Online Appendix for:

Pollination, Production, and Profits:

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October 10, 2025

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A Supplementary Tables and Figures

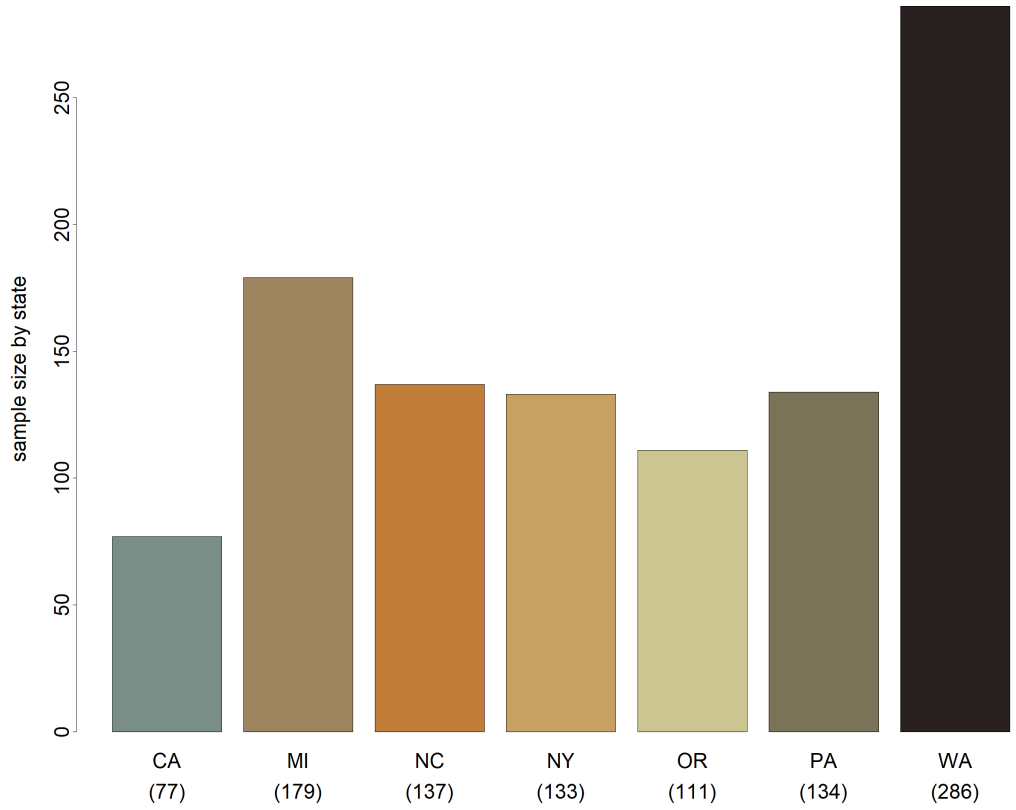

Figure A.1: Sample size by state.
Notes: Figure presents the distribution of the sample of apple farmers from 2007 USDA-ARMS that we employ in our analysis. The West Coast states in our data set are California (CA), Oregon (OR), and Washington (WA). The Midwest and East Coast states in our data set (which we refer to collectively as the 'Eastern' states) are Michigan (MI), New York (NY), North Carolina (NC), and Pennsylvania (PA).

Table A.1: Weighted operation-level summary statistics.

Variable	Weighted Means All	West	East	Difference in Mean (West - East)
year apple operation was established	1981.46	1983.88	1978.39	5.49***
	(14.61)	(14.46)	(14.25)	(0.87)
	[1057]	[474]	[583]	
total cropland acres	330.44	351.34	303.95	47.39
	(777.08)	(832.99)	(699.94)	(46.81)
	[1057]	[474]	[583]	
total apple acres	156.91	177.01	131.44	45.57*
	(397.39)	(511.24)	(161.48)	(23.69)
	[1057]	[474]	[583]	
total bearing apple acres	148.43	169.42	121.84	47.57**
	(393.78)	(509.13)	(149.06)	(23.47)
	[1057]	[474]	[583]	
total non-bearing apple acres	8.47	7.59	9.59	-2*
	(19.6)	(19.52)	(19.67)	(1.16)
	[1057]	[474]	[583]	
total apple blocks	15.08	12.13	18.83	-6.7***
	(20.55)	(18.72)	(22.11)	(1.28)
	[1057]	[474]	[583]	
own honey bees (dummy)	0.03	0.01	0.04	-0.03**
	(0.17)	(0.12)	(0.21)	(0.01)
	[779]	[337]	[442]	
number of bee colonies owned	1.98	0.07	4.23	-4.15***
	(19.98)	(0.92)	(29.31)	(1.41)
	[779]	[337]	[442]	
difficulty with pollination (dummy)	0.2	0.2	0.19	0.01
	(0.4)	(0.4)	(0.39)	(0.03)
	[778]	[336]	[442]	
attended recent pest management training (dummy)	0.54	0.52	0.57	-0.05*
	(0.5)	(0.5)	(0.5)	(0.03)
	[1057]	[474]	[583]	

Notes: Summary statistics are at the operation level for the selected apple operation. From left to right, columns are as follows: variable; mean for observations from all states ('All'); mean for West Coast states ('West'); mean for Midwest and East Coast states ('East'); mean for West Coast minus mean for Midwest and East Coast states ('West - East'). Below the means for each variable, standard deviations are in parentheses and sample sizes are in square brackets. Sample sizes may differ from respective full sample sizes because a farmer did not answer the question, or the question was not applicable. Below the differences in mean between West and East, bootstrapped standard errors from two-sample t-tests for the mean of the West Coast minus the mean for East Coast and Midwest states are in parentheses. Significance codes for two-sample t-tests: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.2: Weighted random block-level summary statistics focused on pollination.

Variable	Weighted Means All	West	East	Difference in Mean (West - East)
rented bees (dummy)	0.74	0.81	0.64	0.17***
	(0.44)	(0.39)	(0.48)	(0.03)
	[1057]	[474]	[583]	
number of bee colonies rented	17.37	18.4	15.71	2.69
	(30.13)	(30.24)	(29.94)	(2.44)
	601	313	288	
number of bee colonies per acre	1.87	1.64	2.24	-0.6***
	(2.26)	(1.79)	(2.82)	(0.19)
	[601]	[313]	[288]	
bee rental fee ($/colony)	47.66	43.61	52.8	-9.19***
	(13.33)	(11)	(14.23)	(0.75)
	[1057]	[474]	[583]	
bee rental cost ($/acre)	66.13	59.78	74.18	-14.4**
	(109.52)	(93.64)	(126.47)	(6.78)
	[1057]	[474]	[583]	
bee rental proportion of total costs	0.07	0.05	0.1	-0.05***
	(0.11)	(0.08)	(0.15)	(0.01)
	[601]	[313]	[288]	

Notes: Summary statistics are at the block level for the selected block for the year 2007. From left to right, columns are as follows: variable; mean for observations from all states ('All'); mean for West Coast states ('West'); mean for Midwest and East Coast states ('East'); mean for West Coast minus mean for Midwest and East Coast states ('West - East'). Below the means for each variable, standard deviations are in parentheses and sample sizes are in square brackets. Sample sizes may differ from respective full sample sizes because a farmer did not answer the question, or the question was not applicable. Below the differences in mean between West and East, bootstrapped standard errors from two-sample t-tests for the mean of the West Coast minus the mean for East Coast and Midwest states are in parentheses. Significance codes for two-sample t-tests: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.3: Weighted random block-level summary statistics focused on production.

