

Causal survival analysis

Treatment Effect Estimation in Causal Survival Analysis: Practical Recommendations

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Source files that define the estimator functions, along with auxiliary utilities necessary for their execution and integration into the simulation framework.

Warning: le package 'this.path' a été compilé avec la version R 4.4.3

Warning: le package 'survRM2' a été compilé avec la version R 4.4.3

Le chargement a nécessité le package : splines

Le chargement a nécessité le package : relsurv

Le chargement a nécessité le package : date

Le chargement a nécessité le package : reticulate

Le chargement a nécessité le package : tune

```
Registered S3 method overwritten by 'mosaic':
  method from
  fortify.SpatialPolygonsDataFrame ggplot2
```

Attachement du package : 'MASS'

L'objet suivant est masqué depuis 'package:dplyr':

```
select
```

Le chargement a nécessité le package : Hmisc

Attachement du package : 'Hmisc'

Les objets suivants sont masqués depuis 'package:dplyr':

```
src, summarize
```

Les objets suivants sont masqués depuis 'package:base':

```
format.pval, units
```

riskRegression version 2023.12.21

Warning: le package 'gridExtra' a été compilé avec la version R 4.4.3

Attachement du package : 'gridExtra'

L'objet suivant est masqué depuis 'package:dplyr':

```
combine
```

Data generating process:

RCT simulations

Descriptive analysis

```
[1] "Descriptive statistics for group A=0: 1002"
```

X1		X2		X3		X4	
Min.	:-1.9275	Min.	:-2.9609	Min.	:-4.2258	Min.	:-2.4755
1st Qu.:	0.3466	1st Qu.:	0.2974	1st Qu.:	-1.6800	1st Qu.:	0.3589
Median :	0.9935	Median :	0.9541	Median :	-0.9924	Median :	1.0407
Mean :	1.0427	Mean :	0.9588	Mean :	-1.0032	Mean :	1.0264
3rd Qu.:	1.7153	3rd Qu.:	1.6730	3rd Qu.:	-0.3116	3rd Qu.:	1.6651
Max. :	4.9556	Max. :	3.8648	Max. :	2.0249	Max. :	4.2014

C		T1		T0		status	
Min.	: 0.0422	Min.	: 10.00	Min.	: 0.0022	Min.	:0.0000
1st Qu.:	10.6077	1st Qu.:	12.78	1st Qu.:	2.7813	1st Qu.:	0.0000
Median :	24.0628	Median :	18.42	Median :	8.4171	Median :	1.0000
Mean :	36.6395	Mean :	31.55	Mean :	21.5520	Mean :	0.7046
3rd Qu.:	48.7516	3rd Qu.:	31.29	3rd Qu.:	21.2920	3rd Qu.:	1.0000
Max. :	342.2808	Max. :	899.73	Max. :	889.7271	Max. :	1.0000

T_tild

Min. : 0.00219

1st Qu.: 2.03088

Median : 5.96405

Mean : 10.62567

3rd Qu.: 13.37164

Max. :137.00850

[1] "Descriptive statistics for group A=1: 998"

X1		X2		X3		X4	
Min.	:-2.4590	Min.	:-2.1453	Min.	:-3.9385	Min.	:-1.9373
1st Qu.:	0.3429	1st Qu.:	0.3310	1st Qu.:	-1.7136	1st Qu.:	0.2962
Median :	1.0087	Median :	0.9902	Median :	-1.0172	Median :	0.9897
Mean :	1.0195	Mean :	1.0103	Mean :	-0.9959	Mean :	0.9830
3rd Qu.:	1.6700	3rd Qu.:	1.6983	3rd Qu.:	-0.3141	3rd Qu.:	1.6417
Max. :	3.9632	Max. :	5.0655	Max. :	2.4069	Max. :	4.3560

C		T1		T0		status	
Min.	: 0.06768	Min.	: 10.00	Min.	: 0.0001	Min.	:0.0000
1st Qu.:	10.41114	1st Qu.:	13.03	1st Qu.:	3.0334	1st Qu.:	0.0000
Median :	24.35345	Median :	18.60	Median :	8.6037	Median :	1.0000
Mean :	35.43644	Mean :	32.19	Mean :	22.1887	Mean :	0.5301
3rd Qu.:	49.04450	3rd Qu.:	31.83	3rd Qu.:	21.8265	3rd Qu.:	1.0000
Max. :	264.60992	Max. :	798.74	Max. :	788.7362	Max. :	1.0000

T_tild

Min. : 0.06768

1st Qu.: 10.07341

Median : 13.66912

Mean : 17.68416
 3rd Qu.: 21.78753
 Max. :138.91984

[1] "Descriptive statistics for group A=0: 1037"

X1	X2	X3	X4
Min. : -2.2063	Min. : -2.5956	Min. : -4.5987	Min. : -1.9103
1st Qu.: 0.3156	1st Qu.: 0.3488	1st Qu.: -1.6643	1st Qu.: 0.3574
Median : 0.9669	Median : 1.0164	Median : -1.0577	Median : 1.0517
Mean : 0.9802	Mean : 1.0212	Mean : -1.0136	Mean : 1.0217
3rd Qu.: 1.6716	3rd Qu.: 1.7039	3rd Qu.: -0.3161	3rd Qu.: 1.7283
Max. : 4.1213	Max. : 4.0160	Max. : 2.2680	Max. : 4.3754

