Assessing the Impact of Marijuana Decriminalization on Vehicle Accident Experience

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Contents

1 Data overview **1**
1.1 Canada 1
1.2 United States 6

2 Methods **8**

3 Results **9**
3.1 Canada 9
3.1.1 Average cost per claim 9
3.1.2 Claim frequency 10
3.1.3 Quebec average cost per claim 11
3.1.4 Quebec claim frequency 14
3.2 United States 18
3.2.1 Propensity score matching 18
3.2.2 Estimates of the effects 19

References **22**

Contents

1 Data overview

1.1 Canada

The legalization of recreational use of marijuana took effect across Canada on 2018-10-17.[1]

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[1]https://www.sencanada.ca/en/sencaplus/news/cannabis-act (accessed 2021-07-11)

The data used in this study come from annual reports of the General Insurance Statistical Agency[2] (GISA) which collects insurance information from most Canadian regions (except British Columbia, Manitoba, Quebec, and Saskatchewan; Exhibits AUTO1003, AUTO1005, and AUTO1010), and Groupement des Assureurs Automobiles[3] (GAA) that provides the information for Quebec (Exhibit 1A.2). From these reports, information on the *collision of private vehicles* per accident year was extracted.

The claims in this category are characterized by loss development factors close to 1, hence are not expected to change substantially as the losses from accidents that happened in the most recent years get finalized. Dollar amounts were adjusted to the prices of 2019 to account for the changing value of money, using the consumer price index (all item groups) by Statistics Canada.[4]

Figure 1 shows the dynamics of the studied variables by region. The regions differ in population, hence the annual number of earned vehicles was used to weight the observations in further analyses (Figure 2).

```
##
##  Descriptive statistics by group
## group: Alberta
##                                vars n       mean       sd     median        min
## Province                          1 4       1.00     0.00       1.00       1.00
## NEarnedVehicles                   2 4 2011693.00 31406.70 2009728.50 1980816.00
## ClaimFreqPer100EarnedVehicles     3 4       4.17     0.16       4.21       3.94
## AvgCostPerClaim                   4 4    6648.98   153.80    6675.32    6438.00
##                                    max    range  skew kurtosis       se
## Province                          1.00     0.00   NaN      NaN     0.00
## NEarnedVehicles                2046499.00 65683.00  0.07    -2.31 15703.35
## ClaimFreqPer100EarnedVehicles       4.32     0.38 -0.51    -1.79     0.08
## AvgCostPerClaim                  6807.30   369.30 -0.37    -1.83    76.90
## ------------------------------------------------------------
## group: New Brunswick
##                                vars n      mean      sd    median       min
## Province                          1 4      2.00    0.00      2.00      2.00
## NEarnedVehicles                   2 4 371501.00 8851.59 372494.50 360422.00
## ClaimFreqPer100EarnedVehicles     3 4      2.97    0.12      3.01      2.79
## AvgCostPerClaim                   4 4   6593.12  351.49   6479.35   6330.78
##                                    max    range  skew kurtosis      se
## Province                          2.00     0.00   NaN      NaN    0.00
## NEarnedVehicles                380593.00 20171.00 -0.19    -2.09 4425.80
## ClaimFreqPer100EarnedVehicles      3.06     0.27 -0.66    -1.74    0.06
## AvgCostPerClaim                 7083.00   752.22  0.49    -1.92  175.75
```

[2]https://www.gisa.ca/ (accessed 2021-07-01)

[3]https://gaa.qc.ca/en/statistics/at-a-glance/ (accessed 2021-07-01)

[4]Statistics Canada. Table 18-10-0005-01 Consumer Price Index, annual average, not seasonally adjusted https://doi.org/10.25318/1810000501-eng (release date 2021-01-20)

```
## ------------------------------------------------------------
## group: Newfoundland and Labrador
##                                vars n      mean      sd    median       min
## Province                          1 4      3.00    0.00      3.00      3.00
## NEarnedVehicles                   2 4 245960.25 4479.98 245550.00 241201.00
## ClaimFreqPer100EarnedVehicles     3 4      3.49    0.06      3.47      3.45
## AvgCostPerClaim                   4 4   6613.30  175.58   6651.49   6367.18
##                                    max    range  skew kurtosis      se
## Province                          3.00     0.00   NaN      NaN    0.00
## NEarnedVehicles                251540.00 10339.00  0.16    -2.06 2239.99
## ClaimFreqPer100EarnedVehicles      3.57     0.12  0.53    -1.88    0.03
## AvgCostPerClaim                 6783.05   415.88 -0.46    -1.81   87.79
## ------------------------------------------------------------
## group: Northwest Territories
##                                vars n     mean     sd   median      min      max
## Province                          1 4     4.00   0.00     4.00     4.00     4.00
## NEarnedVehicles                   2 4 13597.25 260.03 13603.50 13287.00 13895.00
## ClaimFreqPer100EarnedVehicles     3 4     3.21   0.16     3.18     3.06     3.43
## AvgCostPerClaim                   4 4  7959.45 476.66  7919.82  7538.40  8459.75
##                                 range  skew kurtosis     se
## Province                         0.00   NaN      NaN   0.00
## NEarnedVehicles                608.00 -0.04    -2.05 130.02
## ClaimFreqPer100EarnedVehicles    0.37  0.44    -1.82   0.08
## AvgCostPerClaim                921.35  0.05    -2.38 238.33
## ------------------------------------------------------------
## group: Nova Scotia
##                                vars n     mean       sd    median       min
## Province                          1 4      5.0     0.00      5.00      5.00
## NEarnedVehicles                   2 4 406217.0 12432.91 408153.50 390442.00
## ClaimFreqPer100EarnedVehicles     3 4      3.1     0.11      3.08      2.99
## AvgCostPerClaim                   4 4   6720.8   157.02   6735.17   6541.56
##                                    max    range  skew kurtosis      se
## Province                          5.00     0.00   NaN      NaN    0.00
## NEarnedVehicles                418119.00 27677.00 -0.24    -2.10 6216.45
## ClaimFreqPer100EarnedVehicles      3.22     0.23  0.08    -2.32    0.06
## AvgCostPerClaim                 6871.36   329.81 -0.10    -2.28   78.51
## ------------------------------------------------------------
## group: Nunavut
##                                vars n     mean      sd  median     min      max
## Province                          1 4     6.00    0.00    6.00    6.00     6.00
## NEarnedVehicles                   2 4  1815.75   91.51 1831.00 1692.00  1909.00
## ClaimFreqPer100EarnedVehicles     3 4     2.26    0.16    2.28    2.05     2.42
## AvgCostPerClaim                   4 4 10267.94 2484.28 9303.76 8538.00 13926.24
##                                 range  skew kurtosis      se
## Province                         0.00   NaN      NaN    0.00
```

```
## NEarnedVehicles                 217.00 -0.34    -1.89   45.76
## ClaimFreqPer100EarnedVehicles    0.37 -0.25    -1.97    0.08
## AvgCostPerClaim               5388.24  0.67    -1.74 1242.14
## ------------------------------------------------------------
## group: Ontario
##                               vars n       mean        sd     median        min
## Province                         1 4       7.00      0.00       7.00       7.00
## NEarnedVehicles                  2 4 5137798.50 100091.58 5132387.00 5026317.00
## ClaimFreqPer100EarnedVehicles    3 4       3.17      0.15       3.18       2.99
## AvgCostPerClaim                  4 4    7834.57    406.69    7831.84    7365.61
##                                     max     range  skew kurtosis       se
## Province                           7.00      0.00   NaN      NaN     0.00
## NEarnedVehicles                5260103.00 233786.00  0.10    -2.05 50045.79
## ClaimFreqPer100EarnedVehicles       3.32      0.33 -0.11    -2.21     0.08
## AvgCostPerClaim                  8309.00    943.39  0.01    -2.08   203.34
## ------------------------------------------------------------
## group: Prince Edward Island
##                               vars n     mean      sd   median      min
## Province                         1 4     8.00    0.00     8.00     8.00
## NEarnedVehicles                  2 4 63884.25 3246.28 64651.50 59628.00
## ClaimFreqPer100EarnedVehicles    3 4     2.54    0.05     2.55     2.49
## AvgCostPerClaim                  4 4  6407.32  361.06  6320.86  6073.40
##                                     max   range  skew kurtosis      se
## Province                           8.00    0.00   NaN      NaN    0.00
## NEarnedVehicles                66606.00 6978.00 -0.33    -2.07 1623.14
## ClaimFreqPer100EarnedVehicles      2.59    0.10 -0.11    -2.28    0.02
## AvgCostPerClaim                 6914.18  840.79  0.48    -1.84  180.53
## ------------------------------------------------------------
## group: Quebec
##                               vars n       mean        sd     median        min
## Province                         1 4       9.00      0.00       9.00       9.00
## NEarnedVehicles                  2 4 3981579.00 130733.06 3974803.50 3835132.00
## ClaimFreqPer100EarnedVehicles    3 4       4.84      0.10       4.84       4.73
## AvgCostPerClaim                  4 4    4702.20    210.63    4680.60    4484.61
##                                     max     range  skew kurtosis       se
## Province                           9.00      0.00   NaN      NaN     0.00
## NEarnedVehicles                4141577.00 306445.00  0.10    -2.04 65366.53
## ClaimFreqPer100EarnedVehicles       4.93      0.20 -0.06    -2.31     0.05
## AvgCostPerClaim                  4963.00    478.39  0.17    -2.10   105.31
## ------------------------------------------------------------
## group: Yukon
##                               vars n     mean     sd  median      min      max
## Province                         1 4    10.00   0.00    10.0    10.00    10.00
## NEarnedVehicles                  2 4 15990.00 664.81 16001.0 15211.00 16747.00
## ClaimFreqPer100EarnedVehicles    3 4     3.02   0.15     3.0     2.87     3.19
```

```
## AvgCostPerClaim                   4 4  7754.38 692.05  7565.8  7209.88  8676.00
##                                 range  skew kurtosis     se
## Province                         0.00   NaN      NaN   0.00
## NEarnedVehicles               1536.00 -0.03    -2.09 332.41
## ClaimFreqPer100EarnedVehicles    0.32  0.11    -2.26   0.08
## AvgCostPerClaim               1466.12  0.36    -2.04 346.02
```

