

# Effects of Early Warning Emails on Student Performance

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# Outline

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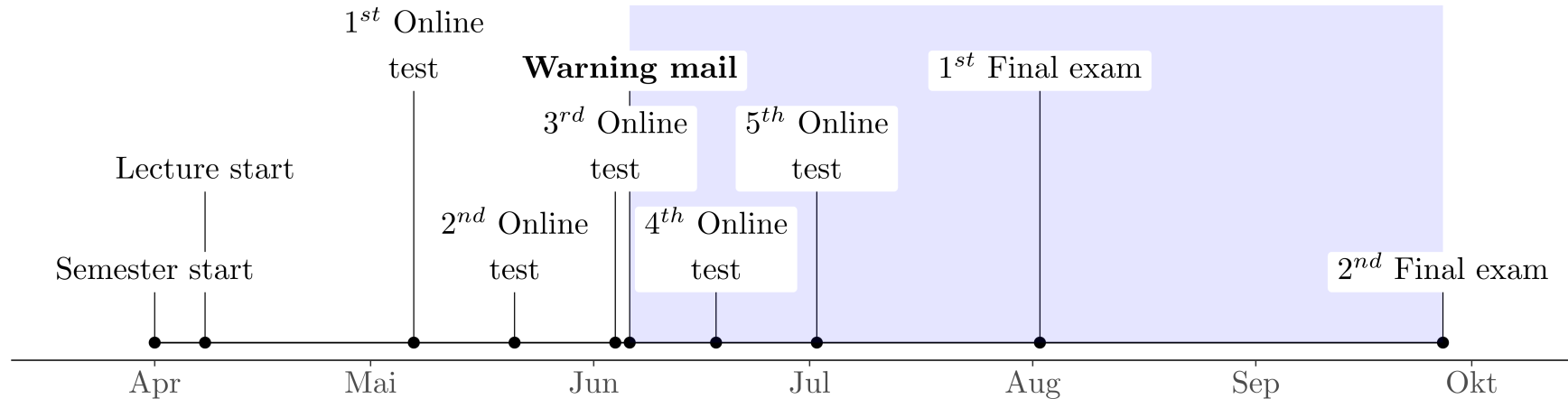
# Research Idea and Course Description

- **Research Idea:** students should receive objective and motivating feedback through a warning email
- Analyzed Course: *Inferential Statistics* at the University of Duisburg-Essen
- Compulsory for business and economics
  - Weekly 2-hour lecture
  - Weekly 2-hour exercise
  - **Kahoot!** games used during classes
  - Homework (formative assessment) and 5 online tests (summative assessment) on the e-assessment platform **JACK**
- **802** students at the beginning of the semester
  - **337** students took an exam at the end of the semester

# Treatment Assignment

- The Logit model was used to predict students' probability to pass the exam based on the first 3 online tests
  - The model was trained with the latest data obtained from the previous edition of the same course
- If predicted probability to pass  $\leq 0.4$  the student got a warning mail

# Course Timeline Main Events



Timeline for the key events in the 2019 summer term course Inferential Statistics (treatment cohort)

- The shaded area indicates the period after treatment
- 57 days between the warning mail and 1<sup>st</sup> exam
- 113 days between the warning email and 2<sup>nd</sup> exam

