Assignment 1

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1. Provide and discuss a table of simple summary statistics showing the mean, standard deviation, min, and max of hospital total revenues and uncompensated care over time.

   The summary statistics of hospital total revenues and uncompensated care over time are presented in Table 1 and 2, respectively. All of the statistics are scaled by million dollar. The tables show that both revenue and uncompensated care are increasing.

2. Create a figure showing the mean hospital uncompensated care from 2003 to 2019. Show this trend separately by hospital ownership type (private not for profit and private for profit).

   The mean hospital uncompensated care from 2003 to 2019 are shown in Figure 1. The uncompensated care of not-for-profit hospitals increased until 2014, but it seems it stays in the similar level after the Medicaid expansion. On the other hand, the uncompensated care of for-profit hospitals kept increasing.

3. To estimate the effect of Medicaid expansion on hospital uncompensated care, I estimate the following two-way fixed effects (TWFE) model.

$$y_{it} = \alpha_i + \gamma_t + \delta D_{it} + \epsilon_{it} \tag{1}$$

   where $D_{it} = 1(E_i \leq t)$, E_i is an expansion year, $1(\cdot)$ is an indicator function. γ_t denotes time fixed effects, α_i denotes hospital fixed effects, and y_{it} denotes the hospital i's amount of uncompensated care in year t.

   The estimation results are presented in Table 3. The first column is the result of the estimation using full sample. The coefficient suggests that the exansion of Medicade decreased hospital uncompensated care by 31 million dollars. The second from the fourth column.

year	mean	sd	min	max
2003	185.19	330.07	-1.76	4722.76
2004	204.75	370.17	0.15	5525.73
2005	224.37	409.97	0.00	6398.55
2006	247.69	453.57	-0.10	7784.09
2007	269.91	495.95	0.06	8577.05
2008	294.73	543.40	0.00	9293.79
2009	322.54	598.49	0.12	9846.46
2010	345.56	643.12	0.31	10185.42
2011	371.55	692.05	-27.58	10572.29
2012	394.66	744.85	-11.80	11865.32
2013	417.37	802.25	0.09	12751.71
2014	449.19	864.63	0.01	13376.35
2015	490.49	935.43	0.01	14143.53
2016	531.44	1022.78	0.08	15618.75
2017	571.88	1127.38	0.12	16863.43
2018	619.71	1247.63	0.28	18677.25
2019	672.38	1379.16	0.00	22000.93

Table 1: Summary statistics of hospital total revenue

4. One can think that the expansion of Medicaid can have a staggered treatment effect. There could be several reasons for the staggered effect. For example, it might takes some times for patients to change their health behavior after the intervention. To investigate the change of the treatment effect over time, I estimate the following event study equation.

$$y_{it} = \alpha_i + \gamma_t + \sum_{\tau<-1} D_{it}^{\tau}\delta_{\tau} + \sum_{\tau\geq 0} D_{it}^{\tau}\delta_{\tau} + \epsilon_{it} \tag{2}$$

where $D_{it}^{\tau} = 1(t - E_i = \tau)$, τ denotes years relative to Medicade expansion, so that $\tau = 0$ denotes the year of expansion.

The estimation results are presented in Table 4. The first column shows that there is a staggered treatment effect. The treatment effect of one year after the intervention was -18.95 and the magnitudes of the effects increase over time. The second column shows the subsample estimation results where only states that adopted Medicaid expansion on year 2014 are used as a treatment group. Similarly to the full sample result, the magnitudes of the effects of the expansion keep increasing.

year	mean	sd	min	max
2003	13.68	32.43	-0.13	777.99
2004	14.54	32.20	0.00	684.01
2005	16.68	31.98	0.00	427.70
2006	19.69	35.01	0.00	378.79
2007	22.91	44.86	0.00	736.39
2008	25.85	50.05	0.00	992.92
2009	27.72	48.80	0.00	583.98
2010	29.83	75.57	0.00	2793.92
2011	34.18	77.86	-17.19	2057.88
2012	37.00	89.18	-1.24	1881.08
2013	38.84	82.77	-0.12	1812.49
2014	37.12	92.37	0.01	1989.89
2015	34.21	91.02	-0.53	2037.43
2016	38.57	99.93	-0.04	2398.38
2017	42.49	108.52	-0.03	2746.88
2018	39.57	104.78	0.01	2596.87
2019	51.05	128.25	-97.79	2639.15

Table 2: Summary statistics of uncompensated care

5. Sun and Abraham (SA) show that the δ_τ coefficients in equation (2) can be written as a non-convex average of all other group-time specific average treatment effects.

$$y_{it} = \alpha_i + \gamma_t + \sum_e \sum_{\tau \neq -1} (D_{it}^\tau \times 1(E_i = e))\delta_{e,\tau} + \epsilon_{it}. \tag{3}$$

   In the following estimation, I investigate whether there are heterogenous treatment effects among the hospitals that adopted the expansion in different years.