C	T1	T0	status
Min. : 0.0055	Min. : 10.00	Min. : 0.001	Min. : 0.0000
1st Qu.: 2.6884	1st Qu.: 12.74	1st Qu.: 2.736	1st Qu.: 0.0000
Median : 6.5368	Median : 18.62	Median : 8.616	Median : 0.0000
Mean : 14.8240	Mean : 32.58	Mean : 22.582	Mean : 0.4282
3rd Qu.: 15.2211	3rd Qu.: 33.07	3rd Qu.: 23.069	3rd Qu.: 1.0000
Max. : 378.2052	Max. : 905.83	Max. : 895.835	Max. : 1.0000

status_tau	T_tild
Min. : 0.0000	Min. : 0.001
1st Qu.: 0.0000	1st Qu.: 1.263
Median : 0.0000	Median : 3.565
Mean : 0.4744	Mean : 8.187
3rd Qu.: 1.0000	3rd Qu.: 8.390
Max. : 1.0000	Max. : 297.391

[1] "Descriptive statistics for group A=1: 963"

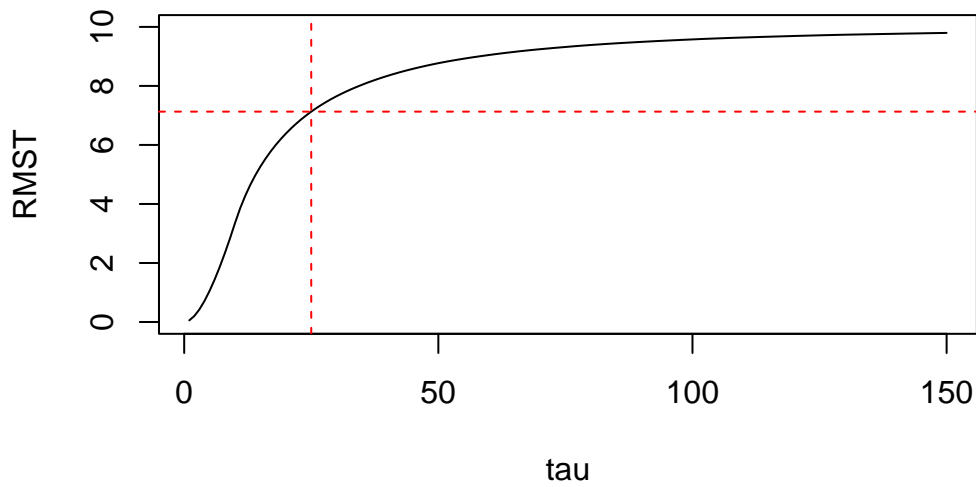
X1	X2	X3	X4
Min. : -1.8810	Min. : -2.0975	Min. : -4.3273	Min. : -2.548
1st Qu.: 0.3638	1st Qu.: 0.3855	1st Qu.: -1.5727	1st Qu.: 0.342
Median : 0.9939	Median : 1.0313	Median : -0.9999	Median : 1.014
Mean : 1.0248	Mean : 1.0171	Mean : -0.9525	Mean : 1.025
3rd Qu.: 1.7069	3rd Qu.: 1.6482	3rd Qu.: -0.3242	3rd Qu.: 1.678
Max. : 4.9953	Max. : 4.3044	Max. : 2.3226	Max. : 4.390

C	T1	T0	status
Min. : 0.0122	Min. : 10.02	Min. : 0.015	Min. : 0.0000
1st Qu.: 2.9972	1st Qu.: 12.94	1st Qu.: 2.940	1st Qu.: 0.0000
Median : 8.1582	Median : 18.08	Median : 8.078	Median : 0.0000

Mean : 18.1935	Mean : 30.52	Mean : 20.521	Mean : 0.2388
3rd Qu.: 20.5724	3rd Qu.: 30.99	3rd Qu.: 20.988	3rd Qu.: 0.0000
Max. : 530.6090	Max. : 828.93	Max. : 818.934	Max. : 1.0000

status_tau		T_tild	
Min. : 0.000	Min. : 0.0122		
1st Qu.: 0.000	1st Qu.: 2.9972		
Median : 0.000	Median : 8.1582		
Mean : 0.296	Mean : 11.9595		
3rd Qu.: 1.000	3rd Qu.: 14.9460		
Max. : 1.000	Max. : 350.9394		

True difference in RMST for RCT scenario 1



[1] "The ground truth for RCT scenario 1 and 2 at time 25 is 7.1"

RCT with independent censoring

RCT with dependent censoring

Observational study simulations

Descriptive analysis

[1] "Descriptive statistics for group A=0: 1060"

