ECON4137 – Spring 2025

IMPORTANT: Always motivate your answers. Show knowledge and understanding of the concepts taught in the course. Make sure not only to repeat material from lectures and curriculum, but engage with the empirical examples and show that you understand what it means in the particular setting. Your answers should be as short as possible and as long as necessary. Each lettered subtask carries 10 points, for a total of 150.

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1. (20 points) Short questions. Y_j are potential outcomes under treatment state j, D_z is potential treatment under instrument state z and D is actual treatment and $X$are some covariates.

   (a) Interpret the following estimands

      i. $\mathbb{E}(Y_1 - Y_0 \mid D_1 > D_0)$

      ii. $\mathbb{E}(Y_1 - Y_0 \mid D = 1)$

   (b) Interpret the following assumptions

      i. $(Y_0, Y_1) \perp D \mid X$

      ii. $\mathbb{E}(Y_1 - Y_0 \mid D = 1) = \mathbb{E}(Y_1 - Y_0 \mid D = 0)$

2. (80 points) In "*Erasmus Program and Labor Market Outcomes: Evidence from a Fuzzy Regression Discontinuity Design*", De Benedetto et. al. (2025)[1] are interested in the causal effects of participation in the Erasmus program on later labor market outcomes. They have data on Erasmus participation, student background characteristics and labor market outcomes from students at an Italian university.

   (a) If you regress a dummy for being employed after graduation on a dummy for having participated in Erasmus, what do you need to assume about **potential outcomes** with and without Erasmus participation to interpret the coefficient on Erasmus as a causal effect? With heterogeneous effects, what causal effect is that?

   (b) In the reasonable case that the assumption above does not hold, what does the simple regression identify? What is the likely direction of selection bias?

   The authors acknowledge the endogeneity of Erasmus participation, and use a fuzzy regression discontinuity design to estimate causal effects. They exploit the selection procedure into Erasmus at the University of Calabria, where a fixed number of Erasmus grants is announced each spring. Applying students are assigned a score that depends on the average of all grades and number of credits completed, and Erasmus grants is offered to students with the highest scores. The authors use the score as the running variable in the fuzzy RD, and the cutoff is simply the score of the lowest ranked student offered a grant in the first round.

[1] Marco Alberto De Benedetto, Maria De Paola, Vincenzo Scoppa and Janna Smirnova: "Erasmus Program and Labor Market Outcomes: Evidence from a Fuzzy Regression Discontinuity Design", Labour Economics, Volume 93, 2025.

Table 3: Erasmus program and the probability of being employed. Fuzzy RDD estimates

	(1)	(2)	(3)	(4)
Panel (a): 2SLS				
Erasmus	0.205***	0.147***	0.161***	0.100*
	(0.065)	(0.055)	(0.046)	(0.060)
Female			-0.025	-0.027
			(0.020)	(0.020)
High-school grade			0.003***	0.003***
			(0.001)	(0.001)
Age			0.052***	0.052***
			(0.005)	(0.006)
Lyceum			-0.004	-0.002
			(0.018)	(0.018)
Province of residence			0.028*	0.028*
			(0.016)	(0.017)
Parental education			-0.049***	-0.052***
			(0.018)	(0.018)
Panel (b): First stage				
Assigned Erasmus	0.513***	0.520***	0.527***	0.505***
	(0.026)	(0.025)	(0.026)	(0.029)
F-stat	217.21	211.37	212.66	135.61
p-value	0.000	0.000	0.000	0.000
Polynomial Forcing Variable	First	First	First	Second
Interaction term	Yes	Yes	Yes	Yes
Departmental ranking FE	No	Yes	Yes	Yes
Year of application FE	No	Yes	Yes	Yes
Year of graduation FE	No	Yes	Yes	Yes
Student characteristics	No	No	Yes	Yes
Parent characteristics	No	No	Yes	Yes
Observations	3,835	3,835	3,835	3,835
R-squared		0.147	0.202	0.204