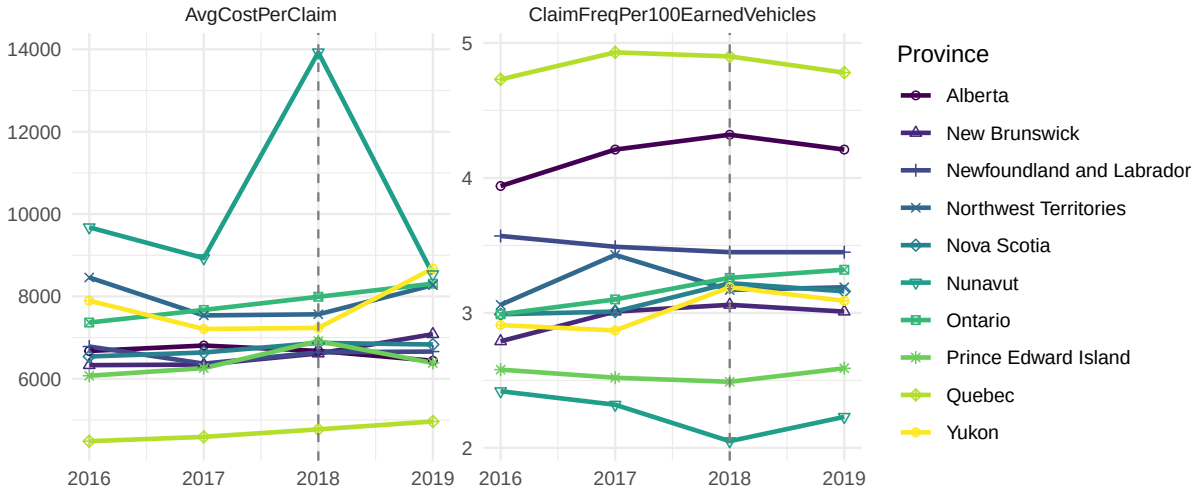


Figure 1: Annual average cost per claim (in 2019 dollars) and frequency of collisions. The dashed line denotes the year of marijuana decriminalization.

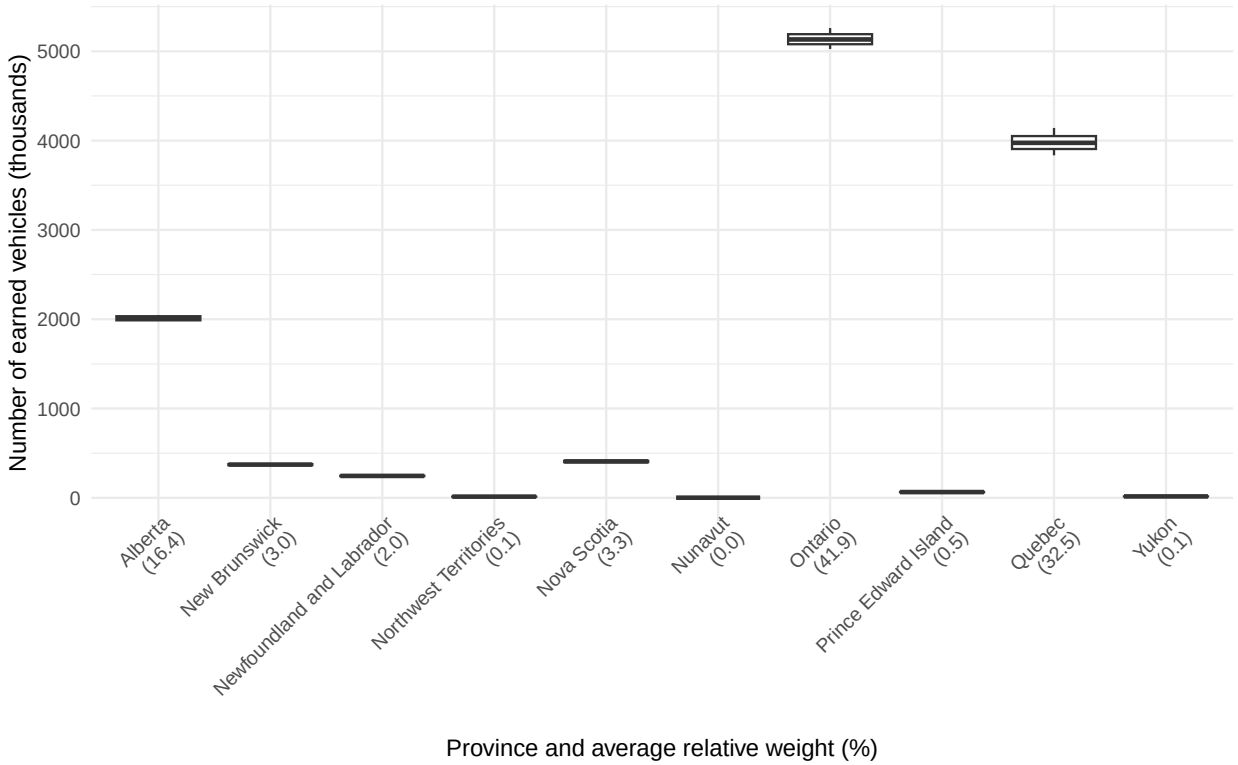


Figure 2: Number of earned vehicles during 2016–2019 used as the regional weights. The lower and upper hinges correspond to the first and third quartiles.