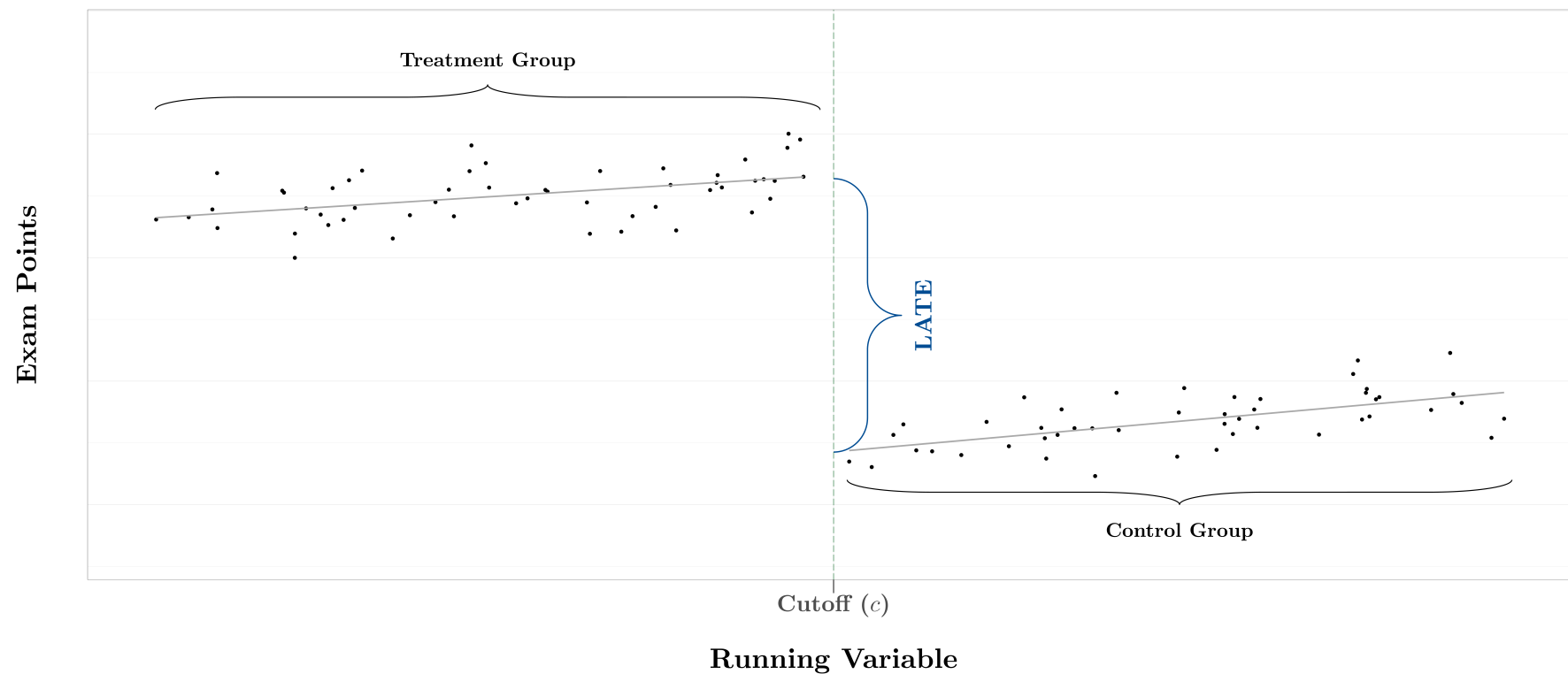
# Literature on Warning Systems in Education

- [Arnold and Pistilli \(2012\)](#) investigated the effect of the signal light system at Purdue University and found a positive effect on student grades
- [Bañeres, Rodríguez, Guerrero-Roldán, and Karadeniz \(2020\)](#) implemented an early warning system but did not analyze the effect on students' performance
- [Şahin and Yurdugül \(2019\)](#) invented an *Intelligent Intervention System* where students get feedback for each assessment
  - Students emphasized the usefulness of the system
- [Mac Iver, Stein, Davis, Balfanz, and Fox \(2019\)](#) could not find an effect from their early warning system in the ninth grade
- [Edmunds and Tancock \(2002\)](#) analyzed the effects of incentives on third and four-graders' reading motivation and did not find an effect

- The literature on the effects of warning system is inconclusive
- Many studies analyzed the system with questionnaires
  - ➔ We try to measure the direct effect on students' performance

