A Appendix Tables and Figures

Table A1: Prescribed Burn Decision: Robustness check

	Log(prescribed burn acres)					
	(1)	(2)	(3)	(4)	(5)	(6)
=1 if it had a wildfire in previous 3yrs	0.619***	0.465	0.416	-1.602	1.004*	1.078**
	(0.088)	(0.281)	(1.178)	(1.740)	(0.556)	(0.516)
Log(Avg max vapor pressure deficit)	2.487***		-0.036	-0.836	2.597***	1.123***
	(0.805)		(0.168)	(0.547)	(0.707)	(0.328)
Avg annual temperature (C)		0.334**				
		(0.138)				
Log(Avg annual precipitation)		0.480				
		(0.460)				
Saw timber volume MBF per acre	0.011	0.024	-0.008	0.046	0.020	0.017
	(0.044)	(0.048)	(0.028)	(0.040)	(0.033)	(0.036)
Avg siteclass	0.062	-0.004	-0.014	0.016	0.019	-0.030
	(0.087)	(0.096)	(0.030)	(0.037)	(0.087)	(0.123)
Avg stand age (10 years)	0.177***	0.127***	0.001	0.001	0.164***	0.142***
	(0.038)	(0.036)	(0.013)	(0.014)	(0.038)	(0.036)
Avg slope (%)	-0.024*	-0.015			-0.024***	-0.023*
	(0.014)	(0.011)			(0.009)	(0.014)
Avg elevation (100 feet)	-0.086*	-0.051			-0.086***	-0.103**
	(0.043)	(0.053)			(0.032)	(0.042)
Share of family ownership	-0.605*	-0.507			-0.517	-0.448
	(0.343)	(0.308)			(0.323)	(0.283)
IV	No	Yes	Yes	Yes	Yes	Yes
Ecoregion-state-year FEs	Yes	Yes	No	No	Yes	No
County FEs	No	No	Yes	Yes	No	No
Year FEs	No	No	No	Yes	No	No
Ecoregion-state FEs	No	No	No	No	No	Yes
Standard-Errors	Ecoregion-state			County		Ecoregion-state
Observations	5,197	5,197	5,197	5,197	5,197	5,197
R^2	0.57645	0.58816	0.82686	0.76921	0.56953	0.48385
Within R^2	0.14545	0.16908	-0.04345	-0.46381	0.13149	0.07905
F-test (1st stage), p-value, =1 if it had a wildfire in previous 3yrs		4.25×10^{-26}	0.00013	0.01938	7.05×10^{-28}	3.99×10^{-29}
Wald (1st stage), p-value, =1 if it had a wildfire in previous 3yrs		4.51×10^{-8}	0.07808	0.23092	0.00035	8.17×10^{-9}

Note. Significance denoted by *p<0.1; **p<0.05; ***p<0.01.

Table A2: Effect of Prescribed Fire on Probability of Wildfire Events: Main Probit Model Coefficient Results with Prescribed Fire Instrumented by Number of Establishments in Forestry Sector