Variable	Weighted Means All	West	East	Difference in Mean (West - East)
year block started production	1989.13	1990.72	1987.15	3.57***
	(11.96)	(11.41)	(12.34)	(0.77)
	[1037]	[467]	[570]	
number apple trees	3512.68	5027.92	1584.66	3443.26***
	(12248.46)	(16008.7)	(2927.93)	(724.74)
	[1039]	[467]	[572]	
trees per acre	283.13	360.71	184.42	176.29***
	(257.16)	(294.51)	(150.46)	(15.19)
	[1039]	[467]	[572]	
average age of trees	18.94	17.21	21.12	-3.92***
	(12.71)	(12.36)	(12.82)	(0.81)
	[1042]	[466]	[576]	
grass valley floor system (dummy)	0.88	0.83	0.94	-0.11***
	(0.33)	(0.38)	(0.24)	(0.02)
	[1056]	[474]	[582]	
semi dwarf tree type (dummy)	0.55	0.48	0.65	-0.18***
	(0.5)	(0.5)	(0.48)	(0.03)
	[1057]	[474]	[583]	
production for fresh market (dummy)	0.84	0.93	0.71	0.22***
	(0.37)	(0.25)	(0.45)	(0.02)
	[1057]	[474]	[583]	
has federal crop insurance in 2007 (dummy)	0.62	0.58	0.68	-0.11***
	(0.48)	(0.49)	(0.47)	(0.03)
	[1057]	[474]	[583]	
deliberately scouts for pests (dummy)	0.85	0.83	0.87	-0.04*
	(0.36)	(0.38)	(0.33)	(0.02)
	[1057]	[474]	[583]	
yield (bushels/acre)	589.78	650.47	512.87	137.59***
	(422.3)	(455.71)	(361.9)	(25.2)
	[1057]	[474]	[583]	
approximate profit ($) per acre	5746.59	7219.82	3879.64	3340.18***
	(7467.6)	(8824.42)	(4652.09)	(455.88)
	[1057]	[474]	[583]	
approximate profit ($) per tree	39.96	47.47	30.41	17.06**
	(121.46)	(152.4)	(62.01)	(7.23)
	[1039]	[467]	[572]	

Notes: Summary statistics are at the block level for the selected block. From left to right, columns are as follows: variable; mean for observations from all states ('All'); mean for West Coast states ('West'); mean for Midwest and East Coast states ('East'); mean for West Coast minus mean for Midwest and East Coast states ('West - East'). Below the means for each variable, standard deviations are in parentheses and sample sizes are in square brackets. Sample sizes may differ from respective full sample sizes because a farmer did not answer the question, or the question was not applicable. Below the differences in mean between West and East, bootstrapped standard errors from two-sample t-tests for the mean of the West Coast minus the mean for East Coast and Midwest states are in parentheses. Revenues and profits are approximate and employ state-level average output prices obtained from USDA-NASS. Significance codes for two-sample t-tests: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.4: Weighted random block-level summary statistics focused on labor inputs.

Variable	Weighted Means All	West	East	Difference in Mean (West - East)
pruning/thinning hours	463.87	681.16	188.51	492.65***
	(1255.72)	(1588.75)	(494.45)	(73.58)
	[1057]	[474]	[583]	
harvesting hours	439.25	530.65	323.42	207.22***
	(1038.28)	(1234.24)	(701.64)	(64.51)
	[1057]	[474]	[583]	
land prep and machine hours	47.81	69.63	20.15	49.48***
	(114.5)	(139.98)	(59.65)	(6.82)
	[1057]	[474]	[583]	
pest scouting hours	49.45	77.77	13.57	64.20***
	(298.22)	(391.9)	(70.22)	(17.55)
	[1057]	[474]	[583]	
part-time and seasonal hours	641.85	824.61	410.25	414.36***
	(1945.7)	(2421.21)	(1033.3)	(116.86)
	[1057]	[474]	[583]	
full-time hours	201.38	317.49	54.25	263.23***
	(574.68)	(715.16)	(250.33)	(36.07)
	[1057]	[474]	[583]	

Notes: Summary statistics are at the block level for the selected block. From left to right, columns are as follows: variable; mean for observations from all states ('All'); mean for West Coast states ('West'); mean for Midwest and East Coast states ('East'); mean for West Coast minus mean for Midwest and East Coast states ('West - East'). Below the means for each variable, standard deviations are in parentheses and sample sizes are in square brackets. Sample sizes may differ from respective full sample sizes because a farmer did not answer the question, or the question was not applicable. Below the differences in mean between West and East, bootstrapped standard errors from two-sample t-tests for the mean of the West Coast minus the mean for East Coast and Midwest states are in parentheses. Revenues and profits are approximate and employ state-level average output prices obtained from USDA-NASS. Significance codes for two-sample t-tests: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.5: Summary statistics for land cover, weather, and apple prices.

Variable	Weighted Means All	West	East	Difference in Mean (West - East)
Land cover variables				
natural forest cover (county proportion)	0.50	0.44	0.53	-0.09**
	(0.22)	(0.26)	(0.19)	(0.035)
	[207]	[71]	[136]	
natural open cover (county proportion)	0.17	0.31	0.10	0.21***
	(0.16)	(0.19)	(0.06)	(0.023)
	[207]	[71]	[136]	
Weather variables				
mean temperature (C), winter	1.86	5.37	0.04	5.33***
	(4.64)	(3.27)	(4.18)	(0.374)
	[414]	[142]	[272]	
mean precipitation (mm), winter	2.84	3.62	2.44	1.18***
	(1.98)	(3.14)	(0.62)	(0.266)
	[414]	[142]	[272]	
mean temperature (C), spring	13.47	13.10	13.66	-0.56***
	(2.51)	(2.84)	(2.31)	(0.276)
	[414]	[142]	[272]	
mean precipitation (mm), spring	2.31	1.62	2.67	-1.05***
	(0.97)	(1.09)	(0.67)	(0.10)
	[414]	[142]	[272]	
mean temperature (C), summer	20.83	20.05	21.23	-1.18***
	(2.59)	(3.20)	(2.09)	(0.297)
	[414]	[142]	[272]	
mean precipitation (mm), summer	2.41	0.36	3.48	-3.12***
	(1.81)	(0.43)	(1.23)	(0.083)
	[414]	[142]	[272]	
mean temperature (C), fall	10.07	10.01	10.10	-0.09
	(2.77)	(3.31)	(2.45)	(0.315)
	[414]	[142]	[272]	
mean precipitation (mm), fall	3.10	2.87	3.23	-0.36
	(1.89)	(2.95)	(0.94)	(0.254)
	[414]	[142]	[272]	
Apple output prices				
total utilized production price ($/lb) in 2007	0.25	0.34	0.18	0.16**
	(0.01)	(0.05)	(0.06)	(0.042)
	[7]	[3]	[4]	

