PROBLEM SET 1

JIALIANG CHEN

Problem 1.

(a). To compute the ATE, we simply supply $Y_1 = 3 + U_1$ and $Y_0 = 2 + U_0$ into the definition and get

$$\text{ATE} = \mathbb{E}[Y_1 - Y_0] = \mathbb{E}[3 + U_1 - 2 - U_0] = 1.$$

(We used the zero mean assumption here.)

(b). See the dofile.

(c). Using our simulation draws, we have ATE = 1.0015 (very close to the real ATE, as we expected), ATET = 0.74 and ATEU = 2.38. The OLS estimate is given by

TABLE 1. The OLS Estimate for Nonrandom Assignment

	(1) Y
D	1.453***
	(56.09)
_cons	1.394***
	(58.69)
N	10000

t statistics in parentheses

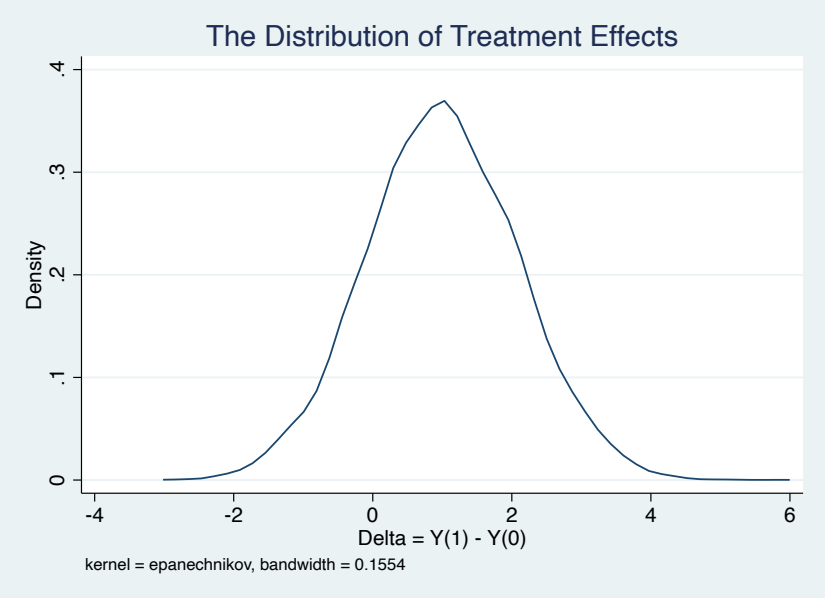
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

and the exact biases are

TABLE 2. The Exact Bias under Nonrandom Assignmen

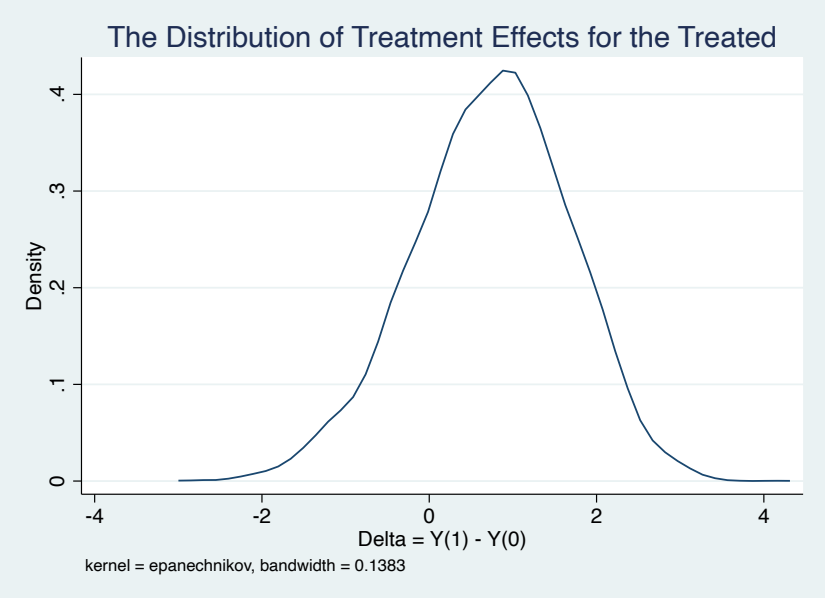
Bias for ATE	Bias for ATET	Bias for ATEU
0.4515	0.713	-0.927