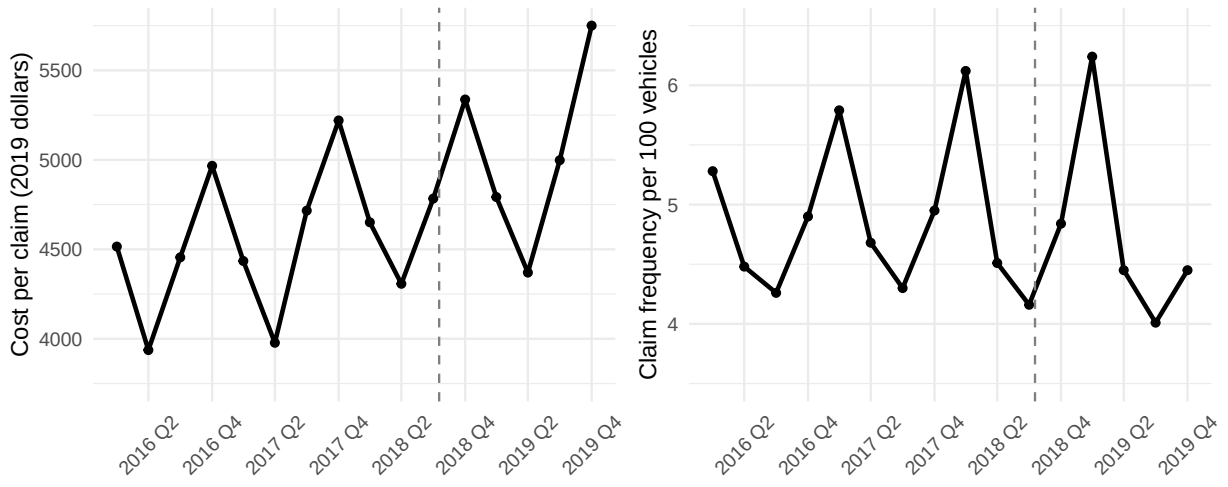


Figure 3: Quarterly average cost per claim (in 2019 dollars) and frequency of collisions in Quebec. The dashed line denotes the date of marijuana decriminalization.

1.2 United States

The following state statistics were used to select the control group states: urbanization (percentage of the total population)[5], population[6], vehicle miles per licensed driver[7], road miles per 1000 persons (calculated as the total road and street mileage divided by the population)[7], and vehicles per 1000 people[7]. Number of licensed drivers was also considered, but correlated too strongly ($r = 0.99$) with population.

Air temperature and precipitation information was obtained from two alternative sources:

1. Hourly data were obtained from the US ASOS network of automated airport weather observations[8], using airport codes from the CTAD. In the cases when an airport from CTAD could not be found, its location was approximated using latitudes and longitudes of reported accidents, and geodesic distances were used to replace the missing airport with a nearby airport represented in the ASOS database.
2. Daily gridded data from Daymet[9], where grid cells were selected based on coordinates of airport weather stations in the ASOS network.

The Fatality Analysis Reporting System (FARS)[10] of the National Highway Traffic Safety Administration (NHTSA) of the United States Department of Transportation was used to extract accident data for this study.

The database was supplemented with such variables as Year (numeric), Month (1–12, categorical), Weekday (1–7, categorical), Weekend (0/1, categorical), Holiday (0/1, categorical, based on Wuertz et al. 2023 holiday calendar for the New York Stock Exchange).

The accident experience metrics were normalized by the number of registered vehicles by year and state, available from https://www.fhwa.dot.gov.

Table 1: Groups of states for studying the cannabis legalization in the United States (from 2016-03 to 2019-12). The dates when the commercial sales started are used in analysis and are shown in parentheses.

Group	States
Legalized	CA (2018-01-01), MA (2018-11-20), NV (2017-07-01)
Fully illegal	ID, KS, NE, NC, SC, TN, WY
Illegal recreational	AL, AR, FL, IN, IA, KY, OK, TX, UT, WV, WI
Legalized after the study period	AZ, MT, NJ, NY, SD, VA

[5]https://en.wikipedia.org/wiki/Urbanization_in_the_United_States (accessed 2021-11-01)
[6]https://www.fhwa.dot.gov/ohim/onh00/onh2p11.htm (accessed 2021-12-25)
[7]https://en.wikipedia.org/wiki/List_of_U.S._states_by_vehicles_per_capita (accessed 2021-11-01)
[8]https://mesonet.agron.iastate.edu/request/download.phtml?network=AWOS
[9]Daymet: Daily Surface Weather Data on a 1-km Grid for North America, Version 4 https://doi.org/10.3334/ORNLDAAC/1840
[10]https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars (accessed 2021-07-01)

Table 1: Groups of states for studying the cannabis legalization in the United States (from 2016-03 to 2019-12). The dates when the commercial sales started are used in analysis and are shown in parentheses.

Group	States
Mixed (unused in the study)	AK, CO, CT, DE, DC, GA, HI, IL, LA, ME, MD, MI, MN, MS, MO, NH, N

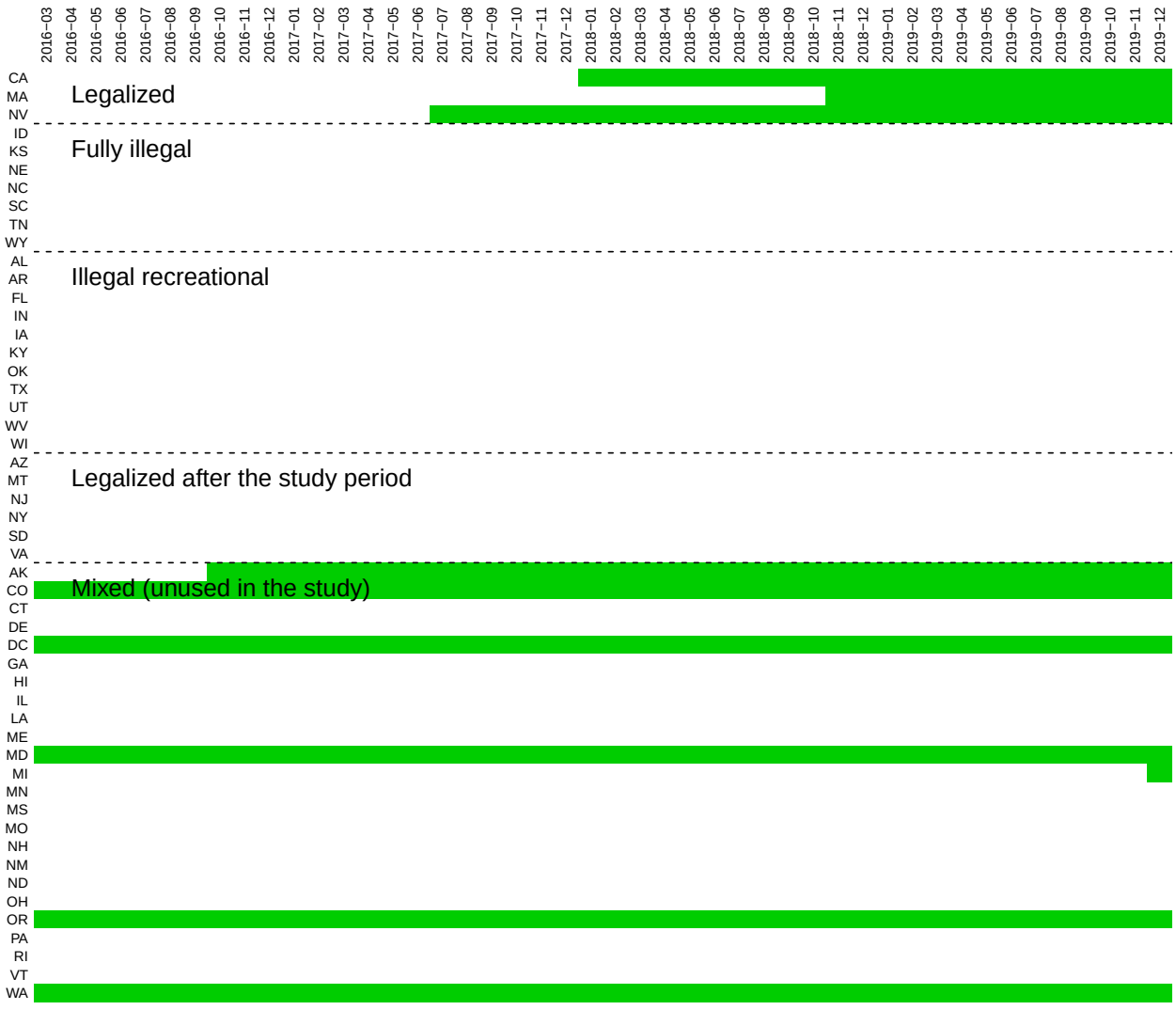


Figure 4: Cannabis legalization in the United States (from 2016-03 to 2019-12). Green shows the times after the commercial sales started.