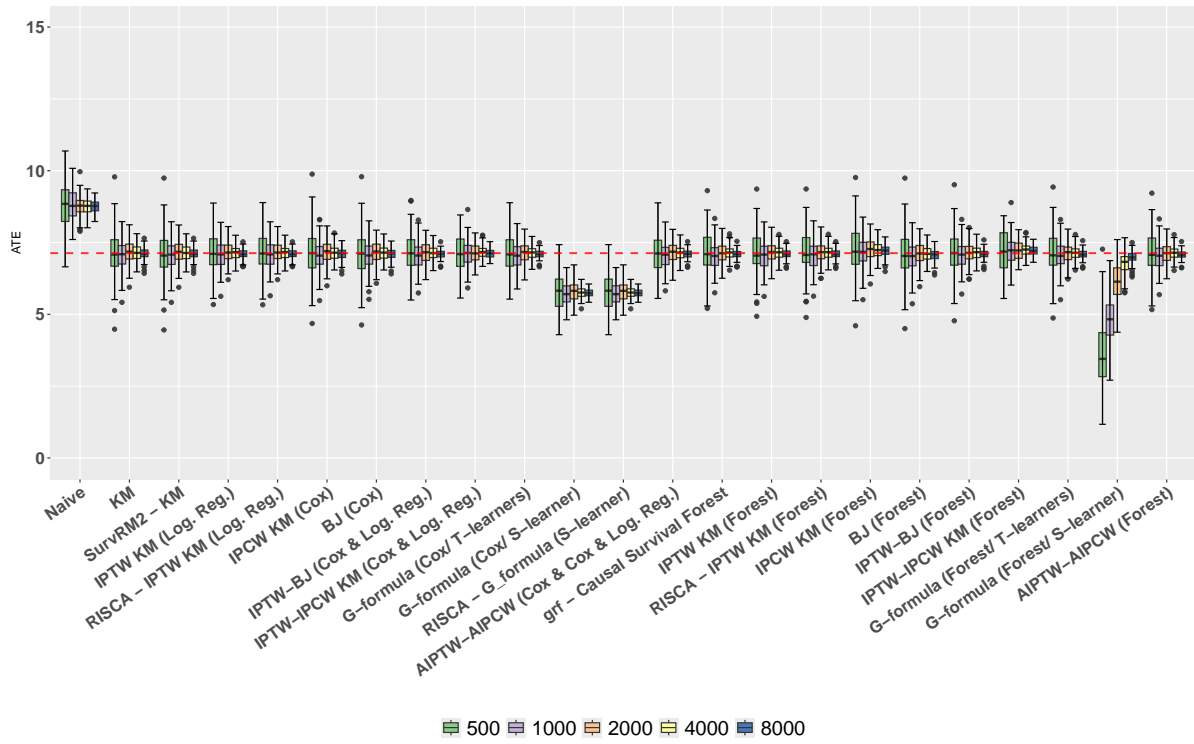


Figure 1: Results of the ATE for the simulation of a RCT with independent censoring.

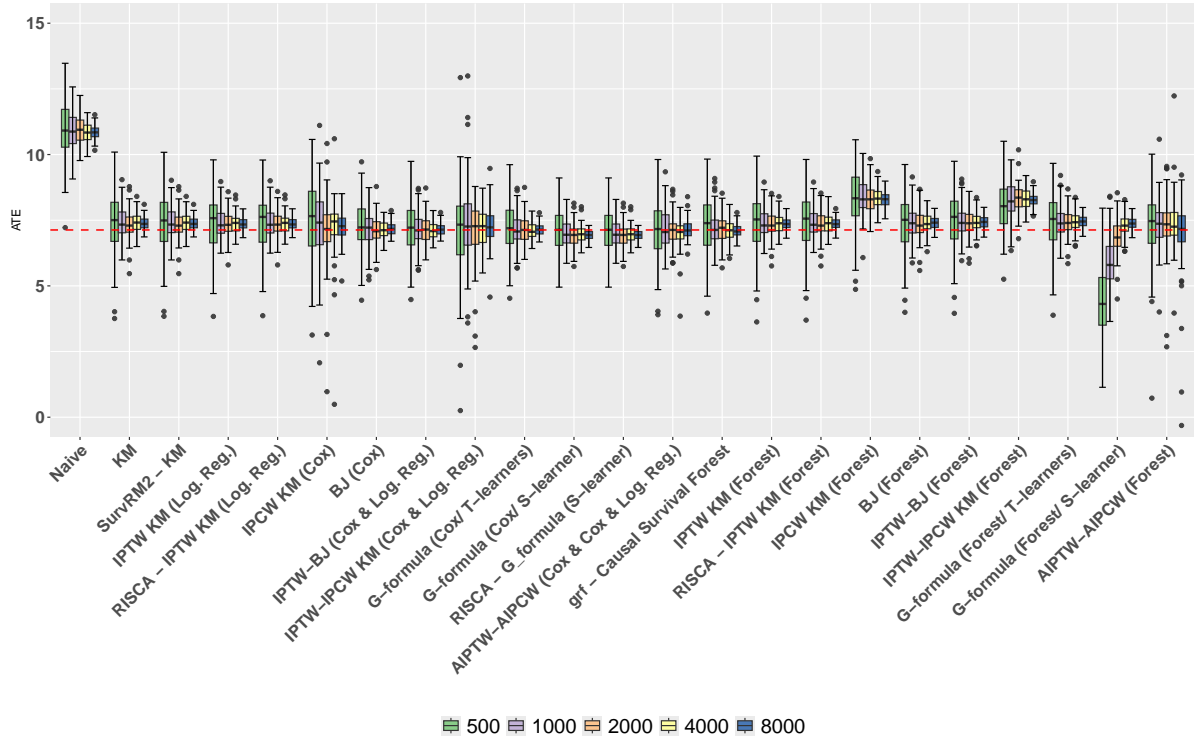


Figure 2: Estimation results of the ATE for the simulation of a RCT with dependent censoring.

X1	X2	X3	X4
Min. : -1.6889	Min. : -1.7669	Min. : -3.84487	Min. : -2.1213
1st Qu.: 0.5131	1st Qu.: 0.5244	1st Qu.: -1.06119	1st Qu.: 0.5706
Median : 1.1739	Median : 1.1997	Median : -0.52012	Median : 1.2596
Mean : 1.1630	Mean : 1.2126	Mean : -0.48448	Mean : 1.2099
3rd Qu.: 1.8246	3rd Qu.: 1.8928	3rd Qu.: 0.05099	3rd Qu.: 1.8713
Max. : 3.8903	Max. : 4.5668	Max. : 2.41125	Max. : 4.0241

C	T1	T0	status
Min. : 0.03044	Min. : 10.01	Min. : 0.0076	Min. : 0.0000
1st Qu.: 10.07603	1st Qu.: 12.93	1st Qu.: 2.9262	1st Qu.: 0.0000
Median : 22.42731	Median : 17.99	Median : 7.9934	Median : 1.0000
Mean : 34.11099	Mean : 31.21	Mean : 21.2134	Mean : 0.6934
3rd Qu.: 47.35037	3rd Qu.: 32.18	3rd Qu.: 22.1834	3rd Qu.: 1.0000
Max. : 263.88911	Max. : 434.84	Max. : 424.8412	Max. : 1.0000

T_tild

Min. : 0.00764

1st Qu.: 2.19219

Median : 5.87889

Mean : 10.26605

3rd Qu.: 12.71914

Max. : 123.73068

[1] "Descriptive statistics for group A=1: 940"