   Table 5 shows the estimation result of equation (3). The first column shows the coefficients of the hospitals whose state adopted the exansion in year 2014 and so on. One can see that the treatment effects were larger in the states that adopted Medicaid exapasion later. One possible explanation could be it took some time for the patients in $E = 14$ states to acknowledge the policy change, but the patients in $E = 16$ states were already aware of the policy change from the other states and were waiting for the policy to be implemented.

6. Figure 2 shows the event study graph based on the SA estiamtor. It shows the similar results from the event study in aggregate level.

	Model 1	Model 2	Model 3	Model 4
expand	−31.388***	−38.359***	−38.090***	−39.504***
	(2.815)	(3.858)	(5.077)	(4.332)
Num.Obs.	36 510	27 789	16 296	14 822

Each column shows the estimation results of (1) Full sample,
(2) Only 2014, (3) Only 2015, (4) Only 2016
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 3: The estimation results of TWFE

7. Callaway and Sant'Anna (CS) offer a non-parametric solution that effectively calcuates a set of group-time specific differences. CS also propose aggregations of group-time specific ATT's to form an overall ATT or a time-specific ATT.

   Table 6 shows the time-specific aggregated ATT. The treatment effect shows the similar results to the event study.

8. The sensitivity results are given in Figure 4.

9. Overall, the findings were robust to the different specifications and estimations.

10. I think I could have enjoyed the assignment more if I had started earlier. I did not have enought time to appreciate the ideas of the different estimators. I am very glad that the lecture introduced several cutting-edge estimators in the literature of DD. I will definitely review the estimators in near future.

    The most challenging part for me was building up the data, and also producing tables and figures using codes. I need some refinements in my practice, but I think I am on the right direction.

	uncomp_care	
	(1)	(2)
expanded × relative_time = -18	42.85***	
	(12.82)	
expanded × relative_time = -17	38.66***	
	(12.29)	
expanded × relative_time = -16	33.89***	
	(11.80)	
expanded × relative_time = -15	31.82***	
	(11.30)	
expanded × relative_time = -14	31.48***	
	(11.09)	
expanded × relative_time = -13	31.75***	
	(10.05)	
expanded × relative_time = -12	29.17***	
	(9.045)	
expanded × relative_time = -11	24.12***	18.80**
	(7.931)	(7.863)
expanded × relative_time = -10	21.03***	16.68**
	(7.160)	(6.637)
expanded × relative_time = -9	19.52***	16.85**
	(6.826)	(6.606)
expanded × relative_time = -8	18.25***	16.88**
	(6.555)	(6.730)
expanded × relative_time = -7	15.95**	16.40**
	(5.930)	(6.145)
expanded × relative_time = -6	14.22***	13.01**
	(5.138)	(5.163)
expanded × relative_time = -5	13.66***	9.286*
	(4.839)	(4.966)
expanded × relative_time = -4	7.548*	8.591*
	(3.970)	(4.621)
expanded × relative_time = -3	5.976***	8.300***
	(2.014)	(2.981)
expanded × relative_time = -2	1.935	1.986
	(1.220)	(1.985)
expanded × relative_time = 0	-9.680***	-11.57***
	(2.258)	(3.314)
expanded × relative_time = 1	-18.95***	-16.88***
	(3.487)	(4.174)
expanded × relative_time = 2	-28.26***	-28.34***
	(4.694)	(6.087)
expanded × relative_time = 3	-35.57***	-37.83***
	(6.481)	(8.424)
expanded × relative_time = 4	-38.57***	-39.45***
	(7.428)	(8.440)
expanded × relative_time = 5	-47.63***	-53.88***
	(9.834)	(11.04)
Observations	36,510	27,789
R^2	0.68833	0.69838
Within R^2	0.03666	0.03846
provider fixed effects	✓	✓
year fixed effects	✓	✓

