Peer Effects and Academic Achievement

A Regression Discontinuity Approach

Arna Vardardottir

Stockholm School of Economics

arna.vardardottir@hhs.se

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Outline

Introduction

- General research question: Do peers matter when it comes to academic achievement?
- Generally accepted that peers do matter but no general consensus on the direction of the effect peers have on one another.
- Different theories attempt to explain this and according to some of them the average ability of classmates has detrimental effect on one's schooling outcomes while others imply that it enhances one's achievements (Marsh, 2005).

Introduction (cont'd)

The exact causal mechanism of peer effects in education is ambiguous.

- One possible, and most direct, channel for peer effects is that students instruct each other.
- Other possible channels are for instance classroom disruption and classroom atmosphere.

Students could also be indirectly affected by their peers:

- Can for instance come about through the way teachers react to different groups of students.
- Also, if students are sorted into classes based on their ability it might allow teachers to match instructions more closely to students' needs because of more homogenous group.

Primary purpose: establish empirically the existence and direction of peer effects, not to distinguish the channels by which peer effects operate.

Identification problem

- The reflection problem: If a student's peers have unobserved characteristics that are systematically related to her own, estimation of peer effects cannot be given a causal interpretation.

Identification problem

- Why do students who belong to the same group tend to Behave similarly?
- 3 effects that all could explain this.
- Endogenous effects: the propensity of a student to do well varies with the prevalance of high academic achievement in the group.
- Correlated effects: individuals in the same group tend to behave similarly because they face similar environments and have similar personal characteristics.
- Exogenouos (or contextual) effects: individuals in the same group tend to behave similarly because of exogenous characteristics to the group.

Identification problem

- Even in the absence of correlated effects there is a reflection problem.
- The reason is that behavior is determined by behavior and hence there is a circularity of cause and effect.
- This hinders the identification of the endogenous effect from the exogenous effect.

Literature

On peer effects in schools:

- Several studies have exploited random assignment to groups to overcome the reflection problem and identify the causal effect of peers' ability. For example, Sacerdote (2001), Zimmerman (2003) and Duflo et al. (2008).
- Random class assignment not that common in higher education.
- Must resort to other methods to identify a causal effect of peers' ability in observational studies.

My contribution

- Use a regression discontinuity (RD) design to estimate the causal effect on student's achievement.
- Data from an Icelandic high-school.
- Student assignment into HA classes based on grades constitutes the source of identifying information.
- To the best of my knowledge, this study is the first to estimate causal effect of classmates using a fuzzy RD approach.

Outline

Educational system in Iceland

- Compulsory education is organised in a single structure system, i.e. primary and lower secondary education form a part of the same school level, and generally take place in the same school. The law concerning compulsory education stipulates that education shall be mandatory for children and adolescents between the ages of six and sixteen.
- Upper secondary education is not compulsory, but anyone who has completed compulsory education has the right to enter a course of studies in an upper secondary school. Students are usually 16-20 years of age.

Educational system in Iceland (cont'd)

- General academic education is primarily organised as a four-year course leading to a matriculation examination.
- At the time of the study, students had to take standardized exams in Mathematics, Icelandic, English and Danish by the end of 10th grade in order to get into an upper secondary school. The grades from these exams and their grades from their primary school determined into which school they got.

The school

- Data on 5 years (1995-1999) of entering students at the Commercial College of Iceland in Reykjavik.
- The data set consists of 1353 students, 644 female and 709 male.
- The Commercial College of Iceland is a four-year senior high school / college for students who have completed the Icelandic compulsory education.
- In their first year all students follow a common curriculum.
- Each class spends the entire school day together.

Selection into classes

- Selection into classes mainly based on students' assignment grades (Mathematics, Icelandic, English and Danish on the standardised tests for 10^{th} grade and the school grades in these subjects).
- Approximately 270 incoming students each year that are assigned to 10 different classes.
- Students assigned to 3-4 HA classes and the rest is randomly assigned into classes.
- Students above the 60^{th} or 70^{th} percentile of the assignment grade are much more likely to end up in HA classes than those below it.

Selection into classes (cont'd)

- The same teachers teach HA classes and normal classes, they cover the same material and take the same exams.
- The only difference between normal and HA classes: HA classes have peers of higher academic ability.
- Tracking into high-ability classes can be used to identify the effect of peers because the rule induces a discontinuity in the relationship between assignment grade and class average grade at the assignment threshold.

Outline

Identification

- A discontinuity in the probability of being assigned to a HA class at the 60^{th} or 70^{th} percentile of the assignment grade.
- Students slightly below the threshold provide the counterfactual outcome for students slightly above.
- Effects of classmates on academic outcomes can be estimated by comparing outcomes for the students whose grades are just below and just above the threshold of getting into a HA class since they on average will have similar characteristics except for the treatment.