	=1 if there is a large wildfire				
	Model 1	Model 2	Model 3	Model 4	Model 5
IHS(2yr avg acres burned in prescribed fire)	0.218***	-0.100	-0.475***		
	(0.071)	(0.124)	(0.114)		
IHS(1yr avg acres burned in prescribed fire)				-0.467***	
				(0.088)	
IHS(3yr avg acres burned in prescribed fire)					-0.403***
					(0.180)
Log(Avg max vapor pressure deficit)	0.796	2.816***	1.981***	1.807***	1.830**
	(1.094)	(0.810)	(0.749)	(0.654)	(0.866)
Saw timber volume MBF per acre	-0.107**	-0.087	-0.048	-0.043	-0.076
	(0.047)	(0.045)	(0.047)	(0.043)	(0.059)
Avg siteclass	0.159	0.378**	0.119	0.160**	0.130
	(0.115)	(0.179)	(0.084)	(0.080)	(0.089)
Avg stand age (10 years)	0.184**	0.106	0.148**	0.140**	0.177**
	(0.072)	(0.074)	(0.074)	(0.067)	(0.090)
Avg slope (%)	-0.007	-0.023**	-0.015	-0.012	-0.014
	(0.005)	(0.010)	(0.009)	(0.008)	(0.009)
Avg elevation (100 feet)	0.018	0.068***	-0.026	-0.040	-0.024
	(0.038)	(0.023)	(0.034)	(0.033)	(0.037)
Share of family ownership	-0.487	-1.540***	-0.404	-0.386	-0.443
	(0.373)	(0.317)	(0.415)	(0.383)	(0.419)
Log(Avg max vapor pressure deficit) Mundlak	1.622		-0.589	-0.445	-0.134
	(1.447)		(0.946)	(0.871)	(1.163)
Saw timber volume MBF per acre Mundlak	0.136		0.105	0.090	0.116
	(0.107)		(0.064)	(0.061)	(0.075)
Avg siteclass Mundlak	0.849***		0.519**	0.386*	0.540**
	(0.296)		(0.212)	(0.202)	(0.242)
Avg stand age (10 years) Mundlak	-0.420***		-0.270**	-0.305***	-0.297**
	(0.142)		(0.117)	(0.118)	(0.144)
Avg slope (%) Mundlak	0.000		0.001	0.001	0.007
	(0.027)		(0.013)	(0.012)	(0.017)
Avg elevation (100 feet) Mundlak	0.071		0.081*	0.093**	0.079
	(0.057)		(0.044)	(0.042)	(0.051)
Share of family ownership Mundlak	-1.540*		-1.035*	-1.350**	-1.204*
	(0.809)		(0.555)	(0.589)	(0.660)
IHS(2yr avg acres burned in prescribed fire) Mundlak	-0.174***		0.476***		
	(0.059)		(0.109)		
IHS(1yr avg acres burned in prescribed fire) Mundlak				0.440***	
				(0.092)	
IHS(3yr avg acres burned in prescribed fire) Mundlak					0.426**
					(0.166)
Observations	5559	5559	5559	6185	4941
IV	No	Establish	Establish	Establish	Establish
Mundlak FE Approx (ecoregion-state-year)	Yes	No	Yes	Yes	Yes
Standard-Errors	Ecoregion-state				

Note. IHS: Inverse Hyperbolic Sine. Establish: The number of establishments in the forestry sector. Significance denoted by *p<0.1; **p<0.05; ***p<0.01.