Table 4: Treatment effect over time

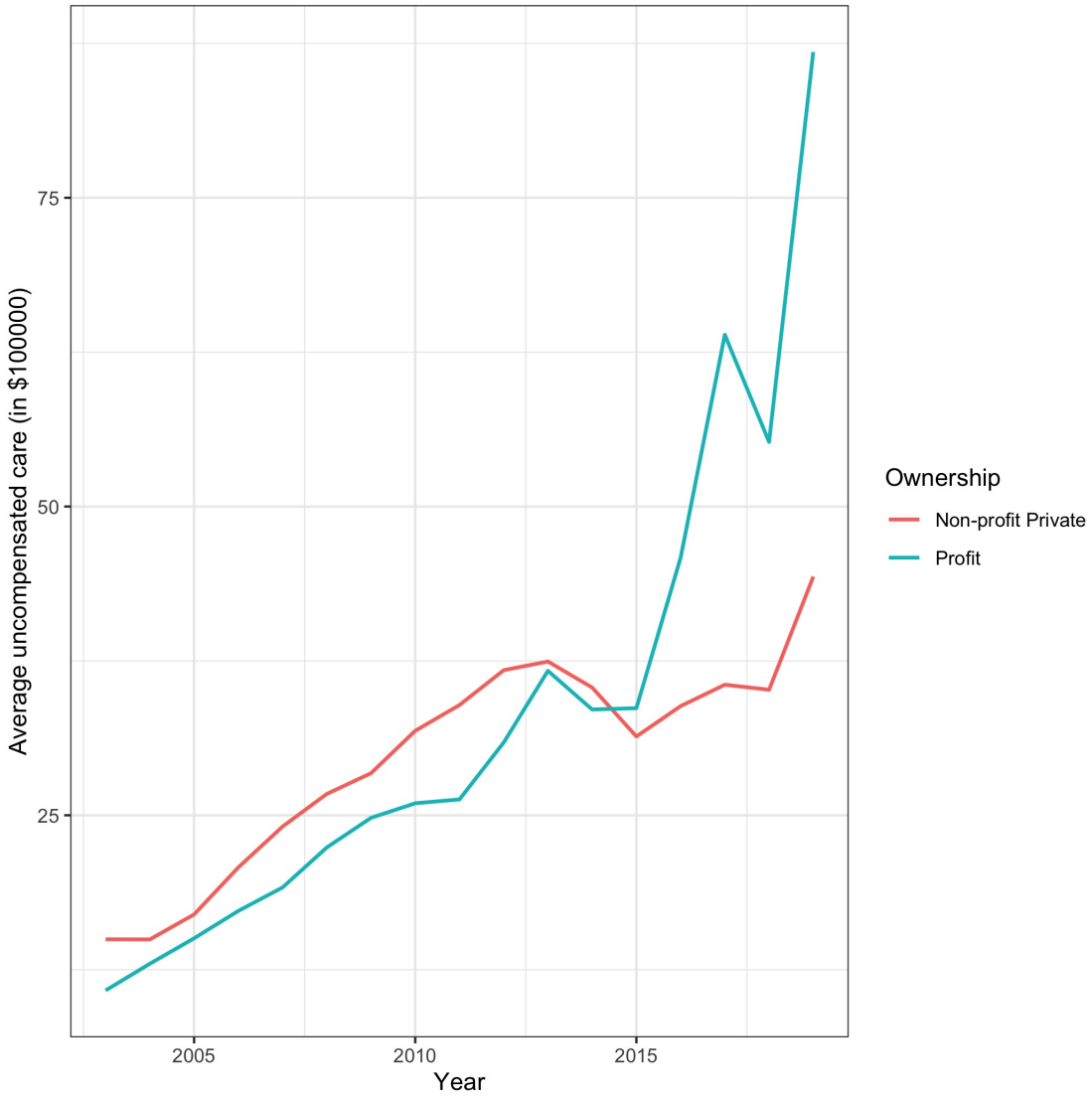
Average uncompensated care (in $100000)
75
50
25
2005
2010
2015
Year
Ownership
Non-profit Private
Profit

