Appendix A.

Table A1. Data sources for stumpage prices

State	Source
Alabama	Timber Mart-South
Arizona	U.S. Forest Service Southwestern Region
Arkansas	Timber Mart-South
California	California State Board of Equalization
Colorado	U.S. Forest Service Rocky Mountain Region
Connecticut	University of Massachusetts Extension
Delaware	University of Maryland Extension
Florida	Timber Mart-South
Georgia	Timber Mart-South
Idaho	Idaho Department of Lands
Illinois	University of Illinois Extension
Indiana	Purdue Extension
Iowa	No Data
Kansas	No Data
Kentucky	Kentucky Division of Forestry
Louisiana	Louisiana Department of Agriculture & Forestry
Maine	Maine Forest Service
Maryland	University of Maryland Extension
Massachusetts	University of Massachusetts Extension
Michigan	Michigan Department of Natural Resources
Minnesota	Minnesota Department of Natural Resources
Mississippi	Mississippi State University Extension
Missouri	Missouri Department of Conservation
Montana	U.S. Forest Service Northern Region
Nebraska	Nebraska Forest Service
Nevada	No Data
New Hampshire	New Hampshire Department of Revenue
New Jersey	No Data
New Mexico	U.S. Forest Service Southwestern Region
New York	New York Department of Environmental Conservation
North Carolina	Timber Mart-South
North Dakota	No Data
Ohio	Ohio State University Extension
Oklahoma	Data extrapolated from Texas price data
Oregon	Oregon Department of Forestry
Pennsylvania	Penn State Extension
Rhode Island	University of Massachusetts Extension
South Carolina	Timber Mart-South
South Dakota	U.S. Forest Service Rocky Mountain Region
Tennessee	Timber Mart-South
Texas	Timber Mart-South
Utah	U.S. Forest Service Intermountain Region
Vermont	Vermont Department of Forests
Virginia	Timber Mart-South
Washington	Washington State Department of Revenue
West Virginia	No Data
Wisconsin	Wisconsin Department of Natural Resources
Wyoming	U.S. Forest Service Intermountain Region

Table A2: Parameter Estimates for Composite Forest Ricardian Models
(Annual Aggregate of Climate)

	Eastern Composite	**Western Composite**	**National Composite**
Mean Temperature	-11.10 (8.45)	3.98 (6.35)	15.81** (7.12)
2nd Order Temp	0.387 (0.911)	0.119 (0.557)	-2.63*** (0.990)
3rd Order Temp	0.0471 (0.0644)		0.193*** (0.0570)
4th Order Temp	-2.02e-03 (1.25e-03)		-4.38s-03*** (1.14e-03)
Annual Precipitation	-0.115 (0.682)	0.0485 (0.0290)	0.019* (0.101)
2nd Order Precip	1.63e-04 (8.87e-04)	4.52e-07 (7.99e-06)	-2.38e-04** (1.11e-04)
3rd Order Precip	-9.98e-08 (4.97e-07)		1.24e-07** (5.19e-08)
4th Order Precip	1.92e-11 (1.00e-11)		-2.04e-11** (8.27e-12)
Temp-Precip Interaction	1.59e-03 (1.94e-03)	-3.89e-03 (4.24e-03)	-2.17e-03* (1.21e-03)
Constant	57.30 (185.0)	-37.92* (20.10)	-70.30** (32.80)
Soil Quality	Yes	Yes	Yes
Spatial FE	Subregion	None	None
Observations	1,624	241	1,865
Adjusted R-squared	0.392	0.248	0.345
Residual SE	9548 (df = 1610)	10200 (df = 234)	9870 (df = 1854)
F Statistic	81.57*** (df = 13; 1610)	14.21*** (df = 6; 234)	99.31*** (df = 10; 1854)

***p<0.1; **p<0.05; ***p<0.01**

Notes: The dependent variable in each model is the per-acre average net returns to forestry in a county. Parameters are estimated by ordinary least squares, weighted by timberland acreage, and with standard errors clustered by eco-region.