Table A3: First Stage Results of Main Wildfire Probit Model

	IHS(2yr PB acres)		IHS(1yr PB acres)	IHS(3yr PB acres)
	Model 2	Model 3	Model 4	Model 5
2yr avg forest sector number of establishments	0.063***	0.020***		
	(0.015)	(0.007)		
1yr avg forest sector number of establishments			0.023***	
			(0.008)	
3yr avg forest sector number of establishments				0.019***
				(0.007)
Log(Avg max vapor pressure deficit)	6.083***	2.386***	2.576***	2.319***
	(1.370)	(0.768)	(0.835)	(0.758)
Saw timber volume MBF per acre	-0.050	0.020	0.024	0.016
	(0.096)	(0.048)	(0.050)	(0.046)
Avg siteclass	-0.088	0.096	0.183	0.104
	(0.216)	(0.121)	(0.115)	(0.128)
Avg stand age (10 years)	-0.214	0.085	0.086	0.089
	(0.154)	(0.061)	(0.060)	(0.062)
Avg slope (%)	-0.065***	-0.020	-0.013	-0.018
	(0.025)	(0.013)	(0.014)	(0.014)
Avg elevation (100 feet)	0.067	-0.060	-0.088**	-0.054
	(0.074)	(0.037)	(0.037)	(0.037)
Share of family ownership	-2.459**	-0.164	-0.082	-0.182
	(1.127)	(0.577)	(0.583)	(0.551)
Log(Avg max vapor pressure deficit) Mundlak		-2.457***	-2.665***	-2.389***
		(0.745)	(0.816)	(0.724)
Saw timber volume MBF per acre Mundlak		0.059	0.063	0.061
		(0.065)	(0.068)	(0.067)
Avg siteclass Mundlak		0.004	-0.097	0.015
		(0.134)	(0.143)	(0.141)
Avg stand age (10 years) Mundlak		-0.115*	-0.136*	-0.101
		(0.069)	(0.075)	(0.073)
Avg slope (%) Mundlak		0.011	0.004	0.009
		(0.016)	(0.016)	(0.017)
Avg elevation (100 feet) Mundlak		0.058	0.085*	0.047
		(0.046)	(0.045)	(0.046)
Share of family ownership Mundlak		-0.352	-0.579	-0.215
		(0.660)	(0.699)	(0.640)
IHS(2yr avg acres burned in prescribed fire) Mundlak		0.976***		
		(0.021)		
2yr avg forest sector number of establishments Mundlak		-0.045**		
		(0.020)		
IHS(1yr avg acres burned in prescribed fire) Mundlak			0.977***	
			(0.021)	
1yr avg forest sector number of establishments Mundlak			-0.052**	
			(0.022)	
IHS(3yr avg acres burned in prescribed fire) Mundlak				0.981***
				(0.022)
3yr avg forest sector number of establishments Mundlak				-0.044**
				(0.021)
Observations	5559	5559	6185	4941
IV	Establish	Establish	Establish	Establish
Mundlak FE Approx (ecoregion-state-year)	No	Yes	Yes	Yes
Standard-Errors	Ecoregion-state	Ecoregion-state	Ecoregion-state	Ecoregion-state
F stat (1st stage) for within-varying plus Mundlak mean IVs	NA	67.25	66.09	50.37
F stat (1st stage) for within-varying IVs only	266.31	18.86	23.52	16.49

Note. IHS: Inverse Hyperbolic Sine. Establish: The number of establishments in the forestry sector. Significance denoted by *p<0.1; **p<0.05; ***p<0.01.

Table A4: Marginal Effect of Prescribed Fire on Probability of Wildfire Events: Robustness Results with Wildfire Suppression Efforts and Naturally Caused Wildfire Count Included as a Control

Marginal Effects	Model 3	Model 4	Model 5
Prescr Burn Acres rolling avg past 2 years	-0.08**		
	(0.04)		
Prescr Burn Acres past 1 year		-0.06**	
		(0.03)	
Prescr Burn Acres rolling avg past 3 years			-0.06
			(0.04)
Log(Avg max vapor pressure deficit)	0.32*	0.30*	0.25
	(0.16)	(0.16)	(0.16)
Observations	5559	5803	4941
IV	Establish	Establish	Establish
Mundlak FE Approx (ecoregion-state-year)	Yes	Yes	Yes
Standard-Errors		Ecoregion-state	
F stat (1st stage) for within-varying plus Mundlak mean IVs	29.36	31.2	25.74
F stat (1st stage) for within-varying IVs only	51.72	52.57	44.82

Note. Establish: The number of establishments in the forestry sector. Significance denoted by $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$. We constructed wildfire suppression effort variable based on the Incident Management Situation Reports (IMSR) dataset (Nguyen et al. 2024), which documents daily wildland fire situations across ten geographical regions in the U.S. The data includes summaries for each reported day on wildfire activities and committed fire suppression resources (i.e., personnel and equipment). Since the data does not have geospatial identification (e.g., coordinates, counties), we matched the incidents to counties using another Incident Status Summary data, also known as ICS-209, which links each wildfire to the county (St. Denis et al. 2023). However, the process still leaves quite a few unmatched wildfires, so for these unmatched cases, we assigned counties that the local National Wildfire Coordinating Group (NWCG) unit the fire belonged to based on the National Interagency Fire Center unit ID database, available at https://unitid.nifc.gov/.