2 Methods

Use two-tailed tests with significance level $\alpha = 0.05$ unless noted otherwise ($1 - \alpha = 0.95$ or 95% corresponds to the confidence level). In other words, the results are statistically significant when the corresponding p-values are below α.

The analysis is done in R (R Core Team 2022).

3 Results

3.1 Canada

In this section, the number of earned vehicles per region (Figure 2) was used as the weights.

3.1.1 Average cost per claim

Results for the average cost per claim are as follows. The p-value for the effect of marijuana decriminalization in Canada in the mixed-effects model is above the significance level (Table 2), which implies there is not enough evidence of the decriminalization effect. The bootstrap distribution for this parameter has its center close to zero (Figure 5) and all versions of the confidence intervals contain zero (Table 3) implying no significant effects.

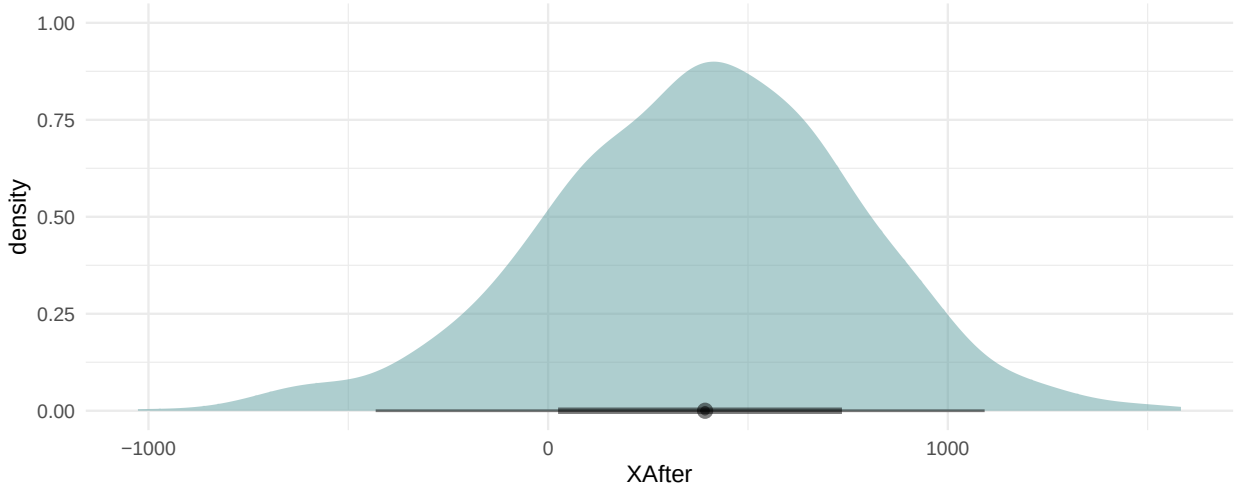


Figure 5: Density plot of the bootstrap distribution of coefficient b in the mixed-effects model of the effect of marijuana decriminalization on the average cost per claim in Canada. The horizontal lines correspond to 66% and 95% confidence.

Table 2: Parametric estimates from the mixed effects model of the effect of marijuana decriminalization on the average cost per claim in Canada

rowname	Value	Std.Error	DF	t-value	p-value
XAfter	376.912	380.70	18	0.99005	0.33527
Year	-12.204	144.01	18	-0.08475	0.93340

Table 3: Bootstrap confidence intervals for the coefficient b in the mixed-effects model of the effect of marijuana decriminalization on the average cost per claim in Canada

rowname	term	estimate	lower	upper type	level
1	XAfter	376.91	-384.09	1,134.1 norm	0.95
2	XAfter	376.91	-338.37	1,185.4 basic	0.95
3	XAfter	376.91	-431.57	1,092.2 perc	0.95

3.1.2 Claim frequency

Results for the claim frequency per 100 earned vehicles lead to the same conclusions as do the results for the average cost per claim presented in the previous section. Specifically, the p-value for the effect of marijuana decriminalization in Canada in the mixed-effects model is above the significance level (Table 4), which implies there is not enough evidence of the decriminalization effect. The bootstrap distribution for this parameter has its center close to zero (Figure 6) and all versions of the confidence intervals contain zero (Table 5) implying no significant effects.

Table 4: Parametric estimates from the mixed-effects model of the effect of marijuana decriminalization on the claim frequency in Canada

rowname	Value	Std.Error	DF	t-value	p-value
XAfter	-0.19125	0.13038	18	-1.4668	0.159684
Year	0.10657	0.04930	18	2.1616	0.044364

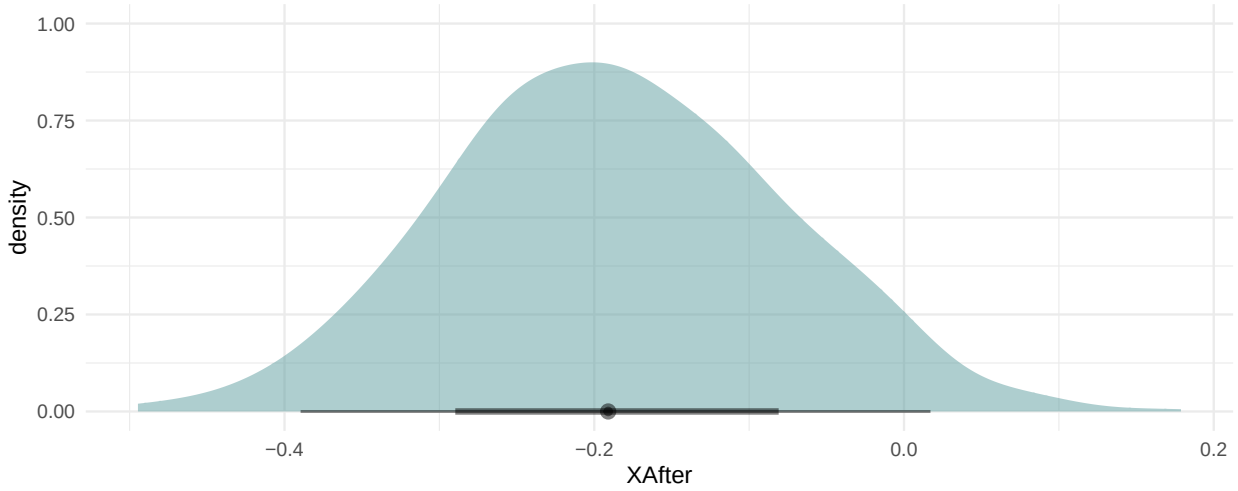


Figure 6: Density plot of the bootstrap distribution of coefficient b in the mixed-effects model of the effect of marijuana decriminalization on the claim frequency in Canada. The horizontal lines correspond to 66% and 95% confidence.

Table 5: Bootstrap confidence intervals for the coefficient b in the mixed-effects model of the effect of marijuana decriminalization on the claim frequency in Canada

rowname	term	estimate	lower	upper	type	level
1	XAfter	-0.19125	-0.40626	0.0160142	norm	0.95
2	XAfter	-0.19125	-0.39958	0.0071157	basic	0.95
3	XAfter	-0.19125	-0.38961	0.0170906	perc	0.95

3.1.3 Quebec average cost per claim

Here model (**??**) is applied to quarterly average costs per claim in Quebec. With the observed trend and seasonality, there is not enough evidence of changing average costs after the marijuana decriminalization (Table 6, p-value above 0.05). See the fit of this model in Figure 7; all observed values belong to the 95% prediction interval.