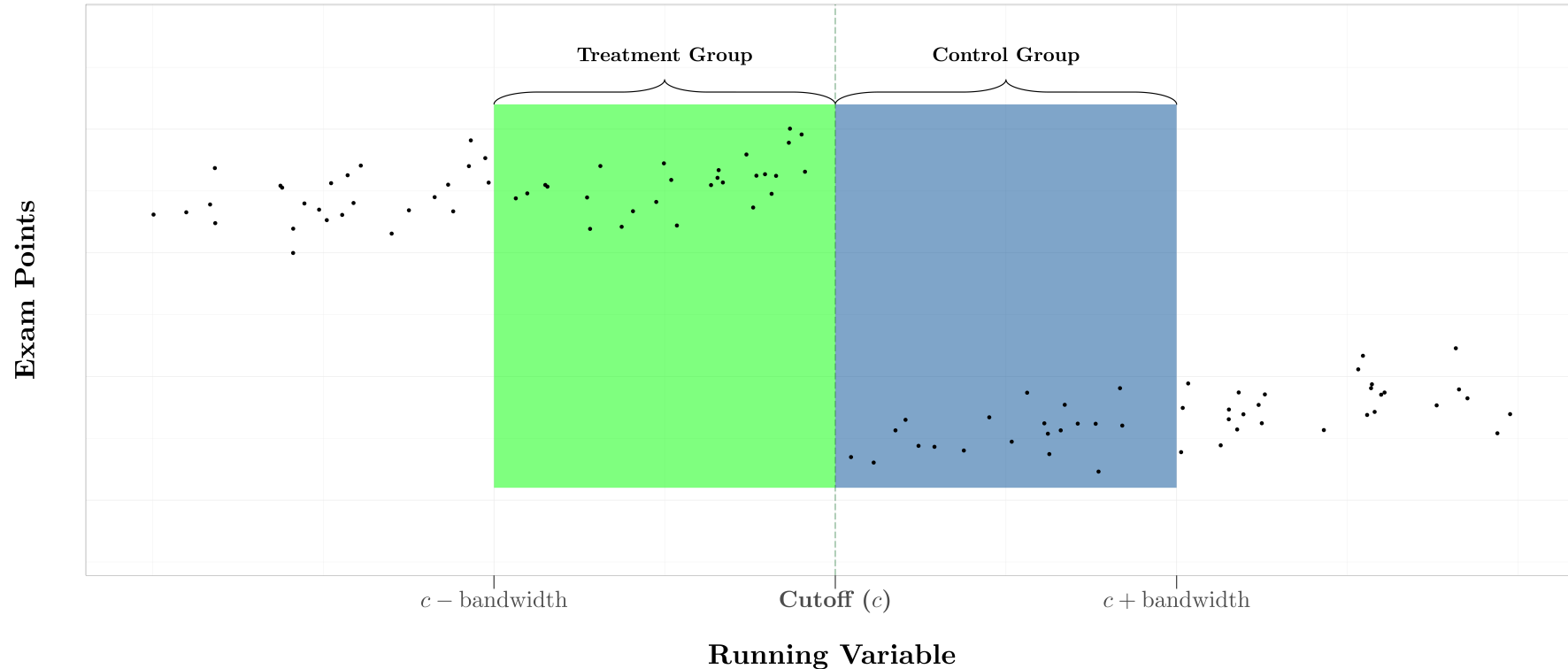
# RDD Toy Example – I

## Parametric Estimation



# RDD Toy Example – II

## Non-parametric Estimation

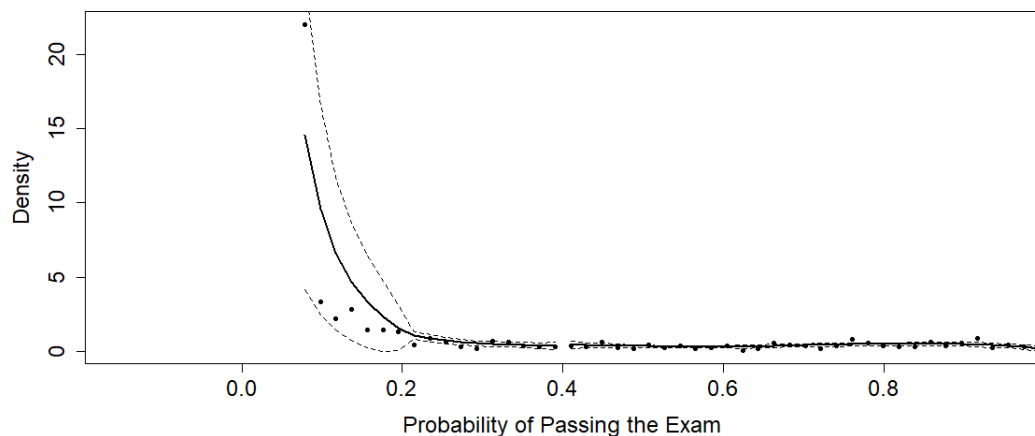


- We used the data-driven approach by [Imbens and Kalyanaraman \(2009\)](#) to determine the bandwidth