X1	X2	X3	X4
Min. : -2.13933	Min. : -2.22096	Min. : -4.973	Min. : -2.83755
1st Qu.: 0.03185	1st Qu.: 0.08502	1st Qu.: -2.161	1st Qu.: 0.03111
Median : 0.69399	Median : 0.79751	Median : -1.656	Median : 0.75674
Mean : 0.71645	Mean : 0.77355	Mean : -1.639	Mean : 0.70258
3rd Qu.: 1.36227	3rd Qu.: 1.43796	3rd Qu.: -1.103	3rd Qu.: 1.33606
Max. : 4.06424	Max. : 3.85721	Max. : 1.166	Max. : 3.96333

C	T1	T0	status
Min. : 0.03125	Min. : 10.03	Min. : 0.025	Min. : 0.0000
1st Qu.: 8.61619	1st Qu.: 13.20	1st Qu.: 3.198	1st Qu.: 0.0000
Median : 22.15707	Median : 20.07	Median : 10.073	Median : 0.0000
Mean : 34.22787	Mean : 34.14	Mean : 24.143	Mean : 0.4628
3rd Qu.: 46.24587	3rd Qu.: 36.72	3rd Qu.: 26.722	3rd Qu.: 1.0000
Max. : 298.42618	Max. : 534.38	Max. : 524.378	Max. : 1.0000

T_tild

Min. : 0.03125

1st Qu.: 8.61619

Median : 13.21800

Mean : 17.25397
 3rd Qu.: 21.49694
 Max. :138.92023

[1] "Descriptive statistics for group A=0: 1103"

X1	X2	X3	X4
Min. : -2.133	Min. : -2.2298	Min. : -2.98723	Min. : -1.8474
1st Qu.: 0.485	1st Qu.: 0.5202	1st Qu.: -1.05797	1st Qu.: 0.5267
Median : 1.192	Median : 1.2128	Median : -0.49059	Median : 1.2173
Mean : 1.162	Mean : 1.2217	Mean : -0.47633	Mean : 1.1800
3rd Qu.: 1.789	3rd Qu.: 1.8890	3rd Qu.: 0.03195	3rd Qu.: 1.8469
Max. : 4.578	Max. : 4.9459	Max. : 3.08038	Max. : 4.0672

C	T1	T0	status
Min. : 0.0097	Min. : 10.02	Min. : 0.0239	Min. : 0.0000
1st Qu.: 2.3708	1st Qu.: 12.96	1st Qu.: 2.9556	1st Qu.: 0.0000
Median : 6.5467	Median : 17.94	Median : 7.9356	Median : 0.0000
Mean : 14.8360	Mean : 30.95	Mean : 20.9537	Mean : 0.4524
3rd Qu.: 16.4916	3rd Qu.: 32.32	3rd Qu.: 22.3157	3rd Qu.: 1.0000
Max. : 351.8459	Max. : 822.34	Max. : 812.3355	Max. : 1.0000

status_tau	T_obs	e
Min. : 0.000	Min. : 0.00974	Min. : 0.0000178
1st Qu.: 0.000	1st Qu.: 1.38815	1st Qu.: 0.0242832
Median : 0.000	Median : 3.33796	Median : 0.0962896
Mean : 0.485	Mean : 7.22676	Mean : 0.2030283
3rd Qu.: 1.000	3rd Qu.: 8.29760	3rd Qu.: 0.3230763
Max. : 1.000	Max. : 114.34345	Max. : 0.9900861

[1] "Descriptive statistics for group A=1: 897"

X1	X2	X3	X4
Min. : -1.99889	Min. : -2.7107	Min. : -4.146	Min. : -2.4631
1st Qu.: 0.09185	1st Qu.: 0.1541	1st Qu.: -2.107	1st Qu.: 0.1497
Median : 0.70124	Median : 0.7531	Median : -1.621	Median : 0.7776
Mean : 0.71740	Mean : 0.7606	Mean : -1.617	Mean : 0.7872
3rd Qu.: 1.32067	3rd Qu.: 1.4208	3rd Qu.: -1.064	3rd Qu.: 1.4663
Max. : 3.61141	Max. : 3.8173	Max. : 1.216	Max. : 4.0969

C	T1	T0	status
Min. : 0.0005	Min. : 10.01	Min. : 0.0065	Min. : 0.0000
1st Qu.: 2.4952	1st Qu.: 12.89	1st Qu.: 2.8913	1st Qu.: 0.0000
Median : 7.3640	Median : 19.92	Median : 9.9197	Median : 0.0000

Mean : 16.0605	Mean : 33.22	Mean : 23.2246	Mean : 0.1761
3rd Qu.: 16.8576	3rd Qu.: 34.07	3rd Qu.: 24.0730	3rd Qu.: 0.0000
Max. : 410.9303	Max. : 615.18	Max. : 605.1838	Max. : 1.0000

status_tau	T_obs	e
Min. : 0.000	Min. : 0.0005	Min. : 0.0114
1st Qu.: 0.000	1st Qu.: 2.4952	1st Qu.: 0.5907
Median : 0.000	Median : 7.3640	Median : 0.8417
Mean : 0.223	Mean : 11.0491	Mean : 0.7428
3rd Qu.: 0.000	3rd Qu.: 13.2816	3rd Qu.: 0.9524
Max. : 1.000	Max. : 365.7302	Max. : 0.9996

[1] "The ground truth for Obs scenario 1 at time 25 is 7.1"

[1] "The ground truth for Obs scenario 2 at #time 25 is 7.1"