Figure 1: dd

	E = 14	E = 15	E = 16
Dependent Var.:	uncomp_care	uncomp_care	uncomp_care
time_to_treat = -11	14.70. (7.820)	20.15** (5.988)	19.46* (7.885)
time_to_treat = -10	13.92* (6.632)	17.17** (6.278)	13.61 (8.802)
time_to_treat = -9	14.48* (6.311)	18.58** (6.348)	11.78 (9.418)
time_to_treat = -8	14.18* (6.566)	17.10** (6.174)	7.556 (8.576)
time_to_treat = -7	13.73* (6.084)	14.12** (4.908)	3.858 (8.620)
time_to_treat = -6	10.93* (5.238)	14.11** (4.454)	5.028 (7.246)
time_to_treat = -5	7.652 (5.004)	24.21. (13.28)	3.350 (6.902)
time_to_treat = -4	7.189 (4.608)	3.256 (4.867)	-3.367 (6.626)
time_to_treat = -3	6.930* (2.696)	5.215. (2.677)	-3.699 (5.640)
time_to_treat = -2	1.740 (1.681)	2.726 (1.798)	-2.723 (2.563)
time_to_treat = 0	-10.90** (3.154)	-1.175 (0.9599)	-11.50*** (2.608)
time_to_treat = 1	-16.16*** (4.021)	-15.60** (5.313)	-34.60** (10.21)
time_to_treat = 2	-26.41*** (5.593)	-26.82*** (6.261)	-36.20*** (9.665)
time_to_treat = 3	-34.12*** (7.554)	-31.00*** (7.142)	-51.67*** (12.77)
time_to_treat = 4	-35.87*** (7.885)	-41.55*** (10.26)	
time_to_treat = 5	-47.76*** (10.68)		
Fixed-Effects:	----------	----------	----------
provider	Yes	Yes	Yes
year	Yes	Yes	Yes
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S.E.: Clustered	by: state	by: state	by: state
Observations	36,510	36,510	36,510
R2	0.68742	0.68742	0.68742
Within R2	0.03383	0.03383	0.03383

Table 5: Heterogenous treatment effect by cohort

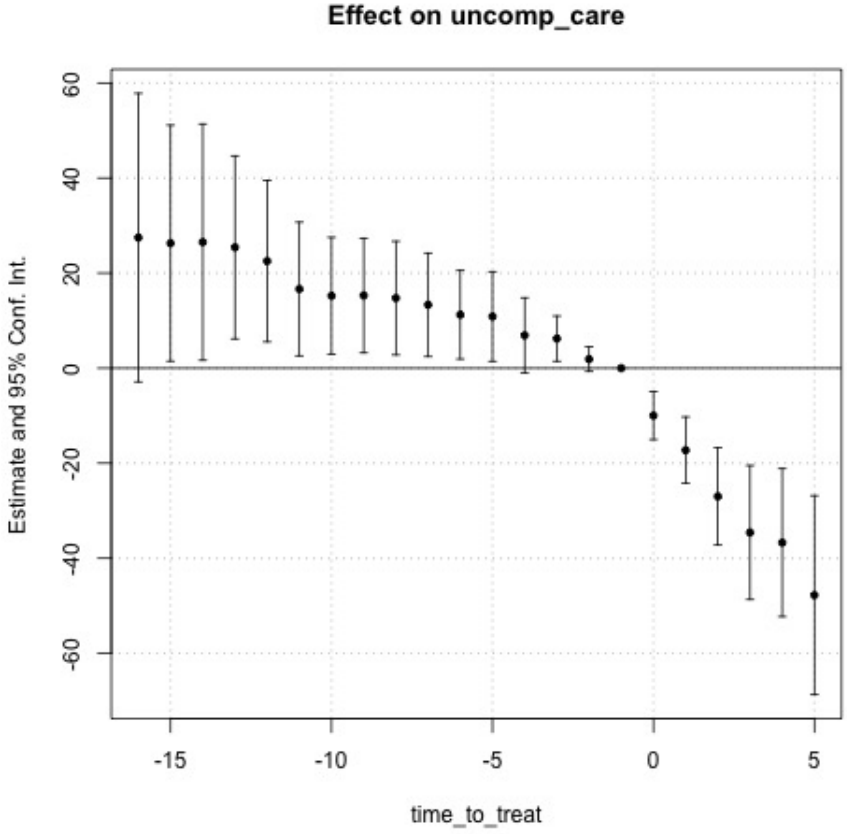
Effect on uncomp_care
Estimate and 95% Conf. Int.
60
40
20
0
-20
-40
-60
-15
-10
-5
0
5
time_to_treat