Notes: From left to right, columns are as follows: variable; mean for observations from all states ('All'); mean for West Coast states ('West'); mean for Midwest and East Coast states ('East'); mean for West Coast minus mean for Midwest and East Coast states ('West - East'). Below the means for each variable, standard deviations are in parentheses and sample sizes are in square brackets. Below the differences in mean between West and East are standard errors in parentheses from two-sample t-tests for the mean of the West Coast minus the mean for East Coast and Midwest states. Land cover variables and weather variables are at the county level; apple prices are at the state level. There are 7 states and 207 counties observed. Significance codes for two-sample t-tests: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

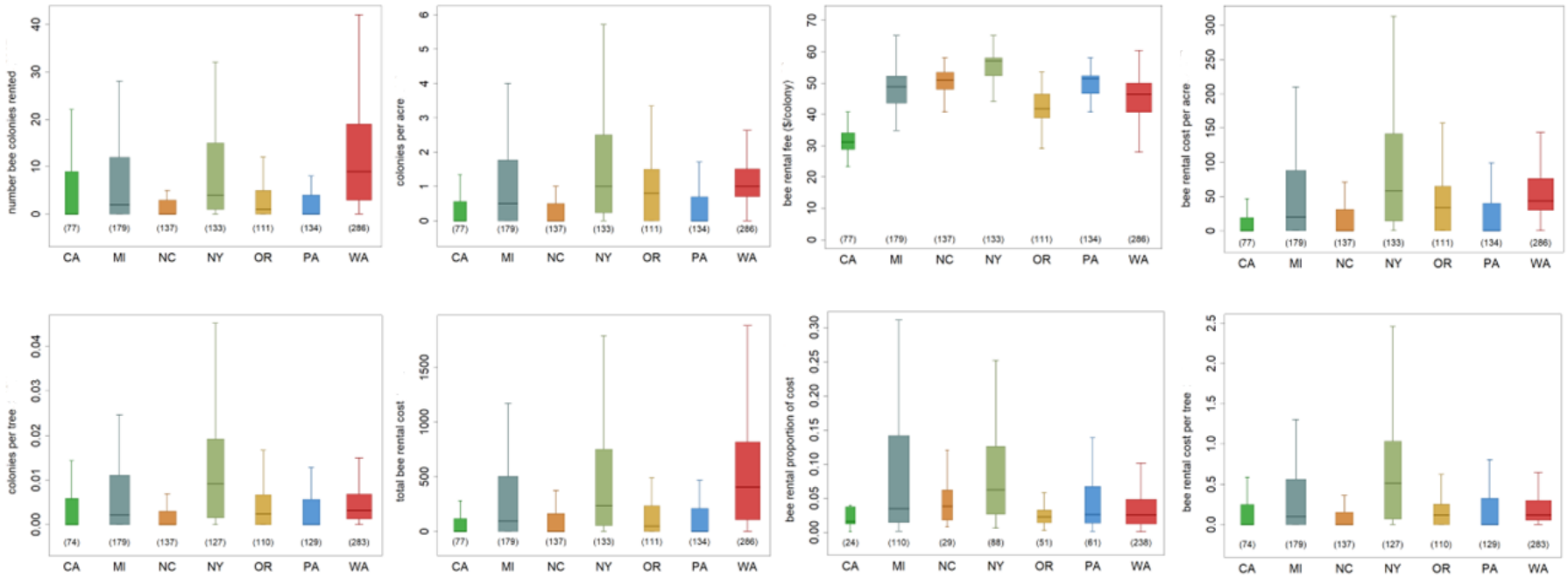

Figure A.2: Honey bee rental quantity and costs by state.
Notes: Figure presents weighted boxplots by state for the year 2007 capturing: the number of honey bee colonies rented; the number of honey bee colonies rented per acre; honey bee rental fee ($/colony); honey bee rental costs per acre; the number of colonies rented per tree; total bee rental costs; bee rental proportion of block-level costs; and bee rental costs per tree. All variables are comprised of random block-level variation. Numbers in parentheses next to state abbreviations indicate the respective sample size for that boxplot.