Table 6: Results of estimating the effect of marijuana decriminalization on average cost per claim in Quebec within a trend-seasonal model

rowname	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-331,924.566	79,125.587	-4.19491	0.0018435344
BAAfter	12.824	97.316	0.13177	0.8977778234
Year	166.800	39.229	4.25193	0.0016843695
Quarter2	-450.174	73.391	-6.13388	0.0001106417
Quarter3	139.939	73.391	1.90675	0.0856636605
Quarter4	716.961	77.319	9.27280	0.0000031612

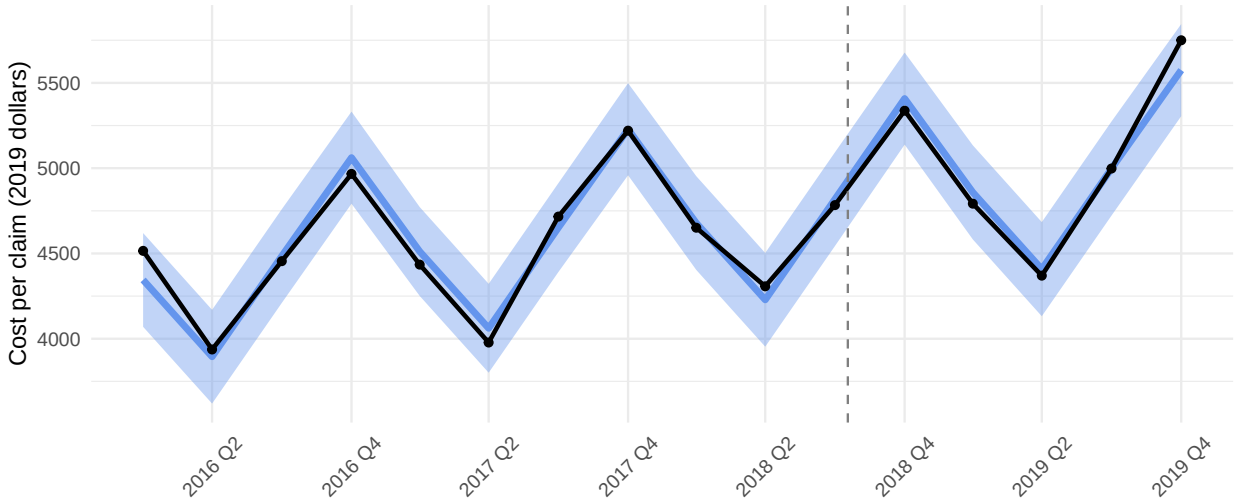


Figure 7: Quarterly average cost per claim (in 2019 dollars) in Quebec. Black are the observed values, blue are the fitted values and 95 percent prediction intervals. The dashed line denotes the date of marijuana decriminalization.

Figure 8 shows the bootstrap distribution of the parameter with a percentile interval. All versions of the 95% intervals contain zero, hence there is not enough evidence of the decriminalization effect: normal interval (-170.50, 190.57), basic interval (-160.59, 193.20), and percentile interval (-167.55, 186.24).

Additionally, a restricted model (without the indicator variable representing the periods Before/After)

$$y_{t'} = a + ct' + \sum_{i=1}^{s-1} d_i S_{it'} + e_{t'} \tag{1}$$

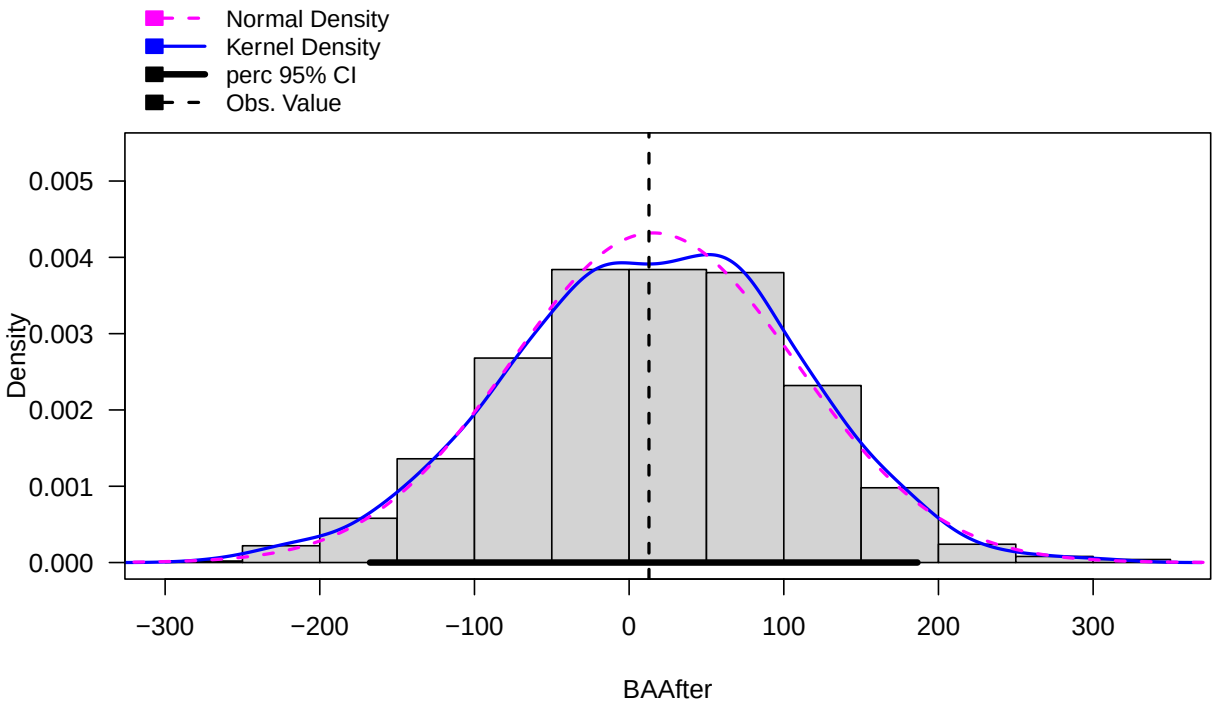


Figure 8: Density plot of the bootstrap distribution of coefficient b in the linear model of the effect of marijuana decriminalization on the average cost per claim in Quebec.

was estimated on t' before the decriminalization date and similar outputs were obtained from this model (Table 7, Figure 9). Figure 9 shows that before-decriminalization trends extended in the future can accurately predict the average costs per claim, without modeling the effect of decriminalization.

Table 7: Results of estimating the restricted trend-seasonal model for average cost per claim in Quebec, using the data before decriminalization

rowname	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-293,708.61	76,830.157	-3.8228	0.00873184
Year	147.86	38.091	3.8818	0.00815333
Quarter2	-459.57	79.293	-5.7958	0.00115583
Quarter3	117.92	79.293	1.4871	0.18754294
Quarter4	633.56	90.675	6.9871	0.00042774

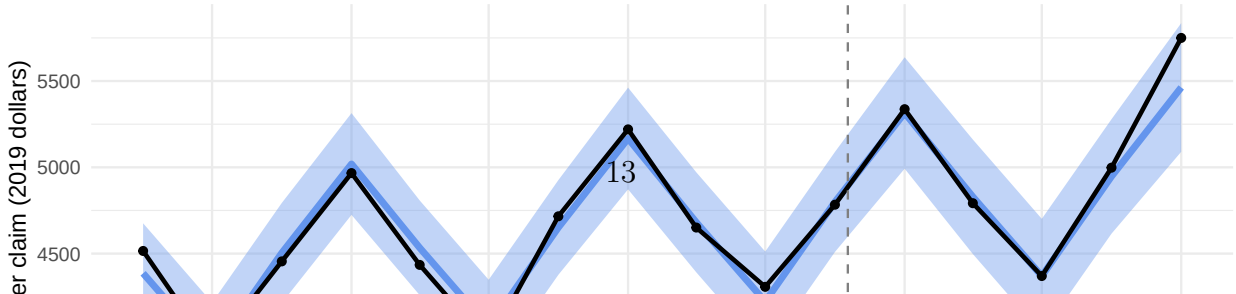


Table 8: Results of estimating the effect of marijuana decriminalization on claim frequency in Quebec within a trend-seasonal model

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-167.0167	206.3290	-0.81	0.4371
BAAfter	-0.2176	0.2538	-0.86	0.4113
Year	0.0857	0.1023	0.84	0.4217
Quarter2	-1.3275	0.1914	-6.94	0.0000
Quarter3	-1.6750	0.1914	-8.75	0.0000
Quarter4	-1.0181	0.2016	-5.05	0.0005

Table 9: Results of estimating the effect of marijuana decriminalization on claim frequency in Quebec within a trend-seasonal model

rowname	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-167.016676	206.32901	-0.80947	0.437082930
BAAfter	-0.217582	0.25376	-0.85743	0.411287857
Year	0.085714	0.10229	0.83791	0.421654958
Quarter2	-1.327500	0.19138	-6.93659	0.000040119
Quarter3	-1.675000	0.19138	-8.75239	0.000005314
Quarter4	-1.018104	0.20162	-5.04968	0.000499480