Figure 1: Manipulation of the forcing variable at the cut-off

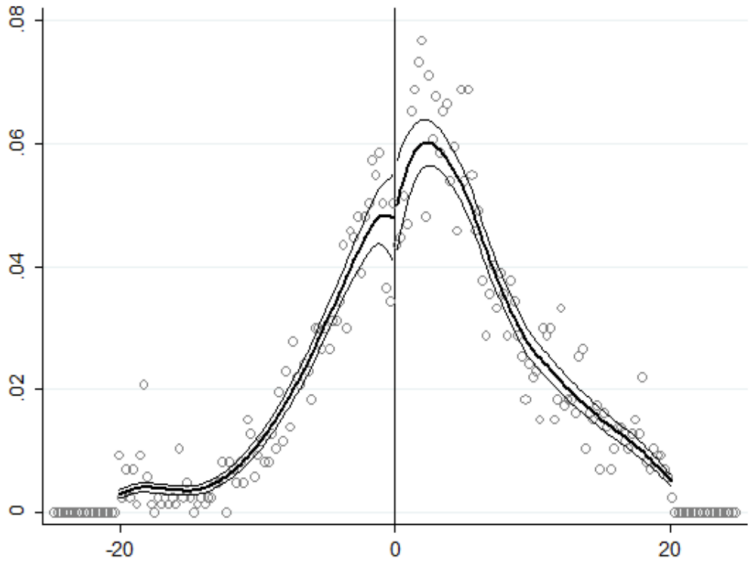


Figure 2: Discontinuity in the covariates at the cut-off

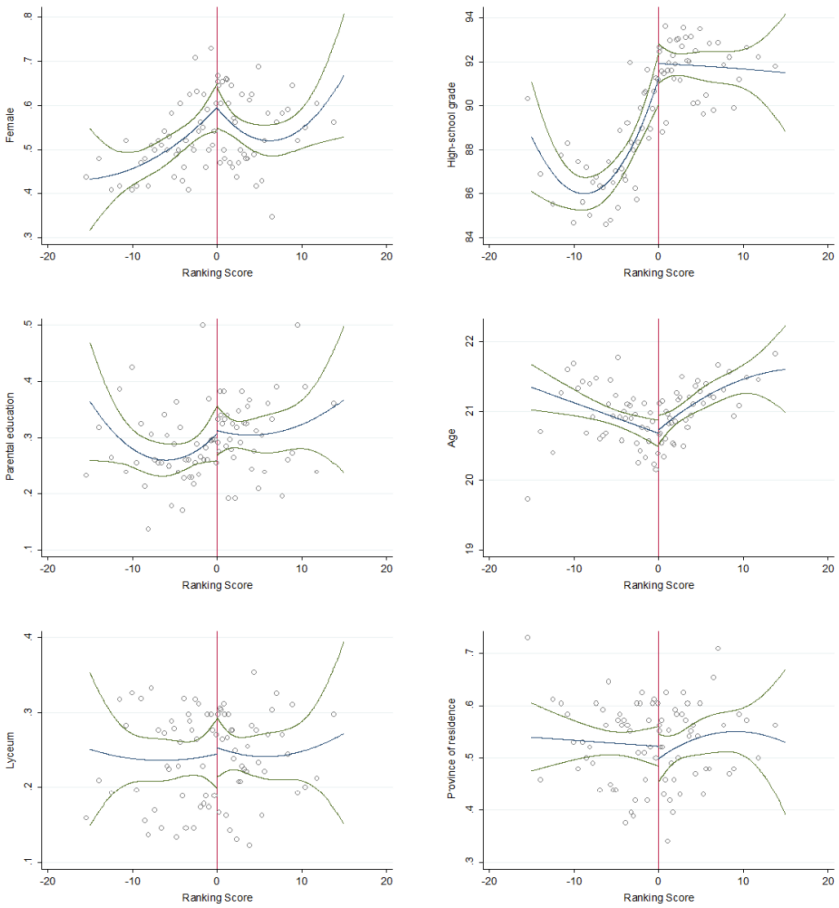


Figure 3: Discontinuity in the probability of participating in the Erasmus program

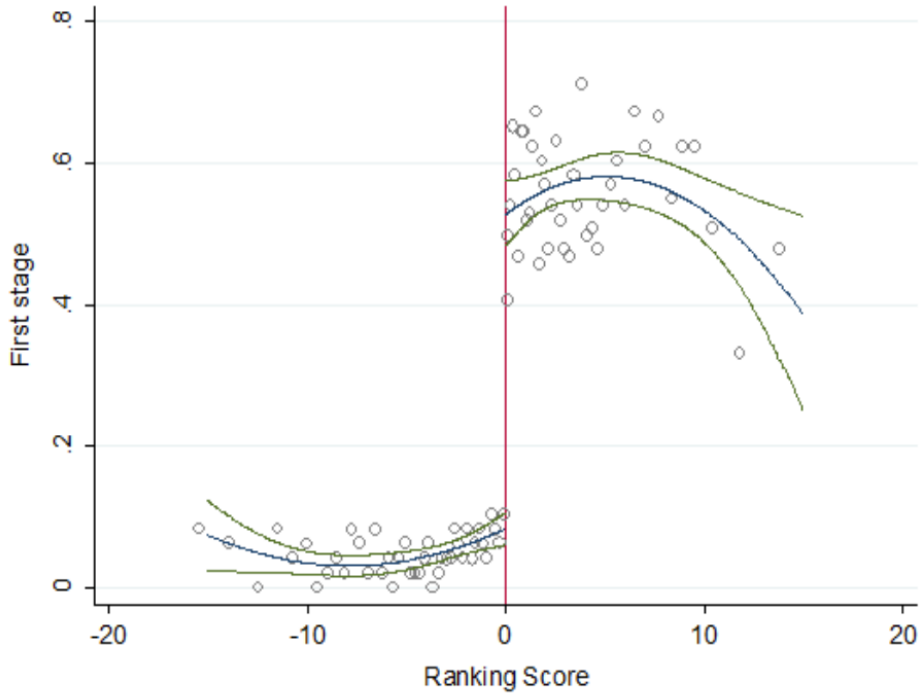
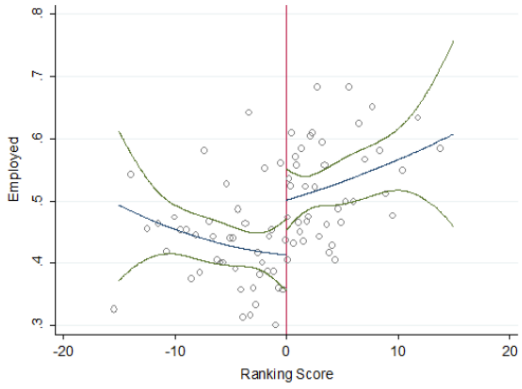
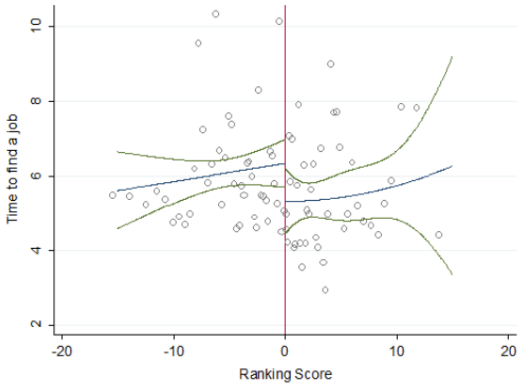