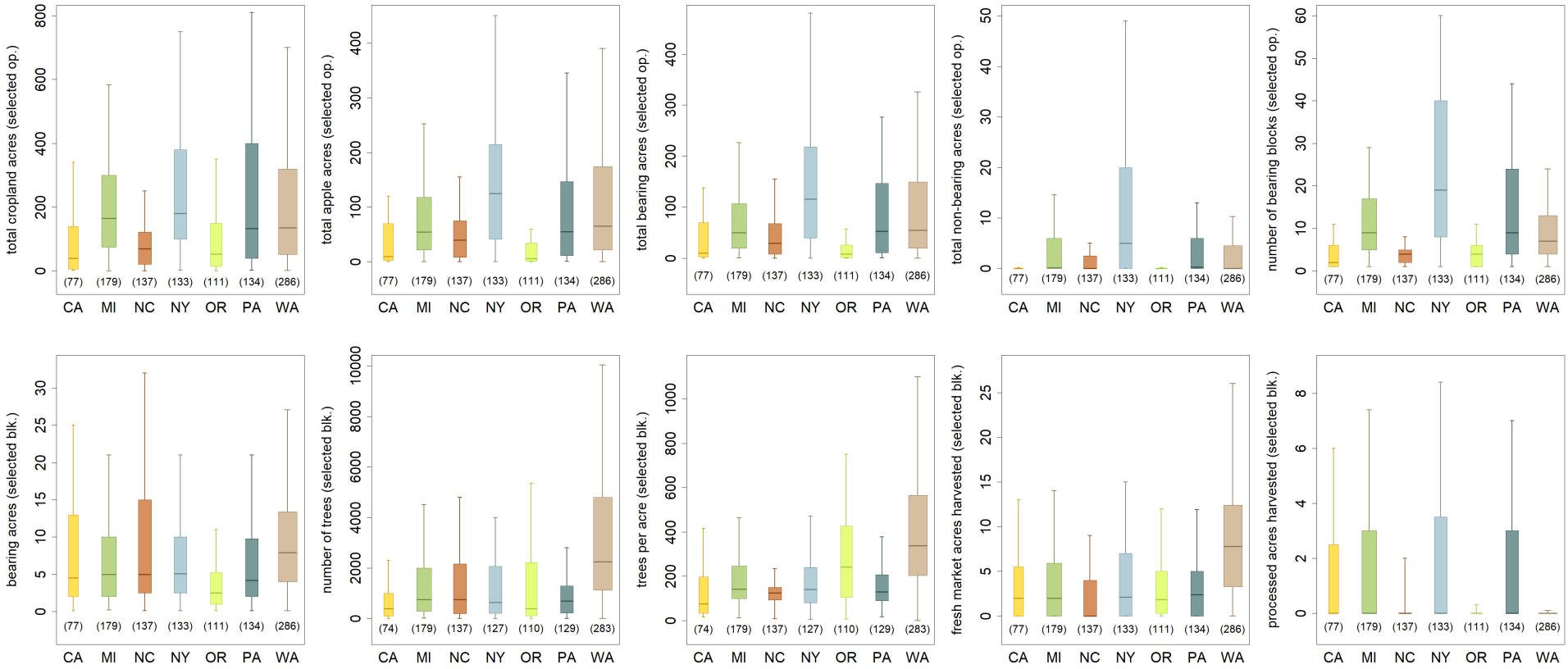

Figure A.3: Operation and block characteristics by state.

Notes: Figure presents weighted boxplots by state for a suite of operation-level and and block-level characteristics. Operation-level characteristics include: total cropland acres; total apple acres; total bearing apple acres; total non-bearing apple acres; and number of bearing apple blocks. Block-level characteristics include: bearing acres; number of trees; trees per acre; fresh market acres harvested; and processed acres harvested. Numbers in parentheses next to state abbreviations indicate the respective sample size.

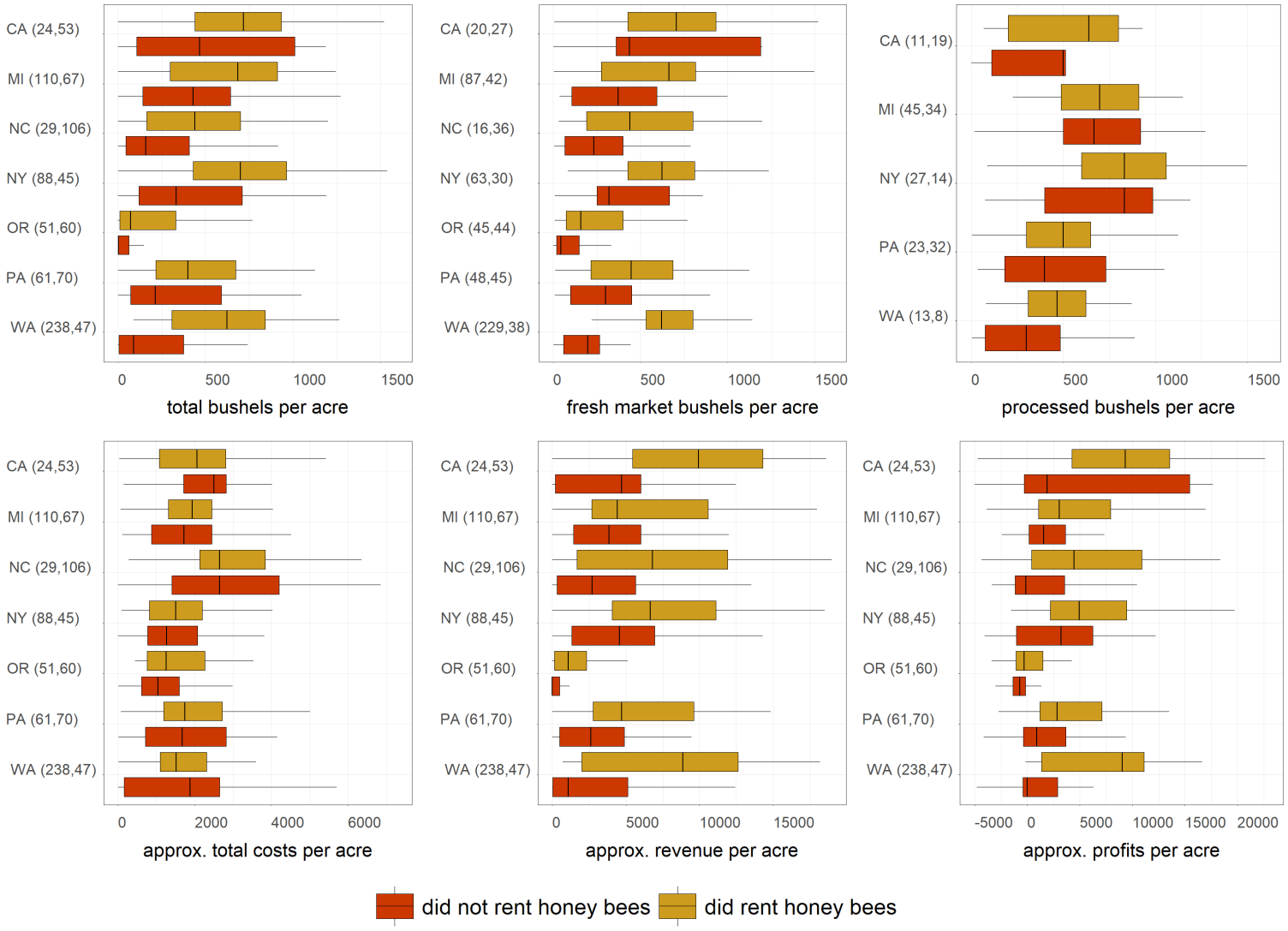

Figure A.4: Yield, costs, revenues, and profits by whether farmer rented honey bees. Notes: Figure presents weighted boxplots by state and whether an apple farmer rented honey bees for: total yield in bushels per acre; fresh market yield in bushels per acre; processed yield in bushels per acre; approximate total costs per acre; approximate total revenue per acre; and approximate profits per acre. All variables comprised random block-level variation. For each state, the number who reported renting honey bees and the number who reported not renting honey bees in that state are in parentheses. For example, WA (238, 47), indicates that, of the apple farmers sampled in Washington State, 238 reported renting honey bees, while 47 reported not renting honey bees. Note farmers in some states did not report any processed yields, hence the top right panel only shows processed yield data for a subset of all seven states.