Table A5: Marginal Effect of Prescribed Fire on Probability of Wildfire Events: Robustness Check with County Fixed Effects

Marginal Effects	Model 3	Model 4	Model 5
Prescr Burn Acres rolling avg past 2 years	0.66		
	(0.67)		
Prescr Burn Acres past 1 year		3.52	
		(150.39)	
Prescr Burn Acres rolling avg past 3 years			0.45
			(0.53)
Log(Avg max vapor pressure deficit)	0.58**	3.24	0.60***
	(0.23)	(117.69)	(0.14)
Observations	5559	6185	4941
IV	Establish	Establish	Establish
Mundlak FE Approx (county)	Yes	Yes	Yes
Standard-Errors		Ecoregion-state	
F stat (1st stage) for within-varying plus Mundlak mean IVs	0.91	0.04	1.39
F stat (1st stage) for within-varying IVs only	1.80	0.01	2.78
Corr. Coef. between Prescr Burn Acres and Mundlak Average	0.9611	0.9408	0.972

Note. Establish: The number of establishments in the forestry sector. Significance denoted by *p<0.1; **p<0.05; ***p<0.01.

Table A6: Annual temperature, precipitation, maximum vapor pressure deficit, and projected future vapor pressure deficit (RCP8.5) by state.

States		Mean	SD
AL	Average annual precipitation (mm)	1539.26	258.09
	Average annual temperature (C)	17.65	1.41
	Average max vapor pressure deficit (hPa)	16.70	2.15
	Projected change in vapor pressure deficit 2030-2040 (%)	7.82	0.52
	Projected change in vapor pressure deficit 2040-2050 (%)	2.23	0.93
	Projected change in vapor pressure deficit 2030-2050 (%)	10.23	1.37
FL	Average annual precipitation (mm)	1480.93	244.70
	Average annual temperature (C)	21.75	1.60
	Average max vapor pressure deficit (hPa)	17.85	1.76
	Projected change in vapor pressure deficit 2030-2040 (%)	5.37	1.64

States		Mean	SD
	Projected change in vapor pressure deficit 2040-2050 (%)	3.46	0.82
	Projected change in vapor pressure deficit 2030-2050 (%)	9.03	2.43
GA	Average annual precipitation (mm)	1337.37	283.68
	Average annual temperature (C)	17.98	1.67
	Average max vapor pressure deficit (hPa)	17.26	2.30
	Projected change in vapor pressure deficit 2030-2040 (%)	8.45	0.68
	Projected change in vapor pressure deficit 2040-2050 (%)	2.45	1.21
	Projected change in vapor pressure deficit 2030-2050 (%)	11.11	1.50
MS	Average annual precipitation (mm)	1592.49	269.57
	Average annual temperature (C)	17.99	1.25
	Average max vapor pressure deficit (hPa)	16.55	1.71
	Projected change in vapor pressure deficit 2030-2040 (%)	8.89	0.91
	Projected change in vapor pressure deficit 2040-2050 (%)	1.40	0.78
	Projected change in vapor pressure deficit 2030-2050 (%)	10.42	1.16
NC	Average annual precipitation (mm)	1396.77	302.48
	Average annual temperature (C)	15.42	1.88
	Average max vapor pressure deficit (hPa)	14.44	2.26
	Projected change in vapor pressure deficit 2030-2040 (%)	6.42	1.18
	Projected change in vapor pressure deficit 2040-2050 (%)	2.38	0.52
	Projected change in vapor pressure deficit 2030-2050 (%)	8.94	1.10
SC	Average annual precipitation (mm)	1304.59	257.33
	Average annual temperature (C)	17.60	1.09
	Average max vapor pressure deficit (hPa)	17.10	1.71
	Projected change in vapor pressure deficit 2030-2040 (%)	7.97	0.62
	Projected change in vapor pressure deficit 2040-2050 (%)	2.13	0.32
	Projected change in vapor pressure deficit 2030-2050 (%)	10.27	0.76

