditional adjudication. Under what assumptions would this simple comparison between the two groups yield a causal effect? Explain your answer both mathematically (using the notation we’ve been using in class) as well as in clear prose.

* From (1) to (2), using the switching equation. From (2) to (3), assuming the treatment is independent of potential outcomes or the treatment is exogenous.
* In words, there is no selection bias. Whatever the potential outcomes are, treatment is randomly assigned.
  1. Do you think that your colleague is right? Would simply comparing the two groups yield a causal effect given your answer in part a? Why/why not?
* No, I don’t think so.
* SDO doesn’t yield a causal effect.
* Because the score which reflects the mental illness severity affects the treatment and outcome, in other words, the score causes the endogeneity in the treatment. Also, there could be other unobservable variables that cause endogeneity in the treatment. Endogeneity violates the assumption of no selection bias.(To avoid the bias in this case, comparing those near the cutoff point given other covariates are placebos yields a causal effect)
  1. But let’s assume that you could use regression discontinuity for this project. What would the running variable be? What is the cutoff? Who is the counterfactual inmate for each defendant in mental health court?
* The running variable is the score of mental illness severity.
* The cutoff is 60.
* The defendant in traditional court is the counterfactual inmate for him/her who is actually placed in the mental health court.
  1. What identifying assumptions do you need for RDD to identify a causal effect? (Express your answer both mathematically using the notation we have developed in class as well as interpret that notation).
* The real function of the running variable jump at certain cutoff due to the treatment effect.
* The potential functions of the running variable are smooth at the cutoff. Or there are no other covariates except for the treatment that jump at the cutoff
* There is no sorting on the running variable.
  1. Say you are worried that therapists are manipulating the data. Maybe they are giving people a 60 if they’re close. What could you do to test that? Describe that procedure.
* I would do a McCrary density test.
* Procedure:

1. Partition the assignment variable into bins
2. Calculate frequencies of units in each bin
3. Treat the frequency counts as the dependent variable in a local linear regression
4. Estimate the conditional expectations, then you have the data on the running variable
5. Based on the null that the density function is continuous at the cutoff point, calculate the test statistics and its p value, reject or fail to reject the null at a given significance level.
   1. Describe what a balance test would look like in this context.

A balance test is to figure out if there are other covariates whose probability of getting treated jump at the cutoff point of the running variable as the treatment variable does.

So in this context, plot the relationship between the probability (percentage) of getting treated by those suspicious covariates and the running variable. Those placebo tests should show no jumps at the cutoff point.

* 1. Write down a regression model that allows for nonlinearities to be modeled both below 60 and above 60.
  2. Describe three figures (pictures) you would need to create for this project. Draw an example of each figure that shows what a valid RDD would look like. For each figure, explain what the figure is doing, and what evidence is and is not consistent with the underlying hypothesis being investigated in that picture.
* Plot the relationship between the recidivism and the mental illness score
* This picture helps us identify if there is a treatment effect.
* The consistent evidence: a jump at certain cutoff point.
* Plot the density of the mental illness score
* This picture helps us identify if there is manipulation on the sorting variable which would bias the causal effect we get.
* The consistent evidence: the density plot is continuous everywhere.
* Plot the relationship between the placebos and the mental illness score
* The picture helps us identify if there are other covariates that jump at the cutoff point which would bias the causal effect we get.
* The consistent evidence: no jump at the cutoff point of the probability of the covariates.

Instrumental variables design

1. Now assume another large city has a mental health court, but this time, the scoring is simpler. Defendants enter a correctional facility through a booking process where they are interviewed by a single officer who follows a strict interview guide (i.e., he has no discretion whatsoever in making a mental illness decision). If the officer who sees them believes they have any mental illnesses, the officer will redirect the inmate to see one of a couple dozen therapists. Therapists see inmates on a first come, first serve basis on when the therapist is working. Some therapists work weekdays during the day, some weekends, some evenings. Therapists are no longer following a strict criteria when interviewing inmates. Rather, they rely on their own subjective judgment, beliefs and training to determine whether the inmate has a mental illness of such severity that it warrants mental health court.
   1. You are interested in using a judge fixed effects design to evaluate the causal effect of mental health court on recidivism. What is the instrumental variable you will use in this project?

The propensity for the therapist to place the inmates in the mental health court.

* 1. List the five assumptions needed for this IV design if there are heterogenous treatment effects. For each assumption, explain what this assumption means in the context of this mental health project itself.
* The IV is independent of the potential treatments and potential outcomes.

In this context: therapists’ propensity is exogenous and random for the judgment and recidivism.

* The IV affects Y only through D(exclude restriction).