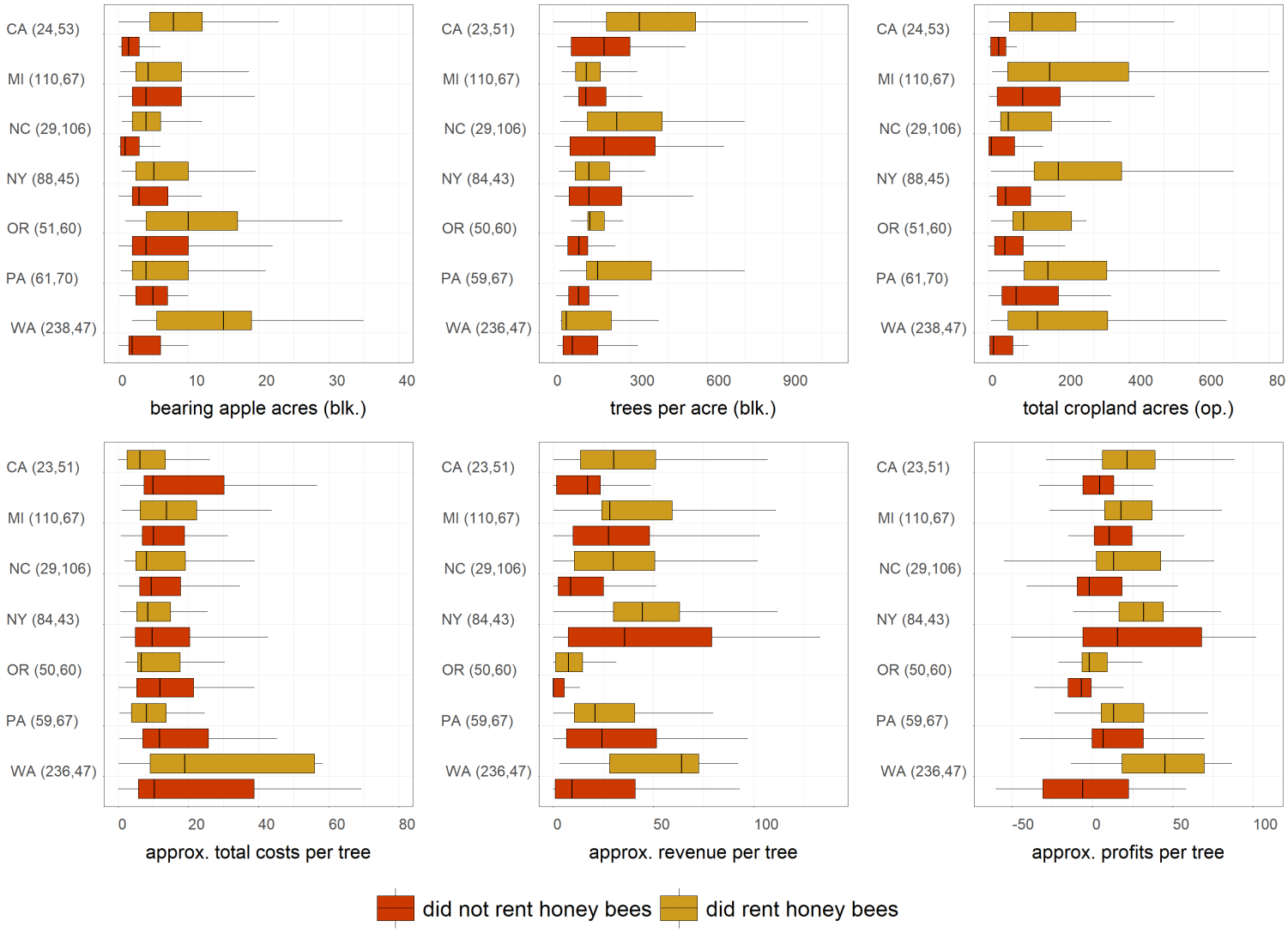

Figure A.5: Acreage, trees, and profits per tree by whether farmer rented honey bees. Notes: Figure presents weighted boxplots by state and whether an apple farmer rented honey bees for: bearing apple acres (block-level); trees per acre (block level); total cropland acreage (operation level); and approximate block-level production costs per tree; revenue per tree; and profits per tree. For each state, the number who reported renting honey bees and the number who reported not renting honey bees in that state are in parentheses. For example, WA (238, 47), indicates that, of the apple farmers sampled in Washington State, 238 reported renting honey bees, while 47 reported not renting honey bees.

Table A.6: Parametric tests of response function $\mu(x)$ for yield.

	no covariate adjustment	covariate-adjusted	covariate-adjusted with state dummies
Pooled Sample			
constant	6.431^{***}	3.692^{***}	3.632^{***}
	(0.000)	(0.001)	(0.001)
linear	4.064^{***}	1.839	1.683
	(0.000)	(0.131)	(0.139)
quadratic	1.746	0.596	0.716
	(0.449)	(0.787)	(0.638)
cubic	1.356	0.018	0.057
	(0.707)	(1.000)	(1.000)
# Bins	3	3	3
# Observations	998	998	998
# Distinct values	263	263	263
Eastern States			
constant	4.495^{***}	3.556^{***}	3.558^{***}
	(0.000)	(0.000)	(0.000)
linear	3.416^{***}	2.337^{**}	2.422^{**}
	(0.010)	(0.027)	(0.020)
quadratic	2.545^{*}	1.917^{*}	2.399^{**}
	(0.098)	(0.069)	(0.021)
cubic	1.573	0.327	0.277
	(0.560)	(0.802)	(0.827)
# Bins	3	3	3
# Observations	550	550	550
# Distinct values	159	159	159
Western States			
constant	4.002^{***}	3.171^{***}	3.116^{***}
	(0.000)	(0.004)	(0.004)
linear	4.105^{***}	3.562^{***}	3.519^{***}
	(0.000)	(0.001)	(0.001)
quadratic	1.137	2.039^{*}	2.053^{*}
	(0.836)	(0.077)	(0.069)
cubic	0.853	0.840	0.840
	(0.939)	(0.572)	(0.572)
# Bins	3	3	3
# Observations	448	448	448
# Distinct values	134	134	134

Notes: Table presents t-statistics (p-values in parentheses) from parametric tests of the response function $\mu(x)$ for yield for specifications using observations from all states ('Pooled Sample'), the Eastern states subsample, and the Western states subsample. Yield is in bushels per acre; x is honey bee colonies per acre defined as the number of honey bee colonies rented divided by selected block size in acres. Tests employ rule of thumb approach for selection of the number of bins (Cattaneo et al., 2024), quantile-spaced bins, and sample weights. Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.7: Shape restriction tests of response function $\mu(x)$ for yield.