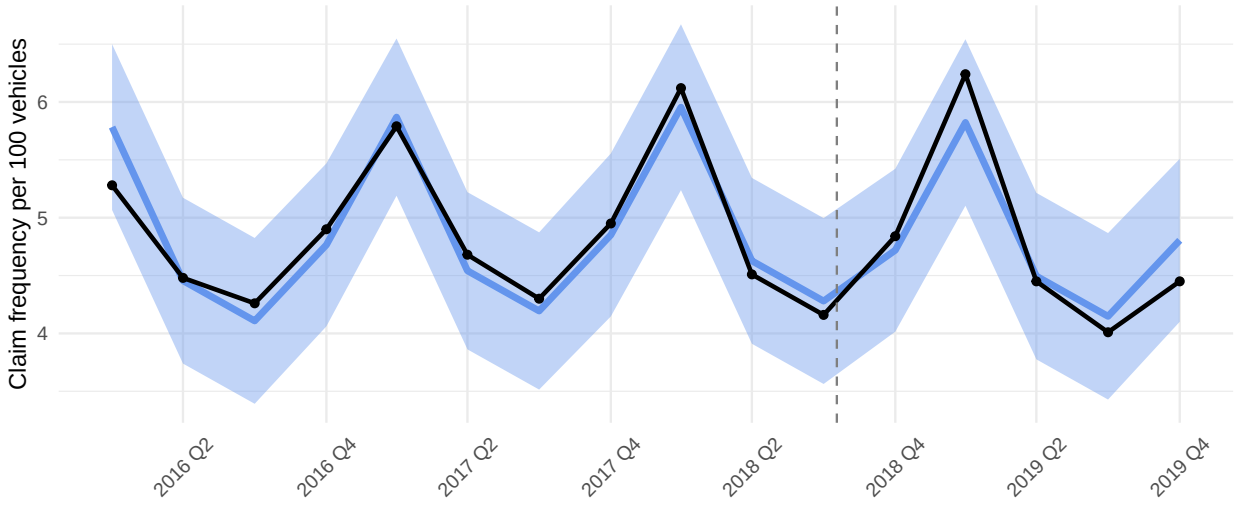


Figure 10: Quarterly claim frequency per 100 earned vehicles in Quebec. Black are the observed values, blue are the fitted values and 95 percent prediction intervals. The dashed line denotes the date of marijuana decriminalization.

Table 10: Results of estimating the restricted trend-seasonal model for claim frequency per 100 earned ve-

Table 10: Results of estimating the restricted trend-seasonal model for claim frequency per 100 earned vehicles in Quebec, using the data before decriminalization

rowname	Estimate	Std. Error	t value	Pr(>|t|)
Year	0.12231	0.087102	1.4042	0.20985112
Quarter2	-1.17333	0.181317	-6.4712	0.00064639
Quarter3	-1.49000	0.181317	-8.2177	0.00017525
Quarter4	-0.74385	0.207344	-3.5875	0.01153847

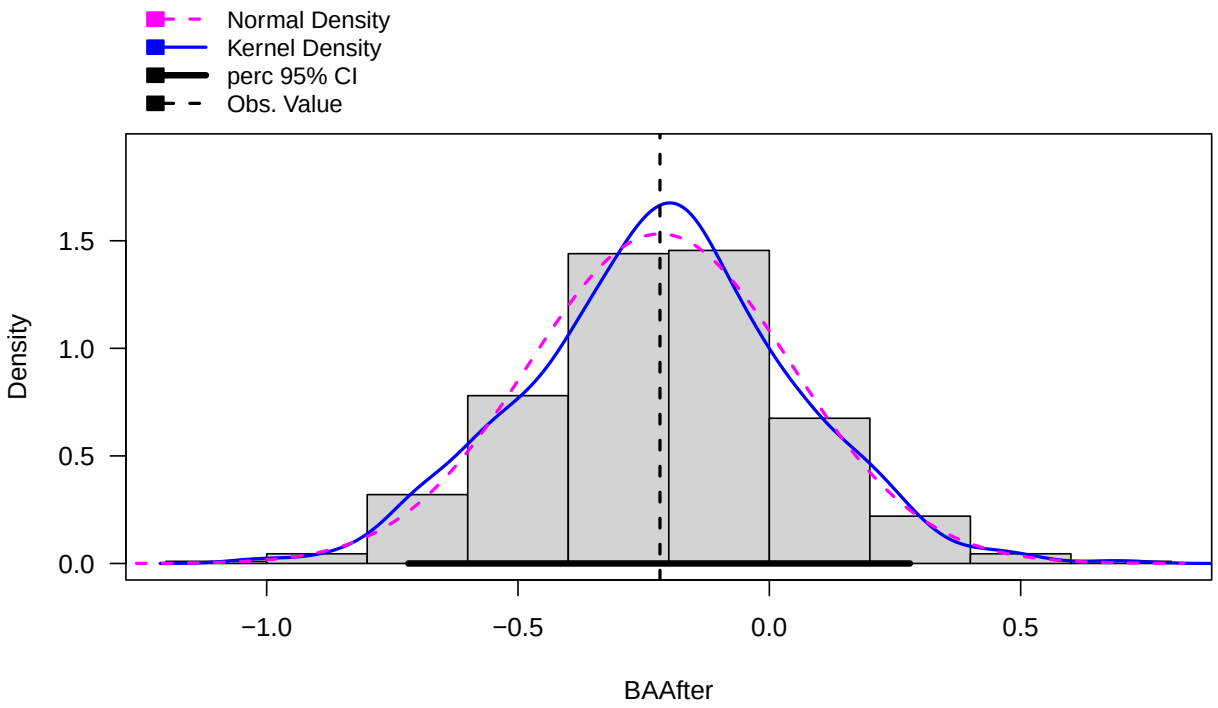


Figure 11: Density plot of the bootstrap distribution of coefficient b in the linear model of the effect of marijuana decriminalization on the average cost per claim in Quebec.

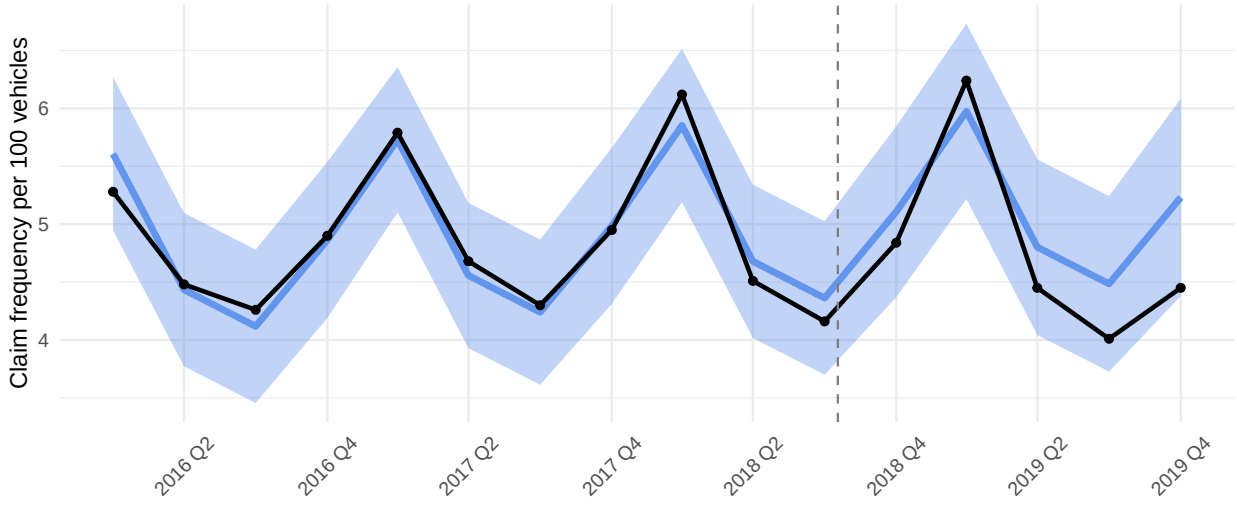


Figure 12: Quarterly claim frequency per 100 earned vehicles in Quebec. Black are the observed values, blue are the fitted values (restricted trend-seasonal model based on the data before decriminalization) and 95 percent prediction intervals. The dashed line denotes the date of marijuana decriminalization.