In this context: therapists’ propensity is independent of unobservables.

* A stable unit treatment value assumption(SUTVA)

In this context: potential outcomes of each person are unrelated to the treatment status of other individuals.

* The first stage: Z should be correlated with the endogenous variable

In this context: therapists’ propensity should increase the probability of going through the mental health court.

* The monotonicity assumption

In this context: therapists’ propensity operates in the same direction on all individual units.

* 1. Which assumptions can be tested empirically and which ones cannot?
* Not testable
* Independence
* Exclude restriction
* SUTVA
* Monotonicity
* Testable
  + First stage
  1. Describe an example for each assumption that in this mental health court example would *violate* the conditions required by the assumption. Be specific. You can use a DAG to help you.
* Independence

Therapist’s propensity is related to the potential treatments and the potential recidivism.

* Exclude restriction

Therapist’s propensity is related to unobservable variables such as living in a neighborhood of a high crime rate, IV affects Y through this new path in addition to Z D Y.

* SUTVA

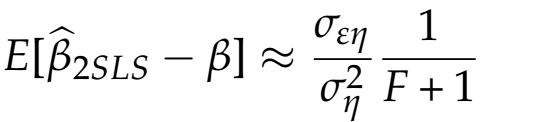
One individual unit’s potential recidivism depends on if another individual is placed in to the mental health court.

* Monotonicity

Therapists show leniency for certain group of individuals and place them in the mental health court while are hash for other individuals and place them in the traditional court.

* First stage

Therapist’s propensity affects the judgment of mental health court weakly.

* 1. Write down the estimating equation(s) you will use for this IV design if you used 2SLS.
  2. What parameter are you estimating with 2SLS? How does it differ from the ATE or the ATT?
* is subject to compliers because of the heterogeneity in the individuals, thus only applies to subsamples while ATE is the average treatment effect over the whole sample. On the other hand, is subject to compliers who could be treated or untreated, thus applies to subsamples who could be treated or untreated while ATT is the average treatment effect over the whole treated sample.
  1. Let’s say that your instrument might suffer from a weak instrument problem. Write down an equation showing the bias that this will create. How can you test whether this bias is a problem?
* 
* Check F in the first stage, If the first stage is weak, then F 0, then the bias of 2SLS approaches . But if the first stage is very strong, F ∞, then the 2SLS bias goes to 0.

Empirical exercise: Fulton Fish Market

The Fulton Fish Market is an open air market in New York City, second in size only to another open market fish market in Japan. Fish are heterogenous across every conceivable dimension – size, type, for instance. Graddy hand collected data on fish sales and was interested in estimating the price elasticity of demand by instrumenting for supply using various measures at sea.

1. You are interested in estimating the price elasticity of demand according to the following equation

Where ln q is the natural log of quantity of fish sold measured in pounds, ln p is the average price per pound and X a series of day of week fixed effects. Be sure to create new variables corresponding to ln q and ln p. The data for this can be downloaded at the following Github URL:

https://storage.googleapis.com/causal-inference-mixtape.appspot.com/fish.dta

* 1. As before, create a repository at Github with directories arranged as we’ve been discussing in class so far. Write down the link to your repository. You will only receive credit for this part if you have placed your programs in a separate directory as your data which is in a separate directory as your assignment which is itself in a separate directory as your tables.

https://github.com/Emily-mu/fish.git

* 1. Run the above OLS regression and report the coefficient on ln p. Explain why this is not the causal parameter, the price elasticity of demand.
  + -0.525\*\*\*
  + Because the (p, q) data are not from a fixed demand curve where the elasticity defines, they are combinations of equilibrium where the demand curve intersects with the supply curve and both of them are subject to shifting left or right due to the change of some covariates.
  1. Estimate two stage least squares twice: the first time use *wave2* as an instrument for log price, and the second time use *speed3.* Interpret the coefficients. Are fish elastic or inelastic?
* -0.84102, by using wave2 as the IV, increasing the price by 1% causes the quantity to decease by 0.84%.
* -1.5668, by using speed3 as the IV, increasing the price by 1% causes the quantity to decease by 1.57%.
  1. Run the first stage for each model. Interpret the coefficient on the instrument. Report F statistics on the first stage of each model. Are either of these instruments weak? Which instrument do you prefer and why?
* 29.228\*\*\*, by using wave2 as the IV, strong.
* 9.942\*\*, by using speed3 as the IV, not weak.
* I prefer wave2, because the relationship between speed3 and log(price) is less strong than the one between wave2 and log(price). The larger the F value, the smaller bias of the 2SLS estimator, the more credibility of the causal effect.