Table A3: Parameter Estimates for Composite Forest Ricardian Models (Seasonal Aggregate of Climate)

	Eastern Composite	**Western Composite**
Winter Temperature	6.98** (3.12)	0.725 (9.48)
2nd Order Winter Temp	0.519* (0.276)	-
Winter Precipitation	0.0711 (0.0398)	-0.0243 (0.0873)
Winter Temp-Precip Interaction	-5.16e-03 (3.46e-03)	0.0217* (0.0104)
Spring Temperature	0.812 (7.36)	11.10 (12.63)
2nd Order Spring Temp	1.57 (0.611)	-
Spring Precipitation	-0.153 (0.105)	-0.070 (0.163)
Spring Temp-Precip Interaction	8.35e-03 (9.23e-03)	-8.19e-04 (0.0104)
Summer Temperature	-61.49** (26.30)	4.38 (16.24)
2nd Order Summer Temp	1.57** (0.611)	-
Summer Precipitation	0.209 (0.163)	0.10 (0.969)
Summer Temp-Precip Interaction	-9.73e-03 (7.05e-03)	-7.18e-03 (0.0557)
Fall Temperature	23.01 (18.60)	-12.0 (11.18)
2nd Order Fall Temp	-1.25 (0.796)	-
Fall Precipitation	-0.253* (0.119)	0.549 (0.343)
Fall Temp-Precip Interaction	0.0176** (7.05e-03)	-0.0529 (0.0311)
Constant	537.7** (224.0)	-6.59 (141.49)
Soil Quality	Yes	Yes
Spatial FE	Subregion	Subregion
Observations	1,624	241
Adjusted R-squared	0.425	0.467
Residual SE	9349 (df = 1603)	8585 (df = 224)
F Statistic	59.12*** (df = 20; 1603)	14.15*** (df = 16; 224)
	*$p<0.1$; **$p<0.05$; ***$p<0.01$	

Notes: The dependent variable in each model is the per-acre average net returns to forestry in a county. Parameters are estimated by ordinary least squares, weighted by timberland acreage, and with standard errors clustered by eco-region.

Table A4: Parameter Estimates for Forest Group Type Ricardian Models (Eastern Forest Group Types)

	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Eastern Redcedar
Mean Temp	8.17*	-7.01	121.6***	67.78***	-31.08**	17.88***	-3.32 (2.55)	6.88***	-2.81	-16.81	0.349
	(4.67)	(9.55)	(20.5)	(12.80)	(12.20)	(4.92)		(0.962)	(2.70)	(10.54)	(9.41)
2nd Order Temp	0.413*	1.99**	-4.25***	-2.07***	2.74*	-2.03***	-	-0.277***	0.374***	0.971	-0.585**
	(0.228)	(0.825)	(0.53)	(0.379)	(1.59)	(0.610)		(0.0383)	(0.0945)	(0.657)	(0.278)
3rd Order Temp	-	-	-	-	-0.0733	0.106***	-	-	-	-	-
					(0.0841)	(0.0310)					
4th Order Temp	-	-	-	-	4.17e-05	-2.08e-03***	-	-	-	-	-
					(1.56e-03)	(5.60e-04)					
Annual Precip	-0.216***	0.192***	-0.0687	-0.123	0.0472	4.43e-03	-0.0673*	-0.0164	0.0337	-0.0148	0.0392
	(0.0674)	(0.0659)	(0.329)	(0.126)	(0.0348)	(0.0127)	(0.0378)	(0.0217)	(0.0439)	(0.0406)	(0.183)
2nd Order Precip	1.14e-04**	-2.70e-05	-2.57e-04***	-	-3.16e-05**	-2.93e-06	-	2.30e-06	-1.68e-05	-2.74e-05	-1.33e-04
	(4.09e-05)	(4.04e-05)	(7.84e-05)		(1.86e-05)	(5.48e-06)		(8.13e-06)	(1.94e-05)	(1.90e-05)	(1.09e-04)
3rd Order Precip	-	-	-	-	-	-	-	-	-	-	-
4th Order Precip	-	-	-	-	-	-	-	-	-	-	-
Temp-Precip Interaction	-0.0101**	-0.0201***	0.0413**	3.77e-03	2.69e-03**	5.64e-04	3.32e-03*	2.38e-03***	-1.13e-03	3.42e-03*	0.0185**
	(4.55e-03)	(5.69e-03)	(0.0171)	(7.29e-03)	(1.35e-03)	(4.92e-04)	(2.01e-03)	(8.41e-04)	(2.09e-03)	(2.77e-03)	(9.18e-03)
Constant	107.8***	-56.9	1206.2***	-394.4**	66.0**	-65.7***	89.0* (47.9)	-52.1***	-16.0	52.0	-27.0
	(26.1)	(37.5)	(369.4)	(160.5)	(31.3)	(12.8)		(13.0)	(27.9)	(41.9)	(61.4)
Soil Quality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spatial FE	None	None	Subregion	Region	Region	Region	None	Subregion	Subregion	Region	Region
White's SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	371	151	328	878	1,207	1,531	825	1,349	703	338	235
Adjusted R-squared	0.196	0.595	0.330	0.046	0.273	0.181	0.040	0.266	0.169	0.222	0.084
Residual SE	2490	2220	4992	13690	3316	2741	2213	2778	3199	2785	2572
	(df = 364)	(df = 144)	(df = 320)	(df = 871)	(df = 1197)	(df = 1521)	(df = 820)	(df = 1337)	(df = 693)	(df = 330)	(df = 226)
F Statistic	16.07***	37.72***	23.99***	8.09***	51.41***	38.64***	9.57***	45.51***	16.90***	14.74***	3.69
	(df = 6; 364)	(df = 6; 144)	(df = 7; 320)	(df = 6; 871)	(df = 9; 1197)	(df = 9; 1521)	(df = 4; 820)	(df = 11; 1337)	(df = 9; 693)	(df = 7; 330)	(df = 8; 226)