States		Mean	SD
TN	Average annual precipitation (mm)	1505.96	242.00
	Average annual temperature (C)	14.74	1.05
	Average max vapor pressure deficit (hPa)	14.12	1.60
	Projected change in vapor pressure deficit 2030-2040 (%)	6.35	0.66
	Projected change in vapor pressure deficit 2040-2050 (%)	0.87	0.30
	Projected change in vapor pressure deficit 2030-2050 (%)	7.27	0.51

Table A7: Simulation results by state: RCP4.5 scenario

State	Delta prescribed burn (PB) acres	Delta wildfire (WF) probability	Delta WF count	Delta as % of total WF count	PB acres increase	VPD change by 2050
All	262,132	-0.002%	3	0.6%	9%	1.1%
AL	38,519	0.2%	5	14%	3%	-1.2%
FL	182,161	0.2%	15	5%	16%	0.9%
GA	16,675	-0.5%	-9	-17%	7%	1.7%
MS	3,185	0.0%	1	8%	0%	-0.9%
NC	8,648	-0.4%	-3	-4%	20%	4.2%
SC	11,960	-1.2%	-7	-31%	15%	4.3%
TN	984	0.1%	2	6%	5%	-1.0%

Note: Column 1 shows the difference in prescribed burn acres between the baseline (holding prescribed fire fixed) and full scenario (not holding prescribed fire fixed) outcomes in 2050: full scenario PB - baseline PB. Column 2 shows the difference in wildfire probability between the baseline and full scenarios in 2050: full Prob(WF) - baseline Prob(WF). Column 3 shows the difference in the number of wildfires between the baseline and full scenarios over the next 20 years: full WF count - baseline WF count. Column 4 shows the percentage of wildfire mitigation (column 3) relative to the total number of wildfires in baseline case over the next 20 years. Column 5 is the percentage increase in prescribed burn in full scenario outcome in 2050 relative to the current level, and column 6 is the percentage change in the projected vapor pressure deficit between 2030 and 2050.