	no covariate adjustment	covariate-adjusted	covariate-adjusted with state dummies
Pooled Sample			
non-positive	6.102^{***}	3.339^{***}	3.317^{***}
	(0.000)	(0.005)	(0.006)
non-negative	-1.523	-0.625	-0.408
	(0.367)	(0.870)	(0.940)
concave	-0.180	0.062	0.062
	(1.000)	(0.985)	(0.985)
convex	-3.526^{***}	-1.781	-1.781
	(0.002)	(0.200)	(0.200)
# Bins	2	2	2
# Observations	998	998	998
# Distinct values	263	263	263
Eastern States			
non-positive	4.909^{***}	3.798^{***}	3.917^{***}
	(0.000)	(0.001)	(0.001)
non-negative	-1.143	-1.230	-1.379
	(0.604)	(0.548)	(0.467)
concave	2.396^{**}	2.513^{**}	2.885^{***}
	(0.034)	(0.026)	(0.007)
convex	-3.752^{***}	-3.108^{***}	-3.264^{***}
	(0.001)	(0.003)	(0.003)
# Bins	2	2	2
# Observations	550	550	550
# Distinct values	159	159	159
Western States			
non-positive	3.476^{***}	3.339^{***}	3.302^{***}
	(0.004)	(0.004)	(0.005)
non-negative	-1.992	-2.268^{*}	-2.250^{*}
	(0.160)	(0.092)	(0.097)
concave	0.581	1.503	1.535
	(0.821)	(0.303)	(0.288)
convex	-2.628^{**}	-2.966^{**}	-2.934^{**}
	(0.028)	(0.012)	(0.013)
# Bins	2	2	2
# Observations	448	448	448
# Distinct values	134	134	134

Notes: Table presents t-statistics (p-values in parentheses) from shape restriction tests of the response function $\mu(x)$ for yield for specifications using observations from all states ('Pooled Sample'), the Eastern states subsample, and the Western states subsample. Yield is in bushels per acre; x is honey bee colonies per acre defined as the number of honey bee colonies rented divided by selected block size in acres. Monotonicity tests are applied to the first derivative of respective optimal binscatter curves for the models represented in each column. Tests for concavity and convexity are applied to the respective second derivatives. Tests employ data-driven rule of thumb approach for selection of the number of bins (Cattaneo et al., 2024), quantile-spaced bins, and sample weights. Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.8: Weighted fixed effects regressions of profits.

Dependent variable is block-level apple profits ($/acre)			
	(1')	(2')	(3')
Honey bee colonies per acre			
honey bee colonies per acre	1,960.228***	2,503.260***	1,248.057***
	(333.261)	(722.191)	(279.880)
honey bee colonies per acre, squared	-228.520***	-251.952**	-148.858***
	(53.250)	(125.501)	(41.850)
Measures of production scale			
trees per acre	1.137	-2.063	9.832**
	(2.387)	(3.839)	(4.091)
trees per acre, squared	-0.003	-0.001	-0.006
	(0.002)	(0.003)	(0.006)
average age of trees	101.202***	108.505*	50.793
	(38.175)	(60.059)	(40.980)
average age of trees, squared	-1.797***	-0.995	-0.966
	(0.553)	(0.848)	(0.612)
Labor input variables			
pruning/thinning hours	-1.685***	-1.932***	-0.880
	(0.296)	(0.387)	(0.777)
harvesting hours	0.290	1.091***	-0.082
	(0.238)	(0.359)	(0.726)
land prep and machine hours	5.330***	4.000*	8.191**
	(1.742)	(2.309)	(3.311)
pest scouting hours	-2.182***	-1.582*	10.609***
	(0.675)	(0.875)	(3.698)
part-time and seasonal hours	0.389**	0.318	0.228
	(0.188)	(0.240)	(0.670)
full-time hours	0.175	0.001	1.027
	(0.387)	(0.495)	(0.944)
Land cover variables			
natural forest cover	-7,087.551**	7,484.971	953.807
	(3,128.340)	(7,290.172)	(9,403.283)
natural forest cover, squared	5,971.366	-15,527.480	-3,723.856
	(4,179.721)	(13,095.410)	(8,270.876)
natural open cover	12,133.830	-31,508.460	-51,704.680**
	(8,809.147)	(23,311.510)	(21,888.870)
natural open cover, squared	-30,528.810***	19,664.850	196,012.500***
	(9,969.366)	(25,837.060)	(68,488.690)
Weather variables			
Jan. average precipitation (mm)	-1,332.129***	-1,669.952	-1,363.136**
	(499.509)	(2,057.735)	(592.773)
Jan. average temperature (C)	-2,930.692***	-3,477.785*	-616.365
	(560.445)	(1,860.393)	(976.520)
Feb. average precipitation (mm)	1,036.647***	541.065	3,112.892***
	(242.447)	(882.131)	(576.872)
Feb. average temperature (C)	-521.125	-9,120.123***	461.329

	(826.015)	(3,072.604)	(1,027.777)
Mar. average precipitation (mm)	61.053	5,597.820***	-2,162.798***
	(482.515)	(2,057.750)	(735.447)
Mar. average temperature (C)	3,005.978***	9,603.848**	1,550.909
	(852.674)	(4,705.287)	(980.820)
Apr. average precipitation (mm)	57.179	-1,743.395	390.248
	(498.175)	(4,017.240)	(420.505)
Apr. average temperature (C)	1,758.182*	6,326.889	-1,709.743
	(1,055.576)	(5,312.031)	(1,111.443)
May average precipitation (mm)	-1,128.667	-7,983.828*	63.514
	(773.492)	(4,806.219)	(614.803)
May average temperature (C)	1,691.349*	-3,380.919	624.308
	(995.250)	(2,977.301)	(1,336.269)
Jun. average precipitation (mm)	-2,117.681***	-3,332.482	384.551
	(586.584)	(2,807.189)	(457.140)
Jun. average temperature (C)	-2,499.604***	-910.948	726.908
	(930.715)	(3,569.491)	(1,580.497)
Jul. average precipitation (mm)	483.970	-4,941.670	-656.405
	(595.241)	(5,255.182)	(484.257)
Jul. average temperature (C)	1,664.957*	-6,849.953	1,086.987
	(929.067)	(4,295.076)	(1,262.590)
Aug. average precipitation (mm)	-939.245***	1,108.229	163.128
	(329.811)	(9,550.536)	(332.495)
Aug. average temperature (C)	-2,036.329**	5,912.543**	791.605
	(980.580)	(2,597.108)	(1,246.859)
Sep. average precipitation (mm)	1,726.846**	-2,581.286	1,002.036*
	(747.164)	(3,372.791)	(563.885)
Sep. average temperature (C)	68.326	-1,180.772	-3,590.827**
	(1,071.213)	(3,077.368)	(1,389.482)
State fixed effects	Y	Y	Y
Sample	All	West	East
Standard errors	HW	S,C	S,C
Adjusted R^2	0.420	0.510	0.327
# Observations	998	448	550