# Model Assumptions

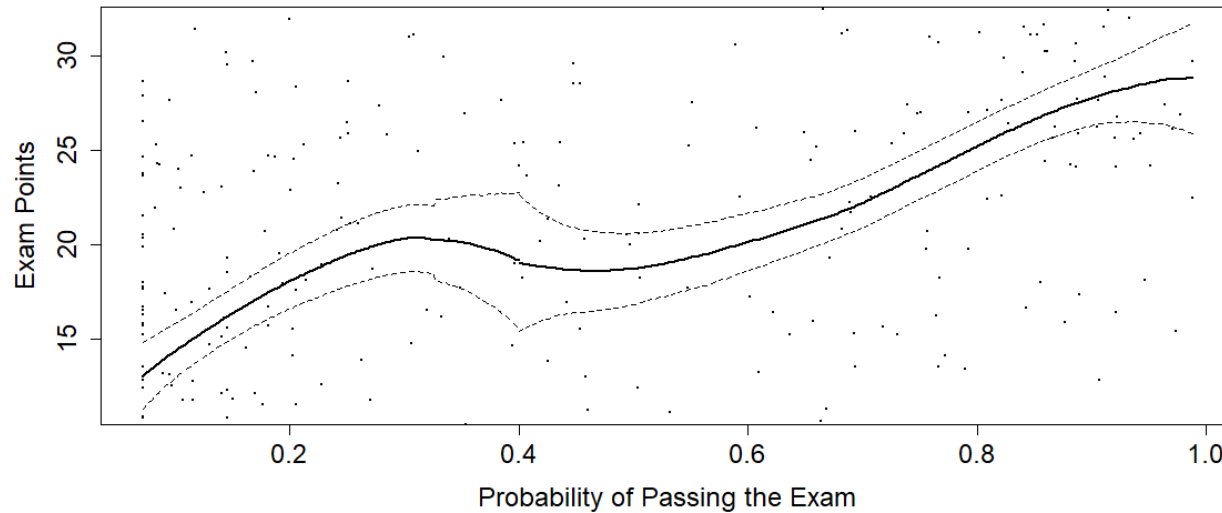
- The running variable  $W$  (predicted probability to pass the exam) must not have a jump around the cutoff in the density function



Graphical illustration of the McCrary sorting test

- There is no jump in the density around the cutoff point of 0.4
  - $p$ -value: 0.509
  - The incentive to manipulate the treatment is quite low
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- Also, standard IV estimation assumptions must hold

# Empirical Results – I



Graphical illustration of the RDD model

## Estimate

- LATE: 0.193
  - SE: 4.889
  - $p$ -value: 0.968
- Bandwidth: 0.255
- $N$ : 126

# Empirical Results – II

- The LATE estimate is positive but not significant
  - An estimate of 0.193 means that students who received the warning email achieved 0.193 points more than comparable students who did not
  - Compared to the 60-point exam, the effect size seems limited
- Bandwidth of 0.255
  - Only students with a predicted probability  $0.4 \text{ (cutoff)} \pm 0.255 \text{ (bandwidth)}$ , are included in the analysis
- This leads to the effective sample size of 126 students

# Discussion – I

- Our RDD results do not provide evidence that the warning email has a significant effect on students' results (or behavior)
  - The variance around the cutoff is relatively high, which compromises the detection of an effect
  - Many individuals are not included in the final analysis for several reasons
    - Students dropping the course
    - Students far away from the cutoff are not providing much information
- ➔ Thus precise estimation of the treatment becomes more difficult

# Discussion – II

- Students also get feedback through their online tests
- The warning may also lead weak students to postpone participation to a later semester
  - The cost in our program to postpone exams is quite low
- The objective feedback and motivation from one warning email is rather small

# Further Research

- The effect on the dropout rate from such warning emails or systems requires further attention
- An automatic repeatedly feedback system could have a more significant impact on student's motivation
  - Detailed recurring feedback could also be used to guide students

We see the open and transparent communication of the student's performance to the students as a positive aspect of the system

# References

- Arnold, K. E. and M. Pistilli (2012). "Course signals at Purdue: using learning analytics to increase student success". Eng. In: *ACM International Conference Proceeding Series*. LAK '12. ACM, pp. 267-270.
- Bañeres, D., M. E. Rodríguez, A. E. Guerrero-Roldán, et al. (2020). "An Early Warning System to Detect At-Risk Students in Online Higher Education". In: *Applied Sciences* 10.13, p. 4427.
- Edmunds, K. and S. M. Tancock (2002). "Incentives: The effects on the reading motivation of fourth-grade students". In: *Reading Research and Instruction* 42.2, pp. 17-37.
- Imbens, G. and K. Kalyanaraman (2009). "Optimal Bandwidth Choice for the Regression Discontinuity Estimator". In: *National Bureau of Economic Research* 1.14726.
- Mac Iver, M. A., M. L. Stein, M. H. Davis, et al. (2019). "An Efficacy Study of a Ninth-Grade Early Warning Indicator Intervention". In: *Journal of Research on Educational Effectiveness* 12.3, pp. 363-390.
- Şahin, M. and H. Yurdugül (2019). "An intervention engine design and development based on learning analytics: the intelligent intervention system (In 2 S)". In: *Smart Learning Environments* 6.1, p. 18.