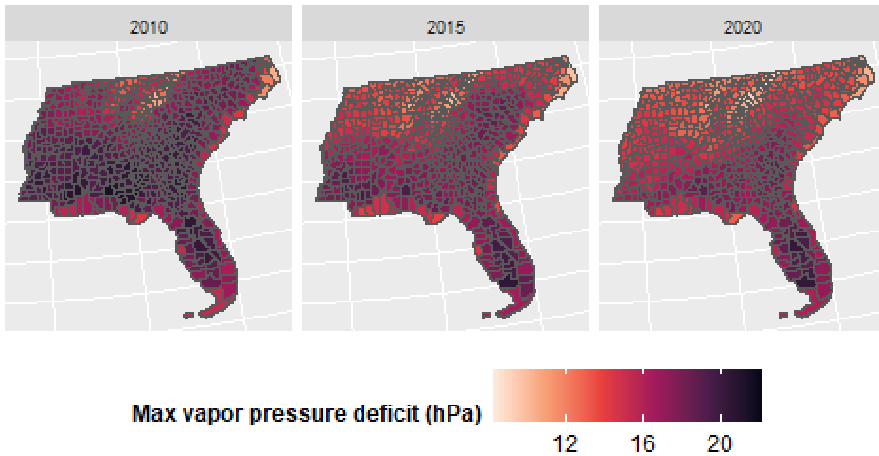

Figure A1: Annual average maximum vapor pressure deficit in 2010, 2015, 2020

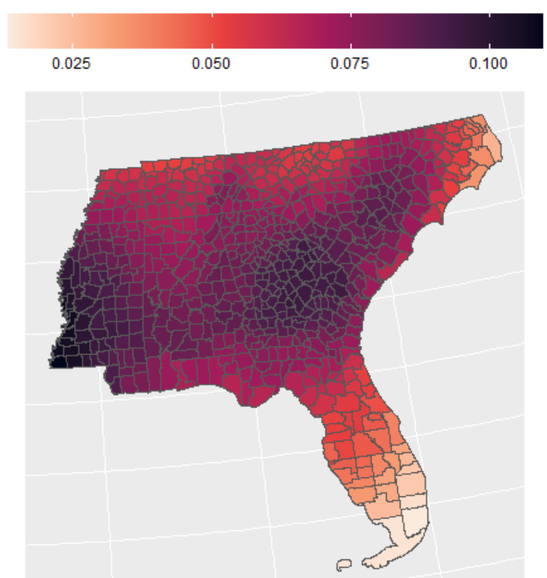

Figure A2: Projected change in vapor pressure deficit in 2030-2040

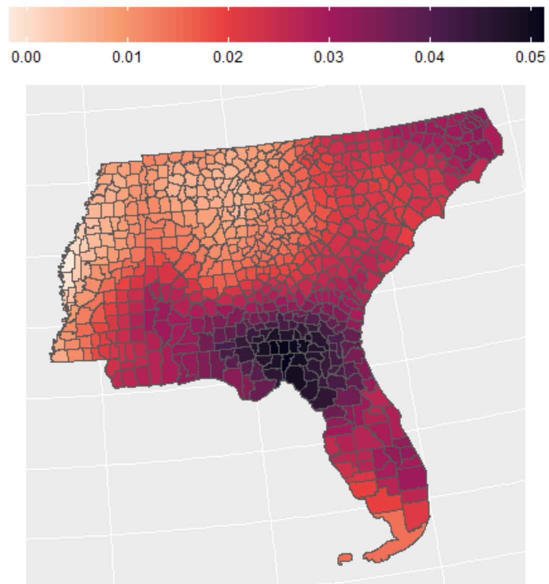

Figure A3: Projected change in vapor pressure deficit in 2040-2050

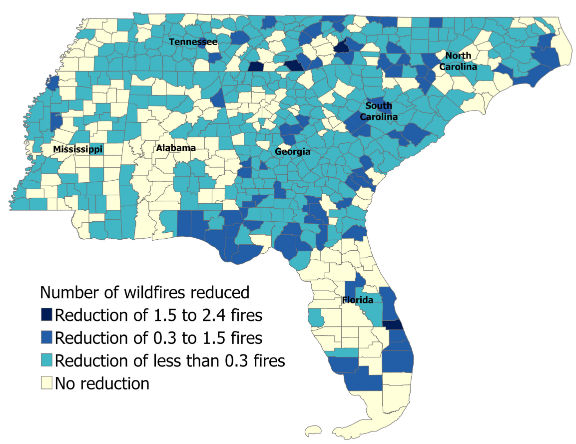

Figure A4: Simulation results: Projected mitigation benefits of wildfire reduction under RCP 4.5 scenario

B Appendix Example Numerical Calculations of Theory of Optimal Protection

The expected bare land value of a timber stand from Eq. (2) in the main text is expressed as:

$$V = \frac{\Big[r + \lambda(C, PB)\Big]\Big[pF(T) - c_1(PB)\Big]e^{-[r+\lambda(PB)]T}}{r\Big(1 - e^{-[r+\lambda(C,PB)]T}\Big)} - \frac{\lambda(C, PB)}{r}c_2 \tag{B.1}$$

where all parameters are defined in the main text. The landowner chooses length T and the amount of prescribed burning PB to maximize V. In this appendix, we use estimates of timber growth $F(T)$ along with stumpage prices (p) to illustrate how changes in climate (C) impact prescribed burning through altering wildfire arrival λ as described in Eq. (7) in the main text:

$$\frac{\partial PB}{\partial C} > 0 => \frac{\partial PB}{\partial \lambda_0} > 0 \tag{B.2}$$