***p<0.1; **p<0.05; ***p<0.01**

Notes: The dependent variable in each model is the per-acre average net returns to specific forest types in a county. Parameters are estimated by ordinary least squares, weighted by timberland acreage, and with standard errors robust to heteroskedasticity.

Table A5. Assessing robustness with alternative Ricardian specifications

	Average Marginal Effects		Climate Change Impact
	Mean Temperature	Precipitation	$ / acre
Preferred Model	3.75*** (0.244)	-0.0007 (0.0048)	5.64 (2.61, 8.66)
Preferred Model Plus Forestland Elevation	4.14*** (0.295)	0.0002 (0.0048)	5.40 (2.21, 8.58)
Preferred Model Plus Mill Capacity	3.74*** (0.244)	-0.0016 (0.0048)	4.80 (1.92, 7.69)
Preferred Model Plus Number of Mills in County	3.81*** (0.244)	-0.0024 (0.0048)	4.99 (2.04, 7.93)
Massetti et. al. Soil Variables Plus Our Best Soil Class	3.59*** (0.318)	0.0031 (0.0052)	4.44 (1.07, 7.81)
National Composite Model	2.64*** (0.186)	-0.0068** (0.0031)	3.37 (0.27, 6.47)

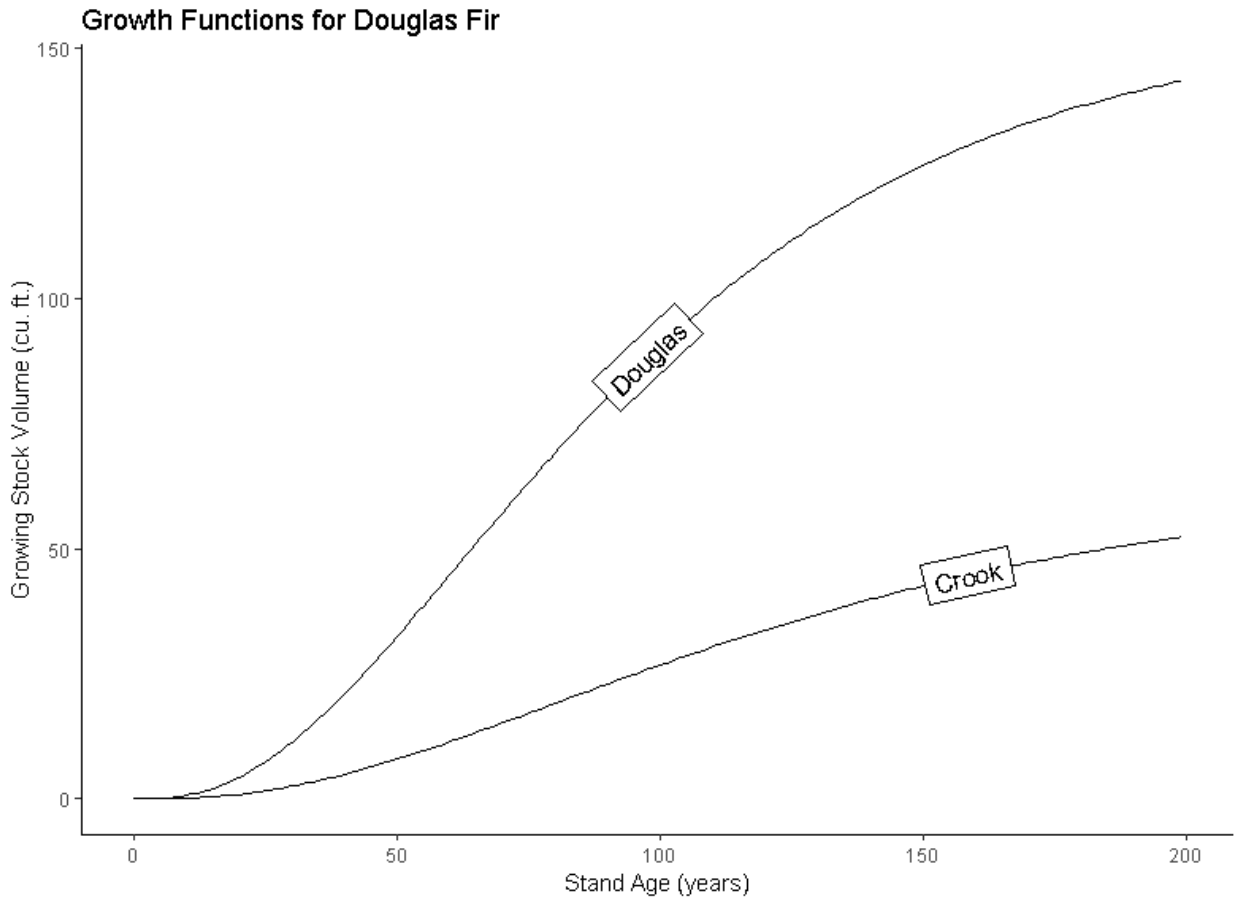
Notes: Rows 1-5 present results from the eastern U.S. composite model. Additional soil variables obtained from Massetti, Mendelsohn, and Conaboyashi (2016). Mill capacity and number of mills derived from Forisk North American Forest Industry Capacity Database Update (2020). Elevation calculated from FIA plot level data as the county-level mean elevation on forestland.

Table A6. Assessing robustness with alternative Ricardian specifications in the seasonal model

	Seasonal Eastern Model (w/o Latitude Control)	Seasonal Eastern Model (w/ Latitude Control)
Average Marginal Effect of Fall Temperature	-9.69*** (3.338)	-7.78** (3.370)
Average Marginal Effect of Winter Temperature	8.76*** (2.040)	6.51*** (2.130)
Average Marginal Effect of Spring Temperature	-3.57 (3.001)	-8.81*** (3.338)
Average Marginal Effect of Summer Temperature	10.22*** (2.559)	13.51*** (2.715)
Average Marginal Effect of Latitude	-	-4.39*** (1.242)
Climate Change Impact ($/acre)	20.29 (6.73, 33.85)	13.97 (-0.55, 28.50)