Observational study with independent censoring

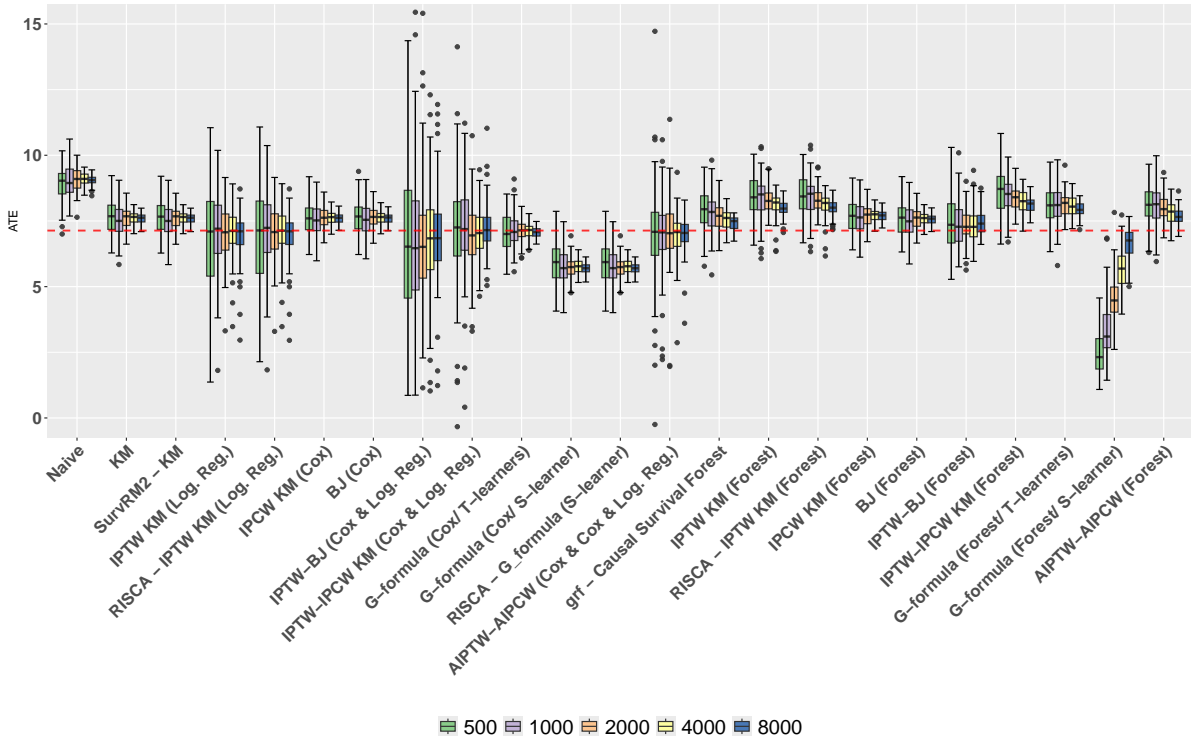


Figure 3: Estimation results of the ATE for the simulation of an observational study with independent censoring.

Observational study with dependent censoring

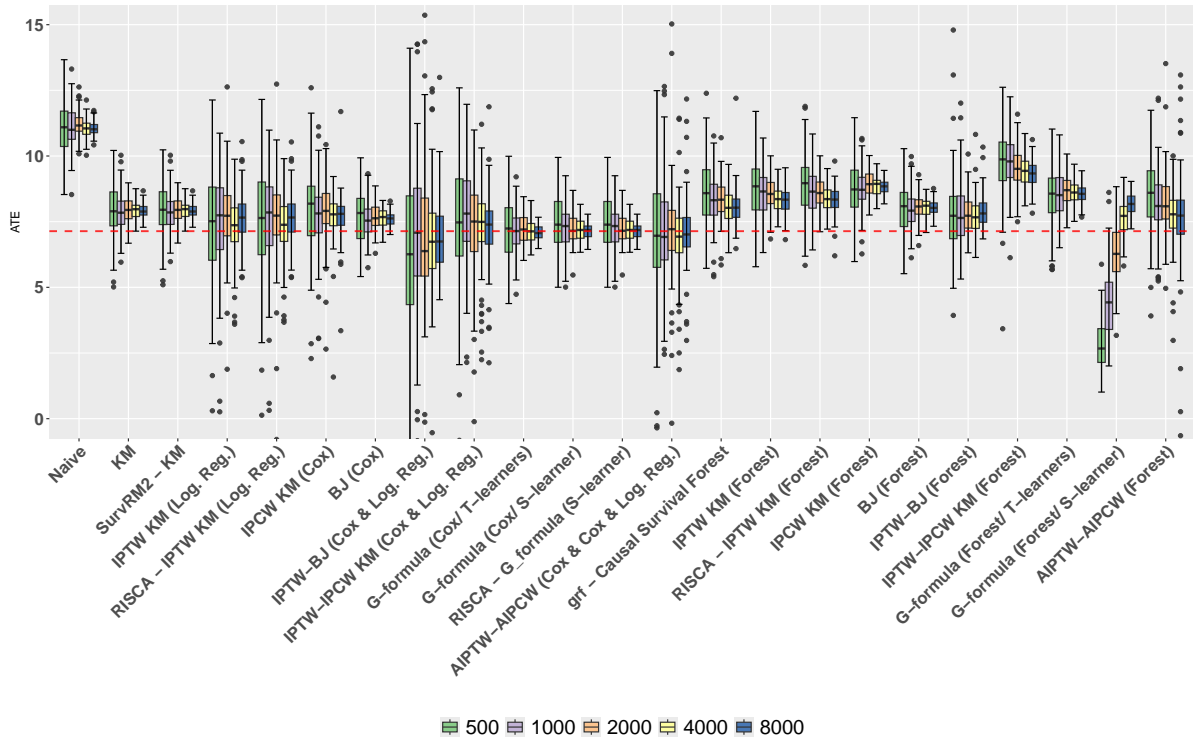


Figure 4: Estimation results of the ATE for the simulation of an observational study with dependent censoring.