Notes: Table presents results from weighted fixed effects regressions of block-level profits per acre regressed on honey bee colonies per acre, block characteristics, labor inputs, monthly average temperature and precipitation (Jan-Sept), and remotely sensed land cover measures to proxy for wild bee habitat and landscape heterogeneity. Specifications use observations from all states ('All'), the Western states subsample ('West'), and the Eastern states subsample ('East'), respectively. Huber-White robust standard errors are in parentheses. Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

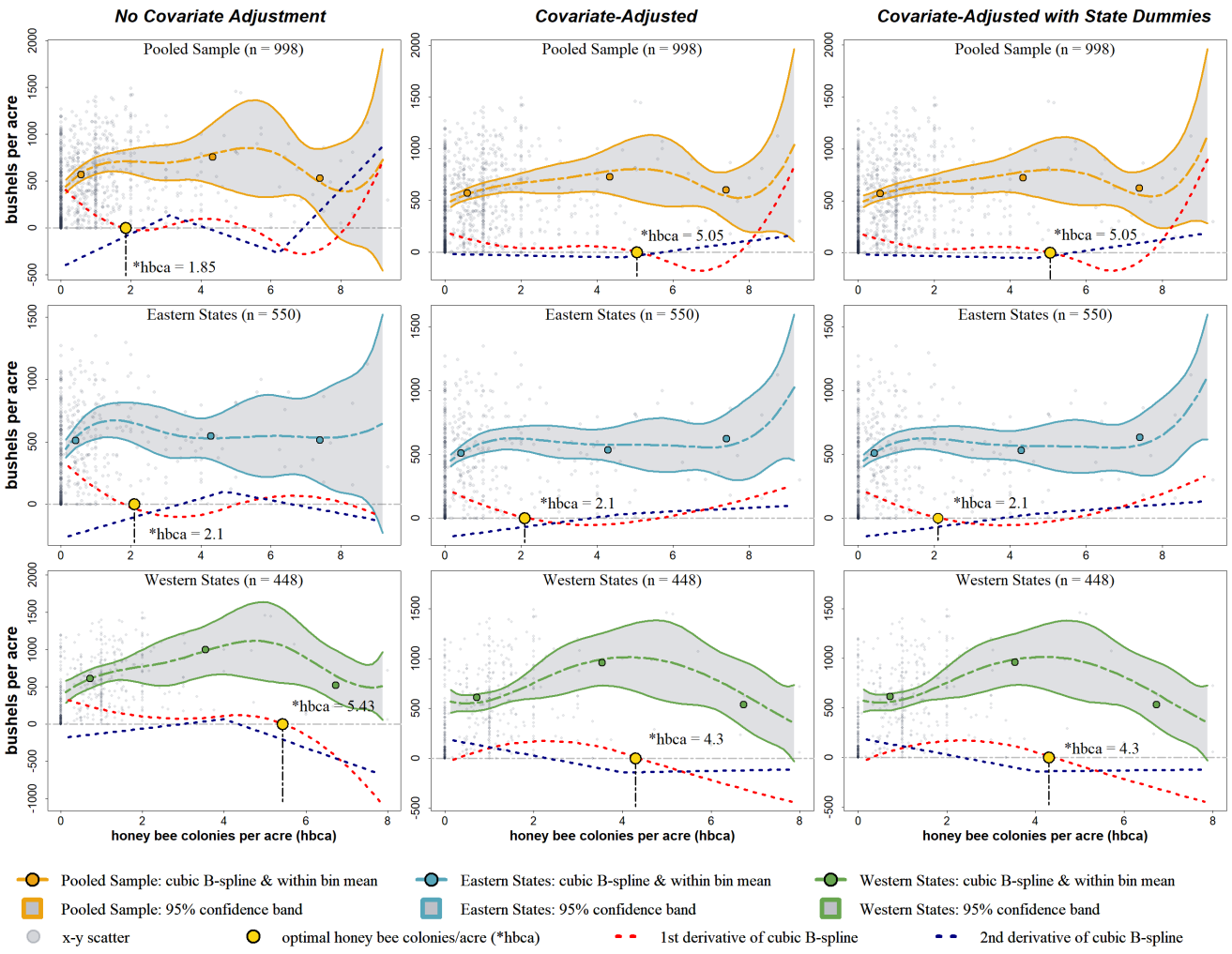

Figure A.6: Optimal binscatter of yield on honey bee colonies per acre: Equally spaced bins. Notes: Optimal binscatter (following Cattaneo et al. 2024) of *yield* in bushels per acre on the semi-parametric function $\mu(x)$, where x is *honey bee colonies per acre*, which is defined as the number of honey bee colonies rented divided by selected block size in acres. Each panel trims the 99% centile of the outcome variable and honey bee colonies per acre to reduce the influence of extreme outliers that can dramatically affect the readability of the figure. Column 1 is the optimal binscatter of yield on honey bee colonies per acre. Column 2 includes covariate-adjustment using the same covariates employed in the fixed effects regression models in Table 1, with the exception of the polynomial versions of some of these variables. Column 3 employs the same model in Column 2 but includes state dummies. These estimations employ *equally spaced*, data-driven rule of thumb bin selection, and cubic B-splines within and between bins. Confidence bands are based on Huber-White robust standard errors. Optimal honey bee colonies per acre are plotted where the estimated first derivative (in red) of the response function equals zero and the response function is at a global (or local) maximum. Second derivatives are also plotted in dark blue.