Figure 2: dd

	Model 1
ATT(-15)	0.545
	(1.685)
ATT(-14)	0.873
	(1.788)
ATT(-13)	−0.683
	(2.356)
ATT(-12)	1.675
	(6.794)
ATT(-11)	−2.511
	(3.443)
ATT(-10)	−1.388
	(1.170)
ATT(-9)	−0.843
	(1.050)
ATT(-8)	−0.735
	(0.988)
ATT(-7)	−2.182
	(1.085)
ATT(-6)	−1.143
	(1.038)
ATT(-5)	0.867
	(3.072)
ATT(-4)	−2.580
	(2.696)
ATT(-3)	3.084
	(2.492)
ATT(-2)	−2.590
	(1.467)
ATT(-1)	−0.880
	(1.672)
ATT(0)	−11.288
	(1.796)
ATT(1)	−16.684
	(1.736)
ATT(2)	−24.748
	(2.172)
ATT(3)	−30.123
	(2.771)
ATT(4)	−30.018
	(4.376)
ATT(5)	−44.639
	(5.698)
Num.Obs.	4437
Std.Errors	by: providergroup
type	dynamic
ngroup	4.000
ntime	9 17.000
control.group	nevertreated
est.method	dr

Table 6: The estimation results of the aggregate ATT of Callaway and Sant'Anna (year)