(d). The distribution of treatment effect

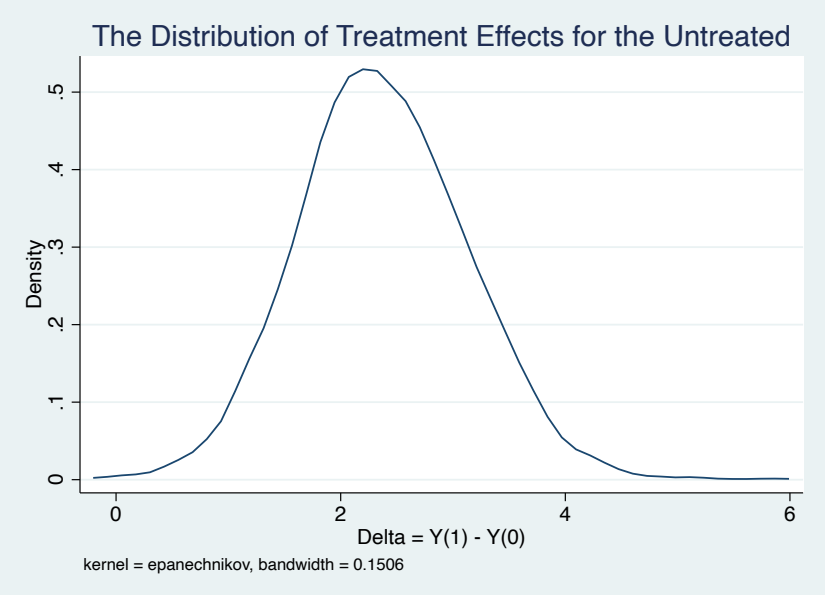


Date: September 29, 2022.

The distribution of treatment effect for the treated



The distribution of treatment effect for the untreated



(d).

TABLE 3. The OLS Estimates for Nonrandom Assignment and Random Assignment.

	(1) Y	(2) Y_rand
D	1.453***	
	(56.09)	
D_rand		0.987***
		(49.10)
_cons	1.394***	2.004***
	(58.69)	(139.59)
N	10000	10000

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE 4. The Exact Bias under Random Assignment

Bias for ATE	Bias for ATET	Bias for ATEU
−0.0145	0.247	−1.393

Problem 2.

(a). Similarly, to compute the ATE, we simply supply $Y_1 = 3 + 0.25X + U_1$ and $Y_0 = 2 + 0.5X + U_0$ into the definition and get

$$\text{ATE} = \mathbb{E}[Y_1 - Y_0] = \mathbb{E}[1 - 0.25X + U_1 - U_0] = 7/8.$$

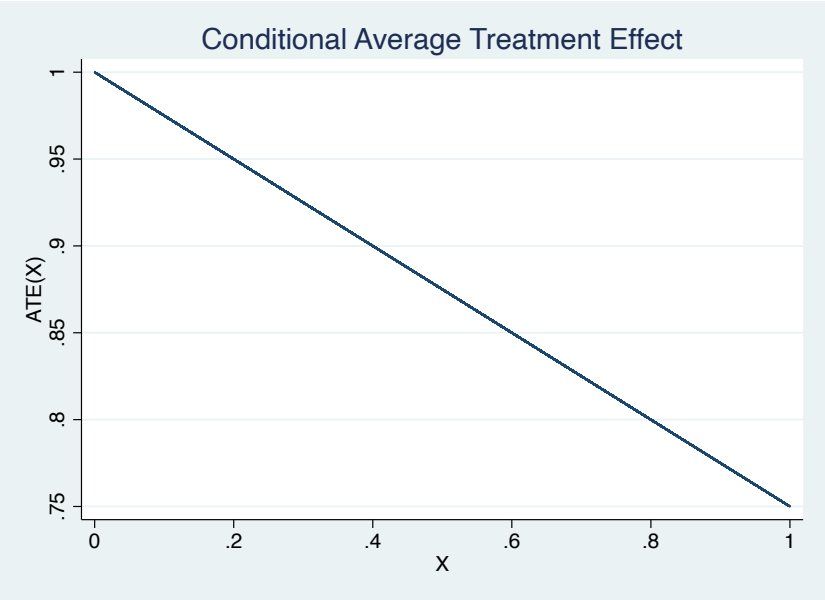
(We used the independence assumption here.)

(b). We have

$$\text{ATE}(X) = \mathbb{E}[Y_1 - Y_0 \mid X] = \mathbb{E}[1 - 0.25X + U_1 - U_0 \mid X] = 1 - 0.25X.$$

(We used the independence assumption here.)

Next, we plot it out .



(c) and (f).

The ATE for this simulation draw is 0.8774426, and the OLS estimate for the nonrandom assignment is shown in the first column of Table 5, and the second column shows the OLS estimate for the random assignment

TABLE 5. The Exact Bias under Random Assignment

	(1) Y	(2) Y_rand
D	0.838***	
	(37.38)	
X	0.322***	0.406***
	(9.33)	(11.51)
D_rand		0.861***
		(42.70)
_cons	2.259***	2.042***
	(87.22)	(89.90)
N	10000	10000

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

and the exact bias are

TABLE 6. The Exact Bias under Nonrandom and Random Assignment

Nonrandom Assignment	Random Assignment
-0.040	-0.0158

(e) The distribution of treatment effects looks like