3.2 United States

3.2.1 Propensity score matching

Below are the matches for each decriminalized state:

- for the state of CA:
  - WV
  - FL, MT, WV
  - FL, MT, SD, TN, WV
- for the state of MA:
  - UT
  - KS, UT, VA
  - ID, IN, KS, UT, VA
- for the state of NV:
  - NY
  - AZ, NY, TX
  - AZ, NC, NE, NY, TX

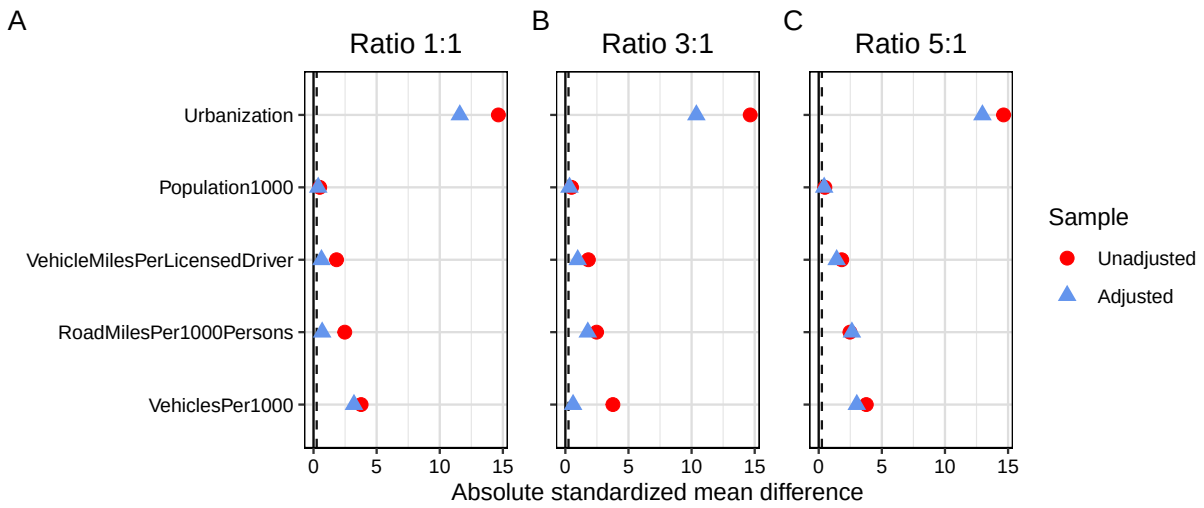


Figure 13: Standardized mean differences for propensity score matching with different ratios of selected control:treated states. The dashed line corresponds to the threshold of 0.25.

Conventional matching

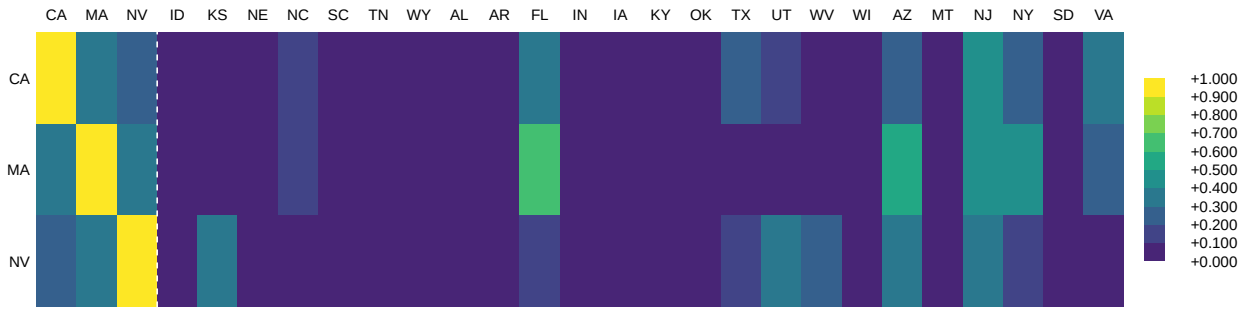
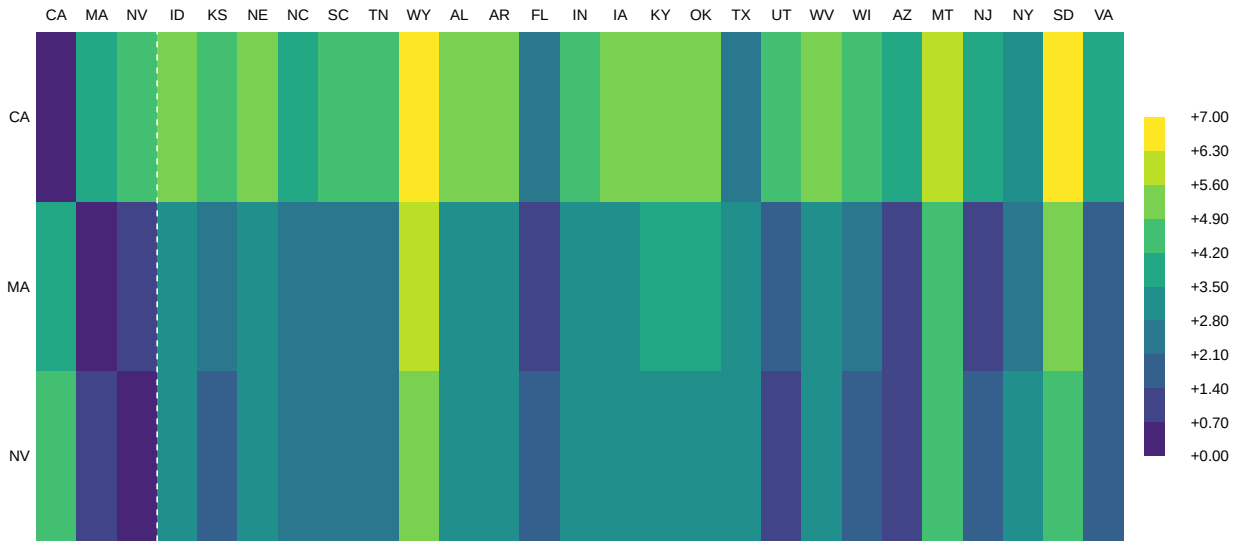


Figure 14: Random forest similarity matrix based on the 5 state variables.



Similarities between states derived from a random forest (Figure 14) were used to find alternative matches. Each state in the "Legalized" group was matched with the most similar state in the control group if the latter has not been used as a match:

- for the state of CA: NJ
- for the state of MA: FL
- for the state of NV: UT

3.2.2 Estimates of the effects

Table 11: Estimates of the decriminalization effects based on regression random forests; Altmann's p-values are in parentheses. The last column of results excludes UT and uses subsets of $+-1$ year from the decriminalization date for other states