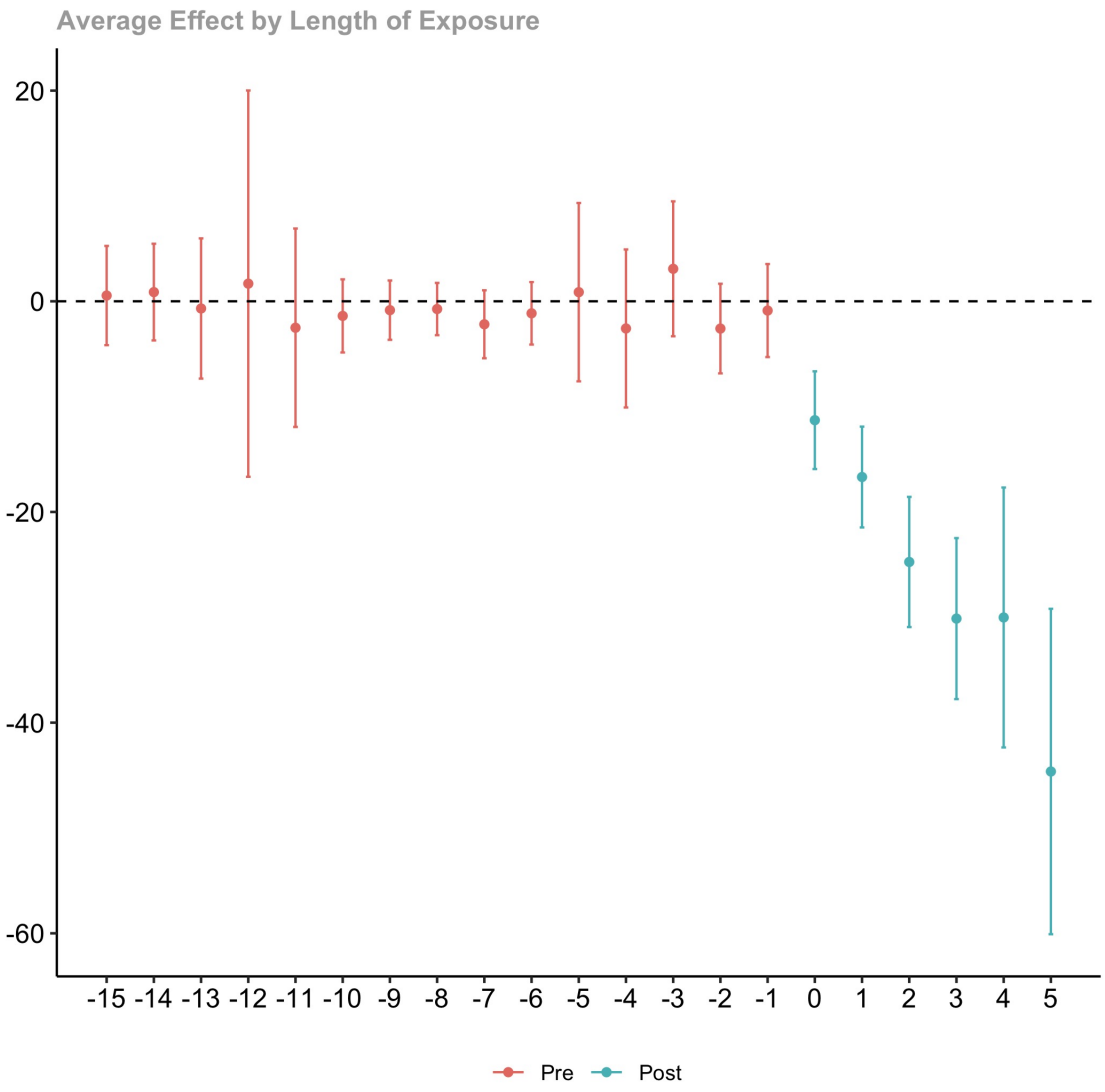

Figure 3: Average Effect by Length of Exposure

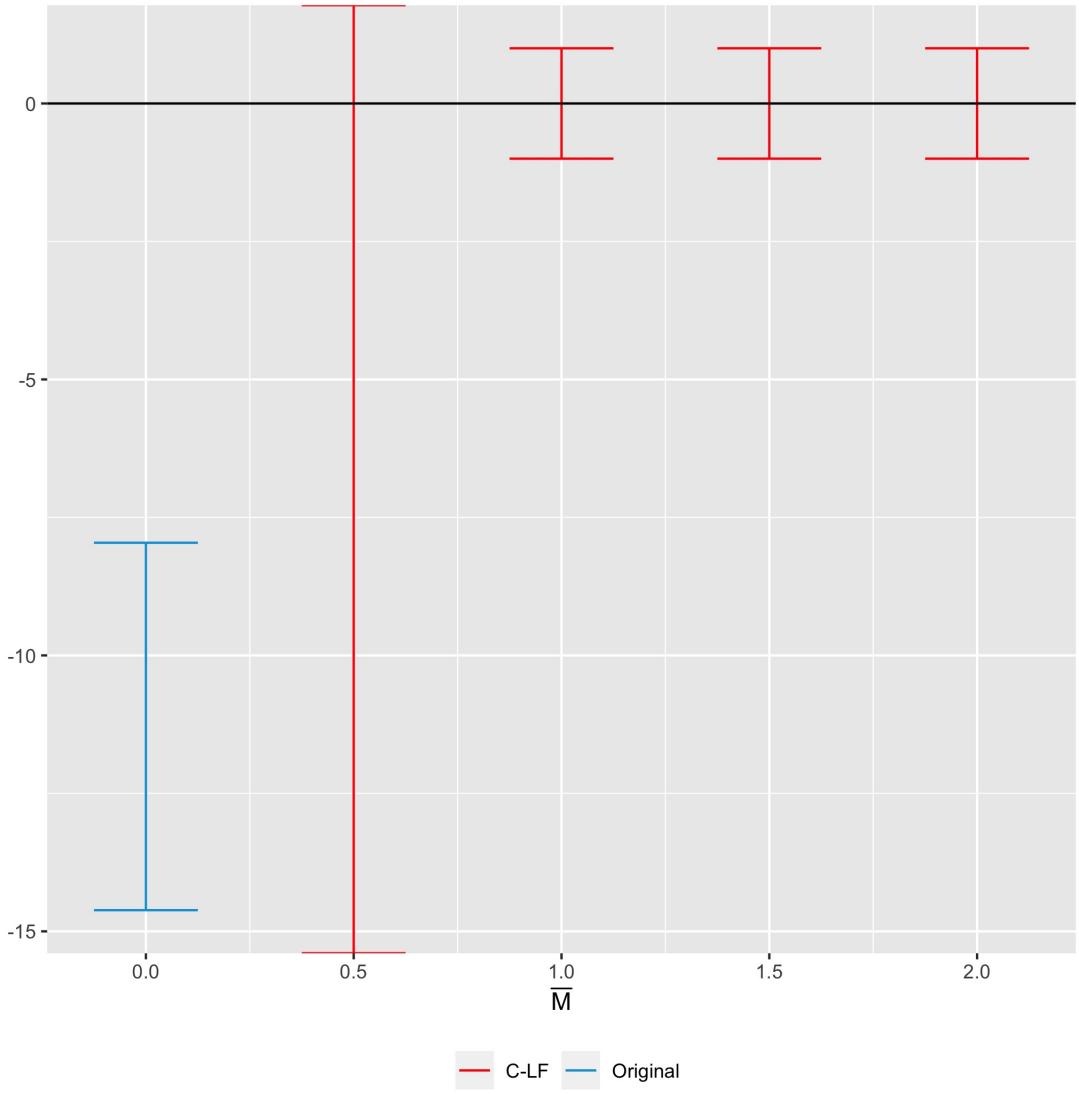

Figure 4: The sensitivity analysis of Rambachan and Roth