Assignment probabilities

Probability of being assigned to a HA class is given by

$$E[H_{itc}|A_{itc}] = Pr[H_{itc} = 1|A_{itc} = a_{itc}] =$$

$$\gamma + \delta \cdot 1\left(\frac{a_{itc} - s_t}{\sigma_{at}} \geq 0\right) + g\left(\frac{a_{itc} - s_t}{\sigma_{at}}\right),$$

where $g(\cdot)$ is a control function, i.e. some low order polynomial in normalised assignment grade, $\frac{a_{itc}-s_t}{\sigma_{at}}$. H_{itc} is a treatment dummy taking the value one if student i in year t and class c was assigned to a HA class and zero otherwise. A_{itc} is the assignment grade of student i in year t and class c.

Assignment into classes

Assignment to HA classes can be represented by

$$H_{itc} = Pr[H_{itc} = 1 | A_{itc} = a_{itc}] + u_{itc}$$

where u is an unobserved component which captures everything else influencing the class assignment decision.

Academic achievement

Academic achievement of students:

$$Y_{itc} = \alpha + \gamma_t + \beta X_c + \tau H_{itc} + f\left(\frac{a_{itc} - s_t}{\sigma_{at}}\right) + \epsilon_{itc}, \qquad (1)$$

- Y_{itc} is an outcome variable for individual i in year t and class c, γ_t is a year specific effect and X_c is a vector of class characteristics.
- The effect of assignment grade is captured by $f\left(\frac{a_{itc}-s_t}{\sigma_{at}}\right)$, i.e., it is supposed to be an adequate description of $E[Y_{0itc}|A_i]$.
- Since classtypes are not randomly assigned, it is likely to be correlated with the error component. OLS estimates of (1) will therefore not have any causal interpretation.

Solving the evaluation problem

- H instrumented with the cutoff indicator C, since it captures higher probability of being in a HA class at the assignment threshold.

$$C_{itc} = \begin{cases} 0 & \text{if} \quad a_{itc} < s_t \\ 1 & \text{if} \quad a_{itc} \geq s_t \end{cases}$$

Key identification assumption underlying RD

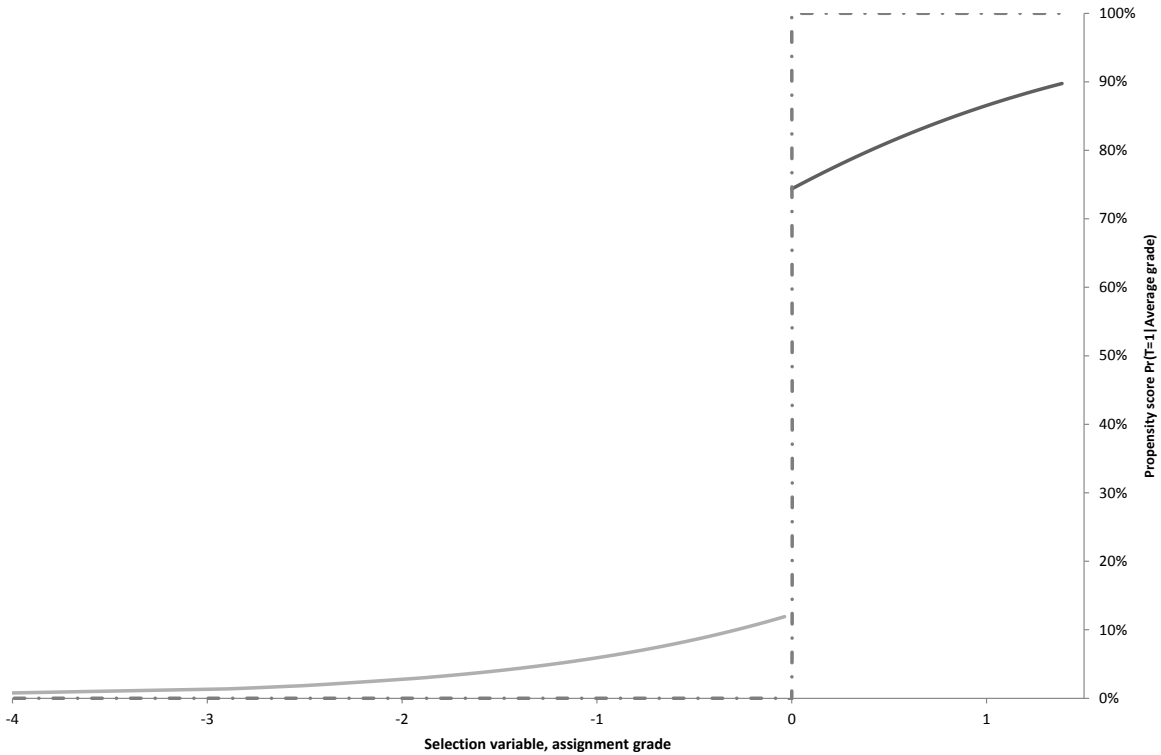
- $f(\cdot)$ is continuous.
- Intuitively this requires that differential assignment into classes is the only source of discontinuity in outcomes around the assignment threshold, s_t, so unobservables vary smoothly as a function of assignment grade.
- In particular, unobservables do not jump at the cutoff.
- Under this assumption the treatment effect τ is obtained by estimating the discontinuity in the empirical regression function at the point where the HA class instrument, C, switches from 0 to 1 at the assignment threshold and can be given a causal interpretation.