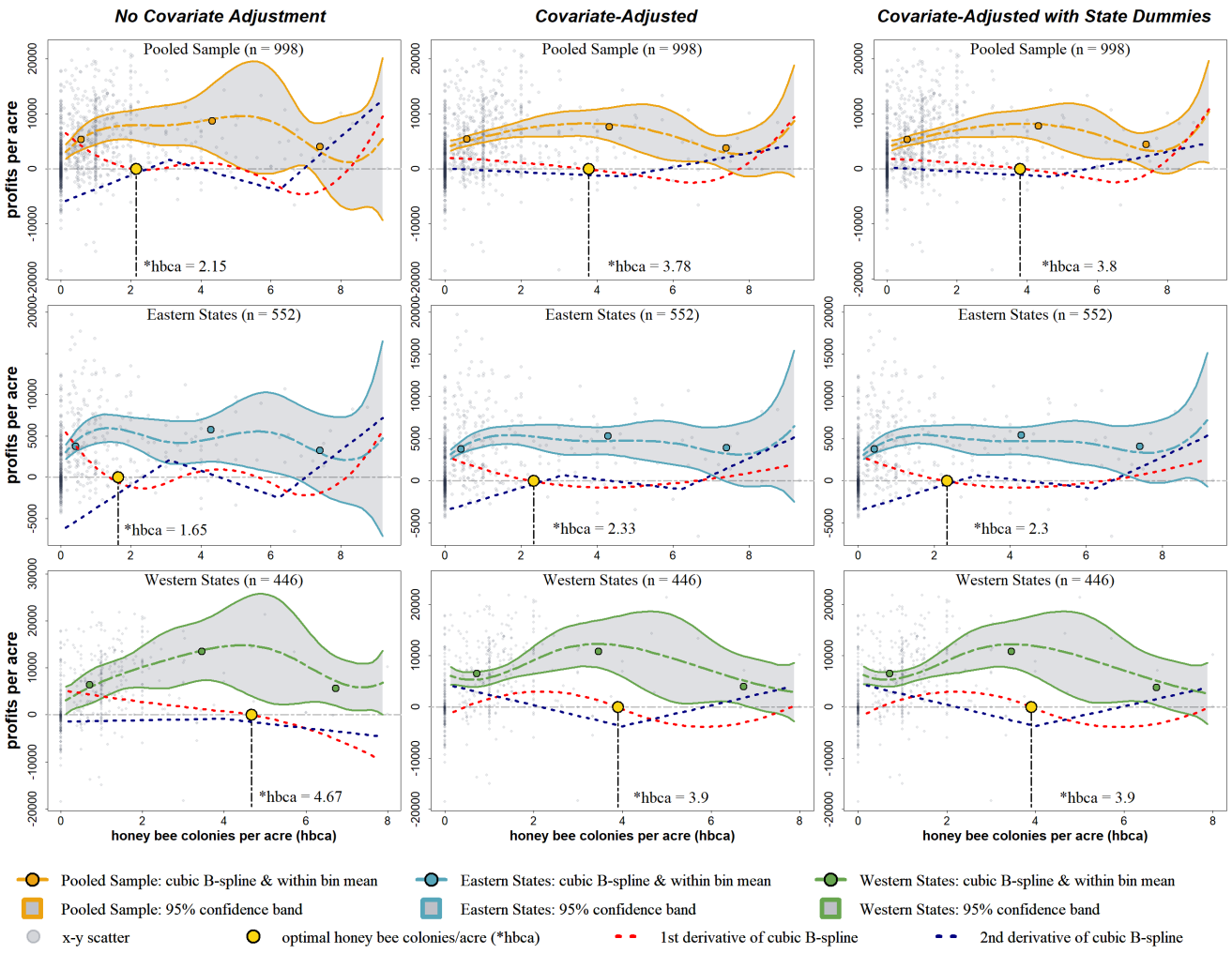

Figure A.7: Optimal binscatter of profits on honey bee colonies per acre: Equally spaced bins.

Notes: Optimal binscatter (following Cattaneo et al. 2024) of *profits* in dollars per acre on the semi-parametric function $\mu(x)$, where x is *honey bee colonies per acre*, which is defined as the number of honey bee colonies rented divided by selected block size in acres. Each panel trims the 99% centile of the outcome variable and honey bee colonies per acre to reduce the influence of extreme outliers that can dramatically affect the readability of the figure. Column 1 is the optimal binscatter of yield on honey bee colonies per acre. Column 2 includes covariate-adjustment using the same covariates employed in the fixed effect regression models in Tables 1 and A.8, with the exception of the polynomial versions of some of these variables. Column 3 employs the same model in Column 2 but includes state dummies. These estimations employ *equally spaced*, data-driven rule of thumb bin selection, and cubic B-splines within and between bins. Confidence bands are based on Huber-White robust standard errors. Optimal honey bee colonies per acre are plotted where the estimated first derivative (in red) of the response function equals zero and the response function is at a global (or local) maximum. Second derivatives are also plotted in dark blue.

Table A.9: Weighted fixed effects regressions of yield for Eastern states using alternative measures of land cover.

Dependent variable is block-level apple yield (bushels/acre)				
	(3)	(4)	(5)	(6)
natural forest cover (county)	753.911	753.911***		
	(725.909)	(116.071)		
natural forest cover (county), squared	-1,023.746	-1,023.746***		
	(638.490)	(139.406)		
natural forest cover (3000 m. buffer)			562.702	
			(654.027)	
natural forest cover (3000 m. buffer), squared			-534.314	
			(508.696)	
natural forest cover (1000 m. buffer)				535.063
				(427.534)
natural forest cover (1000 m. buffer), squared				-427.705
				(383.244)
natural open cover (county)	-3,358.664**	-3,358.664**		
	(1,689.764)	(1,018.183)		
natural open cover (county), squared	6,979.986	6,979.986		
	(5,287.149)	(3,378.463)		
natural open cover (3000 m. buffer)			-2,128.346	
			(1,743.510)	
natural open cover (3000 m. buffer), squared			3,784.642	
			(5,191.345)	
natural open cover (1000 m. buffer)				-1,940.737
				(1,294.280)
natural open cover (1000 m. buffer), squared				3,213.051
				(4,142.928)
Honey bee colonies per acre	Y	Y	Y	Y
Measures of production scale	Y	Y	Y	Y
Labor input variables	Y	Y	Y	Y
Weather variables	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y
Sample	East	East	East	East
Standard errors	HW	S,C	S,C	S,C
Adjusted R^2	0.352	0.352	0.346	0.345
# Observations	550	550	550	550

Notes: Table presents results for weighted fixed effects regressions of block-level yield in bushels per acre regressed on alternative wild bee habitat proxies for the Eastern states. Additional regressors include honey bee colonies per acre, block characteristics, labor inputs, and monthly average temperature and precipitation (Jan-Sept). Remotely sensed habitat measures include county-level proportions in specifications (3) and (4), and the proportion within a buffer of 3000 and 1000 meters around apple producing areas in specifications (5) and (6). A caveat for specifications (2) and (3) is that apple-specific areas are not necessarily identifiable within the USDA-CDL within a given county. To deal with this, we use proportions within buffers around tree crop producing areas, or the county proportion (if tree crop areas are not identifiable). Of the 550 observations in these regressions, 430 farms are in counties where apple specific areas can be identified, 6 farms are in counties where tree crop areas can be identified, and the remaining 114 farms are in counties where natural forest and open cover can only be summarized at the county level. Standard errors are either Huber-White robust standard errors (HW), or multi-way clustered at the county (C) and state (S) levels, and are in parentheses. Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

References

Cattaneo, M.D., R.K. Crump, M.H. Farrell, and Y. Feng. 2024. "On binscatter." *American Economic Review* 114:1488–1514.