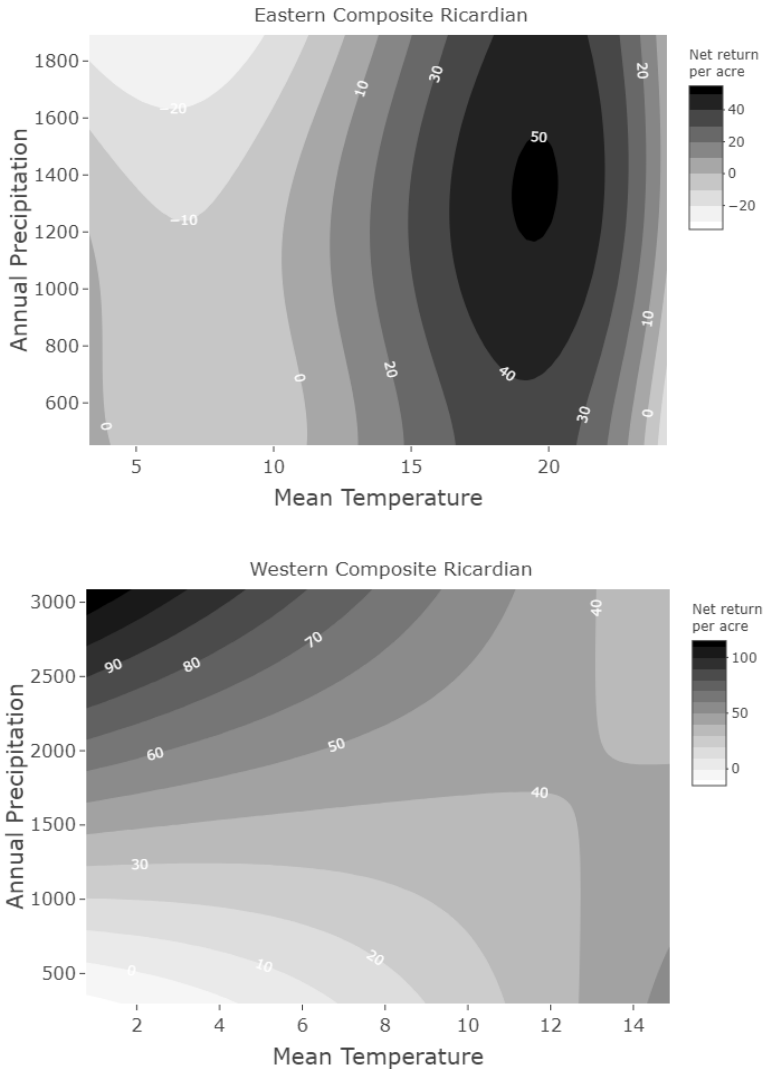
Notes: Latitude calculated from FIA plot level data as the county-level mean latitude on forestland.

Figure A1 – Example estimated von Bertalanffy timber growth functions for two Oregon counties for Douglas-fir



Notes: estimated von Bertalanffy parameters embed the dry climate in Crook county ($\alpha = 63.8$, $\beta = 0.0138$) and the wet climate in Douglas county ($\alpha = 156.4$, $\beta = 0.0180$).

Figure A2 – Estimated contour plots for composite Ricardian functions



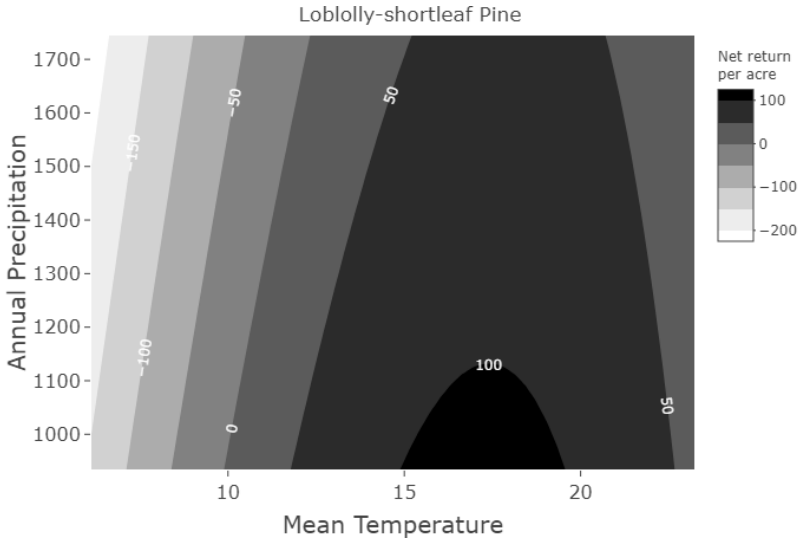

Loblolly-shortleaf Pine
Annual Precipitation
1700
1600
1500
1400
1300
1200
1100
1000
10
15
20
Mean Temperature
−150
−50
50
−100
0
100
50
Net return per acre
100
0
−100
−200

Figure A3 – Climate change impact across alternative Global Climate Models RCP 8.5