Outline

First assumption when applying RD

- Must have an observable assignment variable on which assignment is based and a discontinuity at some cutoff value of the assignment variable in the level of treatment.
- Here: the assignment variable is the assignment grade and the threshold is the assignment grade at the 60^{th} or the 70^{th} percentile (depending on which year we consider).

Assignment into HA classes in 1995-1999



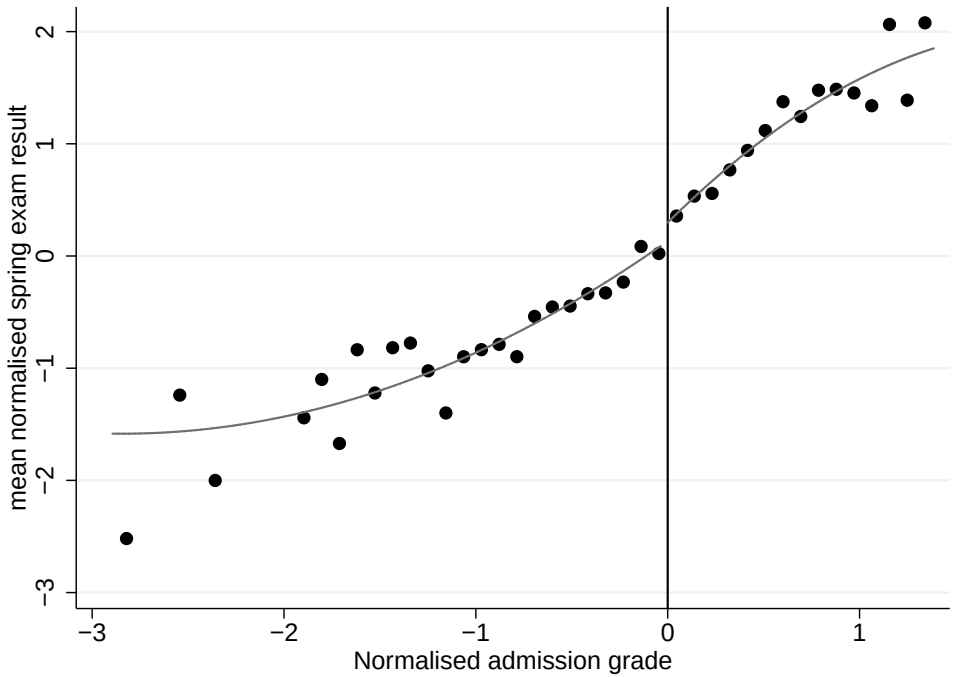
First assumption

Shows that the assignment rule fits the treatment allocation rule of the fuzzy RD design: The assignment as a function of the normalised assignment grade, $\frac{A-S}{\sigma_A}$, contains a jump at a known threshold value for $\frac{A-S}{\sigma_A}$, namely 0, so this first assumption is fulfilled.