Misspecification of the nuisance components simulations

Descriptive analysis

X1		X2		X3		X4	
Min.	:-3.2665	Min.	:-2.4399	Min.	:-3.91408	Min.	:-3.2023
1st Qu.	:-0.1969	1st Qu.	:-0.1526	1st Qu.	0.01008	1st Qu.	:-0.1436
Median	: 0.5017	Median	: 0.5398	Median	: 0.66552	Median	: 0.5533
Mean	: 0.4902	Mean	: 0.5427	Mean	: 0.67422	Mean	: 0.5454
3rd Qu.	: 1.1798	3rd Qu.	: 1.2266	3rd Qu.	: 1.33285	3rd Qu.	: 1.2333
Max.	: 4.4405	Max.	: 3.8895	Max.	: 4.76973	Max.	: 4.1923
tau		A		T0		T1	
Min.	:0.5	Min.	:0.000	Min.	: 0.00000	Min.	: 1.000
1st Qu.	:0.5	1st Qu.	:0.000	1st Qu.	: 0.03297	1st Qu.	: 1.033
Median	:0.5	Median	:1.000	Median	: 0.19533	Median	: 1.195

Mean	:0.5	Mean	:0.585	Mean	: 0.96483	Mean	: 1.965
3rd Qu.:	0.5	3rd Qu.:	1.000	3rd Qu.:	0.70717	3rd Qu.:	1.707
Max.	:0.5	Max.	:1.000	Max.	:148.66596	Max.	:149.666

C		T_obs		T_obs_tau		status	
Min.	: 0.000	Min.	: 0.00000	Min.	:0.0000001	Min.	:0.000
1st Qu.:	0.147	1st Qu.:	0.05471	1st Qu.:	0.0547105	1st Qu.:	0.000
Median	: 0.601	Median	: 0.26111	Median	:0.2611147	Median	:0.000
Mean	: 14.970	Mean	: 0.57851	Mean	:0.2711838	Mean	:0.455
3rd Qu.:	1.989	3rd Qu.:	0.95768	3rd Qu.:	0.5000000	3rd Qu.:	1.000
Max.	:7442.072	Max.	:64.25122	Max.	:0.5000000	Max.	:1.000

status_tau		censor.status		e	
Min.	:0.000	Min.	:0.000	Min.	:0.0001653
1st Qu.:	0.000	1st Qu.:	0.000	1st Qu.:	0.4069833
Median	:1.000	Median	:1.000	Median	:0.5882732
Mean	:0.623	Mean	:0.545	Mean	:0.5785815
3rd Qu.:	1.000	3rd Qu.:	1.000	3rd Qu.:	0.7925204
Max.	:1.000	Max.	:1.000	Max.	:0.9999639

[1] "Descriptive statistics for group A=0: 830"

X1		X2		X3		C	
Min.	:-2.4329	Min.	:-2.24933	Min.	:-2.06328	Min.	: 0.000
1st Qu.:	-0.1733	1st Qu.:	0.02092	1st Qu.:	-0.03158	1st Qu.:	0.163
Median	: 0.5206	Median	: 0.75589	Median	: 0.49266	Median	: 0.605
Mean	: 0.5049	Mean	: 0.73834	Mean	: 0.50242	Mean	: 12.960
3rd Qu.:	1.1825	3rd Qu.:	1.45181	3rd Qu.:	1.05292	3rd Qu.:	2.007
Max.	: 3.3728	Max.	: 3.55906	Max.	: 3.04847	Max.	:4777.151

T1		T0		status		T_obs	
Min.	: 1.000	Min.	: 0.00000	Min.	:0.0000	Min.	:0.00000
1st Qu.:	1.023	1st Qu.:	0.02334	1st Qu.:	0.0000	1st Qu.:	0.01608
Median	: 1.154	Median	: 0.15391	Median	:1.0000	Median	:0.09482
Mean	: 1.577	Mean	: 0.57698	Mean	:0.6988	Mean	:0.24150
3rd Qu.:	1.510	3rd Qu.:	0.51034	3rd Qu.:	1.0000	3rd Qu.:	0.28838
Max.	:21.672	Max.	:20.67202	Max.	:1.0000	Max.	:3.79985

status_tau		e	
Min.	:0.0000	Min.	:0.0001653
1st Qu.:	1.0000	1st Qu.:	0.2100453
Median	:1.0000	Median	:0.4255847
Mean	:0.7518	Mean	:0.4106731
3rd Qu.:	1.0000	3rd Qu.:	0.5872620
Max.	:1.0000	Max.	:0.9901589

[1] "Descriptive statistics for group A=1: 1170"

X1	X2	X3	C
Min. : -3.2665	Min. : -2.4399	Min. : -3.91408	Min. : 0.000
1st Qu.: -0.2187	1st Qu.: -0.2496	1st Qu.: 0.04506	1st Qu.: 0.138
Median : 0.4755	Median : 0.3835	Median : 0.85356	Median : 0.600
Mean : 0.4797	Mean : 0.4039	Mean : 0.79610	Mean : 16.396
3rd Qu.: 1.1789	3rd Qu.: 1.0812	3rd Qu.: 1.53362	3rd Qu.: 1.928
Max. : 4.4405	Max. : 3.8895	Max. : 4.76973	Max. : 7442.072

T1	T0	status	T_obs
Min. : 1.000	Min. : 0.00000	Min. : 0.0000	Min. : 0.00001
1st Qu.: 1.040	1st Qu.: 0.03976	1st Qu.: 0.0000	1st Qu.: 0.13814
Median : 1.238	Median : 0.23777	Median : 0.0000	Median : 0.59956
Mean : 2.240	Mean : 1.23997	Mean : 0.2821	Mean : 0.81759
3rd Qu.: 1.866	3rd Qu.: 0.86631	3rd Qu.: 1.0000	3rd Qu.: 1.06112
Max. : 149.666	Max. : 148.66596	Max. : 1.0000	Max. : 64.25122

status_tau	e
Min. : 0.0000	Min. : 0.05757
1st Qu.: 0.0000	1st Qu.: 0.54401
Median : 1.0000	Median : 0.71473
Mean : 0.5316	Mean : 0.69770
3rd Qu.: 1.0000	3rd Qu.: 0.88387
Max. : 1.0000	Max. : 0.99996