Figure 4: Discontinuity in the labour market outcomes at the cut-off





(c) Using math and words, explain what the authors must assume about **potential outcomes and treatments** to identify the causal effect of being offered an Erasmus grant on the probability of going abroad with Erasmus and on the probability of being employed after graduation. Interpret the causal effect in the left panel of figure 4 in the heterogeneous effects framework.

(d) Explain what Figures 1 and 2 shows, and whether or not they support the identifying assumptions in c).

(e) The authors preferred specification is a fuzzy regression discontinuity design, where Erasmus participation is instrumented with threshold crossing, and both equations control for a linear function of the running variable on either side of the cutoff. What assumptions do the authors need in addition to the ones you discussed in c) to interpret the fuzzy RD estimate causally? Answer this question in the potential outcomes framework.

(f) Using figure 3, estimate the share of nevertakers, alwaystakers and compliers.

(g) How do you interpret the estimate in column 2, row 1 of Table 3 when treatment effects are heterogeneous?

(h) Discuss external validity of the Fuzzy RD estimate when treatment effects are heterogeneous. Is this the relevant parameter for evaluating the impact of an expansion of the Erasmus program? How you would go about to understand what population contribute to the treatment effect from the Fuzzy RD?

3. (50 points) You work in the public transport company Ruter in Oslo and are tasked with analyzing the demand for various modes of travel. You have data on all trips taken by a representative sample of travellers in Oslo using car, bus, metro, bicycle and walking, and plan to use a multinomial logit model. This model has has choice probabilities given by

$$Pr(y_i = j \mid x) = \frac{\exp(x_{ij}'\beta)}{1 + \sum_{k=2}^{M} \exp(x_{ik}'\beta)}$$

Where x_{ij} are characteristics for individual i in mode j and β are parameters.

(a) What does independence of irrelevant alternatives (IIA) imply in this setting? Do you find it reasonable?

(b) Describe what alternative models you could consider to relax the IIA assumption, and the logic behind how they allow for differential substition in this setting.

(c) How would you test whether IIA is reasonable in this setting?

Happy with finding no evidence against IIA with the test in c), you proceed to estimate the multinomial logit model, using *price in NOK* and *travel time in minutes* as regressors. You get the results shown in table 1.

Table 1: Coefficients from the conditional logit model of travel mode choice

Variable	**Coeff**	**std.error**
Price in NOK	-0.0323	0.0014
Travel time in minutes	-0.0184	0.0023
Car ($j = 1$): Constant	(ref)	(ref)
Bus ($j = 2$): Constant	-0.428	0.028
Metro ($j = 3$): Constant	-0.231	0.014
Bicycle ($j = 4$): Constant	0.045	0.100
Walking ($j = 5$): Constant	-0.578	0.078

(d) How can you interpret the coefficients on price and travel time? What can you learn from the signs and relative magnitutes of the coefficients about marginal effects on the choice probabilities?

(e) Compute and interpret

i. The willingness to pay to reduce the travel time by 1 minute.

ii. $\Pr(j = 2 \mid j \leq 2, x = (10, 10))$: The probability that an individual who face a bus price of 10 NOK and a traveltime by bus of 10 minutes chooses the bus conditional on choosing either the car or the bus.