States	Fatality.rate	Rate.of.fatal.accidents	Rate.of.road.accidents
CA, WV	-0.032 (1.00)	-0.015 (0.58)	2.444 (0.01)
MA, UT	-0.026 (0.88)	-0.020 (0.89)	–
NV, NY	-0.015 (0.24)	-0.018 (0.99)	-0.387 (0.02)
CA, WV, MA, UT, NV, NY	-0.011 (0.95)	-0.009 (0.99)	0.642 (0.01)
CA, NJ	-0.014 (0.97)	-0.015 (0.98)	1.196 (0.01)
MA, FL	-0.066 (0.01)	-0.060 (0.01)	-0.943 (0.01)
NV, UT	-0.015 (0.95)	-0.012 (0.81)	–
CA, NJ, MA, FL, NV, UT	-0.012 (0.50)	-0.012 (0.54)	0.321 (0.01)

	group1	mean	sd	min	Q0.25	Q0.5	Q0.75	max	n
Trange1	CA	12.844	2.907	4.794	10.864	13.249	14.971	19.482	1400
Trange2	FL	10.285	2.133	5.059	8.880	9.809	11.429	18.798	1400
Trange3	MA	10.549	2.893	3.542	8.374	10.562	12.680	19.428	1400
Trange4	NJ	10.577	3.502	2.378	7.986	10.620	12.786	22.030	1400
Trange5	NV	15.248	3.646	5.405	12.617	15.812	18.186	22.357	1400
Trange6	NY	10.555	2.972	3.073	8.427	10.416	12.588	19.895	1400
Trange7	UT	14.465	3.317	5.819	12.019	14.871	17.070	21.252	1400
Trange8	WV	12.034	3.675	2.800	9.579	11.998	14.394	24.189	1400
Precip1	CA	1.481	3.664	0.000	0.000	0.071	0.784	30.314	1400
Precip2	FL	4.279	6.354	0.000	0.329	2.168	6.116	127.453	1400
Precip3	MA	3.364	5.901	0.000	0.252	0.939	3.606	47.100	1400
Precip4	NJ	3.709	7.202	0.000	0.000	0.285	4.075	79.102	1400
Precip5	NV	0.966	1.741	0.000	0.000	0.284	1.040	14.713	1400
Precip6	NY	3.317	4.431	0.000	0.553	1.556	4.417	49.675	1400
Precip7	UT	1.236	1.782	0.000	0.127	0.572	1.533	18.373	1400
Precip8	WV	3.612	4.790	0.000	0.304	1.668	5.381	37.362	1400
Temp1	CA	17.199	5.474	5.052	12.871	16.984	21.914	30.542	1400
Temp2	FL	22.972	5.090	4.607	19.530	23.895	27.524	29.899	1400
Temp3	MA	10.777	9.086	-13.850	3.077	10.894	19.020	27.552	1400
Temp4	NJ	13.295	9.405	-12.706	5.124	14.107	21.967	30.918	1400
Temp5	NV	13.288	8.694	-7.635	6.035	12.531	21.511	29.559	1400

Temp6	NY	10.073	9.612	-15.718	2.017	10.619	18.971	26.675	1400
Temp7	UT	12.100	9.470	-12.422	4.308	11.476	21.379	27.942	1400
Temp8	WV	12.950	9.135	-14.100	5.316	14.183	21.422	27.102	1400
Fatals1m1	CA	0.335	0.127	0.032	0.232	0.325	0.419	0.860	1401
Fatals1m2	FL	0.500	0.208	0.000	0.354	0.472	0.617	1.205	1401
Fatals1m3	MA	0.166	0.191	0.000	0.000	0.197	0.198	0.988	1401
Fatals1m4	NJ	0.209	0.206	0.000	0.000	0.166	0.330	1.347	1401
Fatals1m5	NV	0.353	0.411	0.000	0.000	0.393	0.417	2.784	1401
Fatals1m6	NY	0.260	0.181	0.000	0.092	0.261	0.360	2.090	1401
Fatals1m7	UT	0.331	0.419	0.000	0.000	0.411	0.432	2.529	1401
Fatals1m8	WV	0.486	0.584	0.000	0.000	0.587	0.599	4.133	1401
NFatAcc1m1	CA	0.308	0.111	0.032	0.227	0.292	0.387	0.741	1401
NFatAcc1m2	FL	0.465	0.187	0.000	0.343	0.449	0.590	1.121	1401
NFatAcc1m3	MA	0.158	0.175	0.000	0.000	0.197	0.198	0.988	1401
NFatAcc1m4	NJ	0.196	0.186	0.000	0.000	0.165	0.330	1.010	1401
NFatAcc1m5	NV	0.329	0.369	0.000	0.000	0.393	0.417	1.989	1401
NFatAcc1m6	NY	0.244	0.161	0.000	0.092	0.184	0.351	0.958	1401
NFatAcc1m7	UT	0.303	0.366	0.000	0.000	0.411	0.424	2.158	1401
NFatAcc1m8	WV	0.450	0.513	0.000	0.000	0.587	0.599	2.933	1401

	group1	mean	sd	min	Q0.25	Q0.5	Q0.75	
RegisteredVehicles1	CA	30846728	368957.7	30221033	30795141	31022327	31247270	3124
RegisteredVehicles2	FL	17248521	467869.0	16600317	16959269	17496001	17833720	1783
RegisteredVehicles3	MA	5064167	3271.8	5061260	5061260	5061498	5065221	506
RegisteredVehicles4	NJ	6025180	45593.9	5940997	6033015	6055389	6057711	605
RegisteredVehicles5	NV	2482129	55336.1	2398659	2455442	2514338	2546583	254
RegisteredVehicles6	NY	11216616	248449.0	10857455	10857455	11389158	11482229	1148
RegisteredVehicles7	UT	2371212	40099.8	2317282	2355773	2372800	2430275	243
RegisteredVehicles8	WV	1688827	13249.8	1668113	1668113	1691237	1693719	170

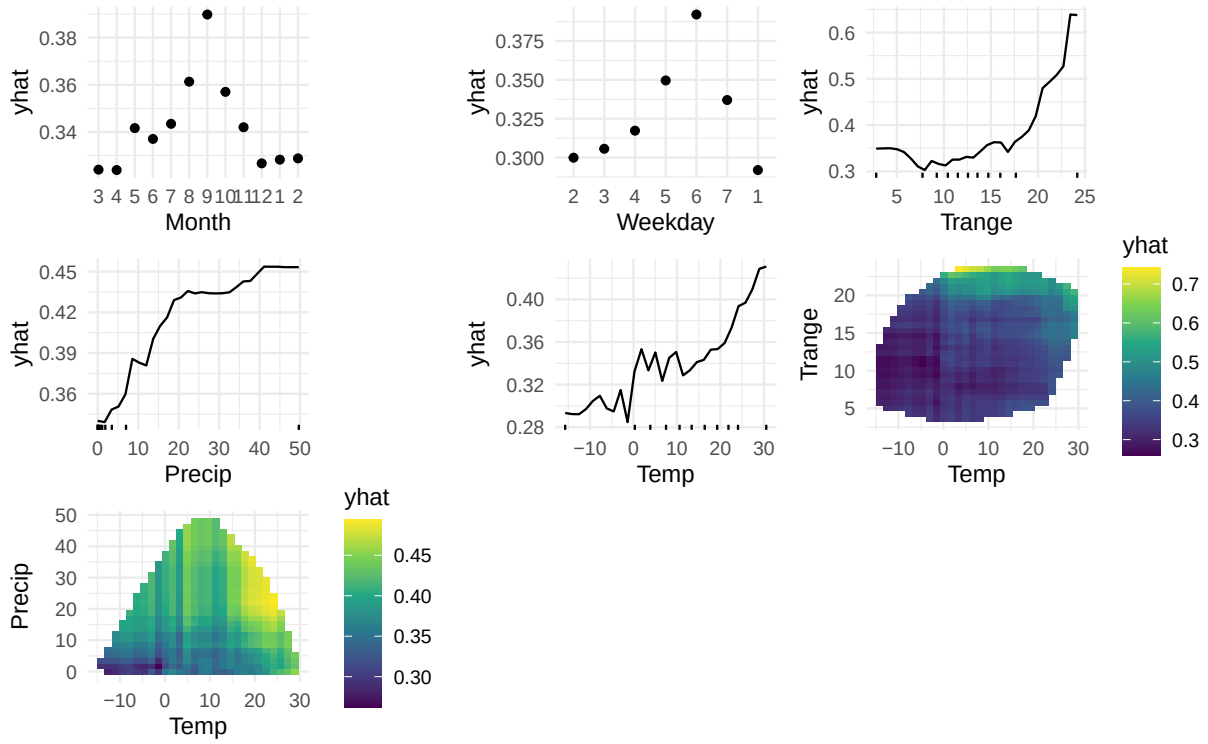


Figure 15: Partial dependence plots from the random forest model of fatality rate based on all propensity score-matched states (CA, WV, MA, UT, NV, NY). The inner tickmarks on the horizontal axis denote deciles of the corresponding variable; two-dimensional plots are restricted to the convex hull of the observed data to avoid extrapolation.

References

R Core Team (2022) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Wuertz D, Setz T, Chalabi Y, Boshnakov GN (2023) timeDate: Rmetrics - chronological and calendar objects. R package version 4032.109, https://geobosh.github.io/timeDateDoc/