First exploration for a possible effect

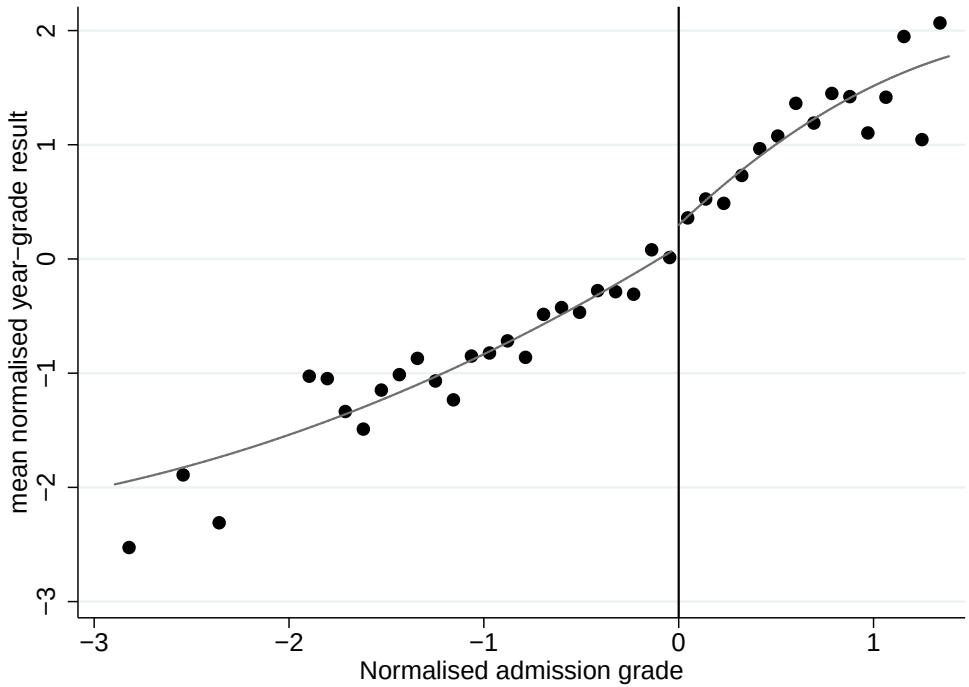
- Plot the average grades by the end of the first year as a function of the average assignment grade and see whether it exhibits similar trend around the threshold value.
- Done by using binned local averages, i.e. the assignment grade is binned so that all grades between x and y were assigned the assignment grade of $\frac{x+y}{2}$, grades between y and z were assigned the assignment grade of $\frac{y+z}{2}$, and so forth.
- Done both for spring exam results and year grade.

First exploration for a possible effect (cont'd)



Spring exam results as a function of assignment grades in 1995-1999, using binned local averages

First exploration for possible effect (cont'd)



Year grade results as a function of assignment grades in 1995-1999, using binned local averages

First exploration for possible effect (cont'd)

- The figures suggest that there is a discontinuity in normalised spring exam result and year grade around the assignment threshold.
- They present therefore evidence that academic achievement, as measured by spring exam results or year grade, is affected by being assigned into a HA class.

IV regressions of academic achievement on class-type

	1	2	3	4	5
Spring exam result	0.367***	0.246***	0.224**	0.306	0.290
	(0.0936)	(0.0930)	(0.1033)	(0.1897)	(0.1897)
Year grade result	0.333***	0.235***	0.224***	0.312*	0.312*
	(0.0898)	(0.0796)	(0.0868)	(0.1706)	(0.1777)
Sample	Full	Full	Full	+/− 5	+/− 5
Transformed assignment grade polynomial	First	Second	Third	First	Second
Controls	No	No	No	No	No
	6	7	8	9	10
Spring exam result	0.213**	0.290	0.273	0.185*	0.549
	(0.0988)	(0.1818)	(0.1811)	(0.995)	(0.6245)
Year grade result	0.221***	0.303*	0.304*	0.184*	0.084
	(0.0856)	(0.1695)	(0.1769)	(0.1845)	(0.5569)
Sample	Full	+/− 5	+/− 5	+/− 10	+/− 2.5
Transformed assignment grade polynomial	Third	First	Second	Second	Second
Controls	Yes	Yes	Yes	No	No

Standard errors are clustered at the class level and are within parentheses. Each entry is separate regression. The full sample includes 1290 observations. The $+/-5$ sample includes all observations that are in the range of $[-0.5, 0.5]$ of the shifted assignment grade and there are 712 such observations. The $+/-10$ sample includes 1136 observations. The $+/-2.5$ sample includes 422 observations. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Interpretation of results

- The treatment effect is quite large.
- The difference between the normalised assignment grade of normal- and high-ability classes is 0.55 but the treatment effect for spring exam results and year grade is approximately 0.213-0.246 and 0.221-0.235, respectively.
- My estimates suggest that a 1 standard deviation increase in the average ability of peers would increase one's own outcomes by approximately 0.42 standard deviations.
- The previous literature finds peer effects that range from close to zero (Sanbonmatsu et al., 2004) to about 0.5 standard deviations for a one standard deviation change in the peer measure (Hoxby 2000; Boozer and Cacciola 2001).
- My results fall within this range but are close to the upper end. Consistent with the fact that the estimated peer effects

Thank you very much for your attention!