[1] "The ground truth for mis scenario at time 0.45 is 0.26"

Observational study with dependent censoring without misspecification

Observational study with dependent censoring with misspecification of one component

Observational study with dependent censoring with misspecification of two components

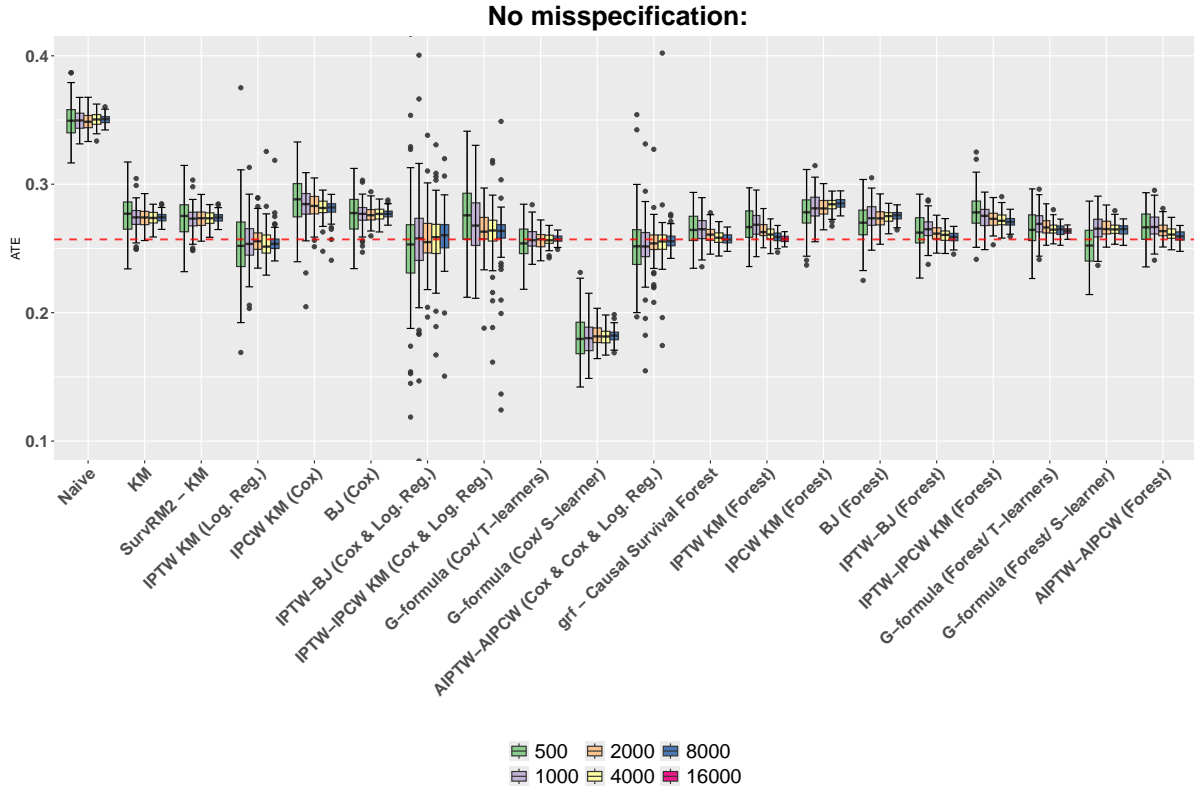


Figure 5: Estimation results of the ATE for the simulation of an observational study with dependent censoring and non linear relationships.

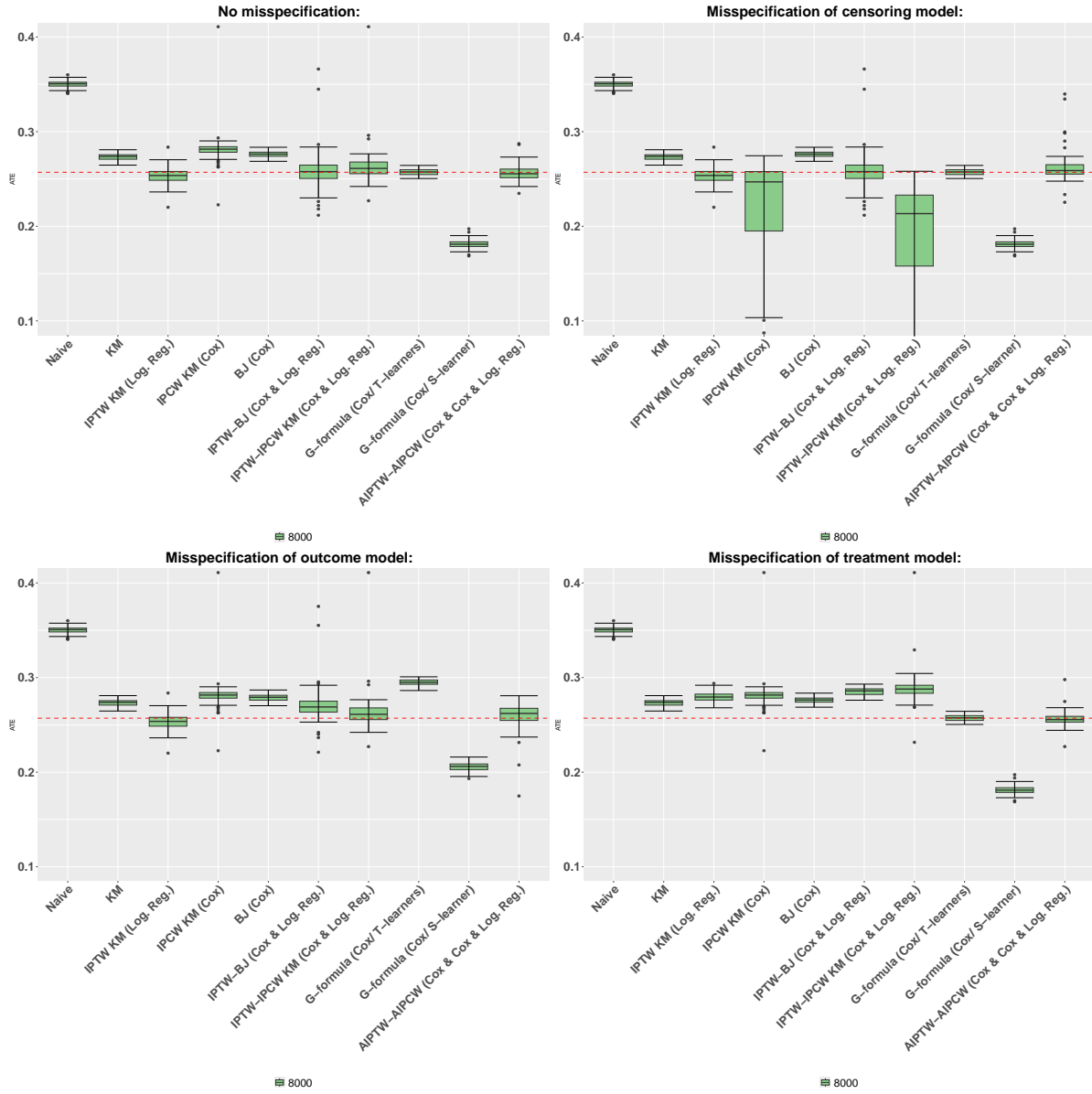


Figure 6: Estimation results of the ATE for an observational study with dependent censoring in case of a single misspecification.

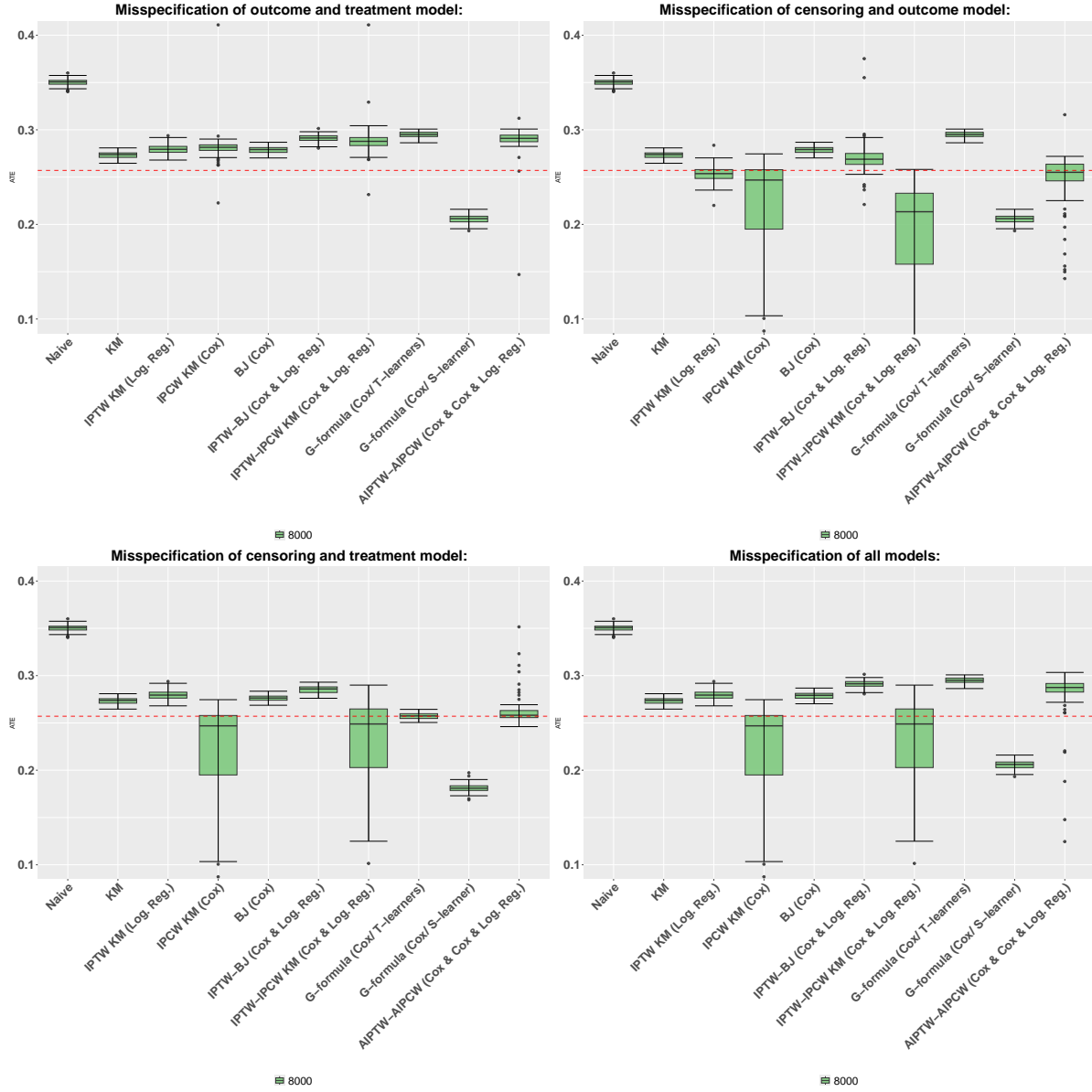


Figure 7: Estimation results of the ATE for an observational study with dependent censoring in case of a two or more misspecifications.