To develop numerical solutions that illustrate Eq. (7), shown here as Eq. B.2, we specify a specific functional form of the fire arrival rate as a logistic using Eq. (5) in the main text:

$$\lambda = \lambda(C, PB) = \frac{1}{\big[1 + e^{(\alpha_0+\alpha_1 C+\alpha_2 PB)}\big]}, \text{ where } \alpha_1 < 0, \alpha_2 > 0 => \frac{\partial \lambda}{\partial C} > 0 \text{ and } \frac{\partial \lambda}{\partial PB} < 0 \tag{B.3}$$

In the absence of prescribed burning, the exogenous fire arrival rate depends only on C and is:

$$\lambda_0 = \lambda(C, PB = 0) = \frac{1}{\big[1 + e^{(\alpha_0+\alpha_1 C)}\big]} \tag{B.4}$$

One additional assumed functional form is our use of the von Bertallanfy function for tree growth:

$$F(T) = a(1 - e^{-bT})^3 \tag{B.5}$$

To illustrate that $\frac{\partial PB}{\partial \lambda_0} > 0$, we use data from Mihiar and Lewis (2021) on tree growth $F(T)$, stumpage prices (p), and trees per acre for two widely managed pine species in two separate counties in our study region:

Table B1: Forestry revenue parameters for two representative counties

County	Forest type	a	b	Trees per acre	p
Escambia County, FL	Longleaf/Slash pine	27.58	0.046	208	1.97
Berkeley County, SC	Loblolly/Shortleaf pine	21.17	0.067	96	1.83

We have no information on the fire arrival rate parameters (α_0, α_1) or on the cost function for prescribed burning $c_1(PB)$, but we do have empirical knowledge of burning and climate that can be used to calibrate reasonable values for these parameters:

Table B2: Burning and climate data for two representative counties

County	Avg annual prescribed burning (% of forest)	Avg annual wildfire (% of forest)	Maximum annual wildfire (% of forest)	Vapor Pressure Deficit (VPD)
Escambia County, FL	0.0326	0.00048	0.006	15.25
Berkeley County, SC	0.09	0.0014	0.006	16.81

Given the burning and climate data for these representative counties, and the logistic functional form for fire arrival (Eq. 5), the implicit value of $\alpha_0 + \alpha_1 C + \alpha_2 PB$ can be computed as approximately 5.1, such that $\lambda = \lambda(C, PB) = \frac{1}{\left[1 + e^{(5.1)}\right]} = 0.006$, which matches the largest proportion of forest burned by wildfire in these counties during our study time frame. We further assume that PB is measured as the fraction of land that is subject to prescribed burning, and the prescribed burning cost function is assumed to be of a quadratic form with increasing marginal costs:

$$c_1(PB) = 46 + 1500PB + 150PB^2 \tag{B.6}$$

With this function, a country with an average $PB = 0.03$ would have annual prescribed burning costs of approximately \$91/acre. Finally, we assume a post-fire salvage cost of $c_2 = \$200$/acre.

Given these assumptions, we numerically compute the optimal value of PB given exogenous changes in climate, which is reflected in changes in λ_0. Since we have no information about what magnitude α_2 should be, we calibrate it for each county so as to get optimal prescribed burning proportions that are roughly consistent with the empirical data. Table B3 shows the key comparative static that $\dfrac{\partial PB}{\partial \lambda_0} > 0$, which in turn determines the wildfire arrival $\lambda(C, PB)$.

Table B3: Optimal prescribed burning shares as a function of exogenous changes in wildfire arrival rate

	Escambia County, FL ($\alpha_2 = 5$)		Berkeley County, SC ($\alpha_2 = 15$)	
Exogenous wildfire arrival $\lambda_0 = \lambda(C, 0))$	Optimal prescribed burning share PB	Wildfire arrival $\lambda(C, PB)$	Optimal prescribed burning share PB	Wildfire arrival $\lambda(C, PB)$
0.006	0.017	0.00505	0.022	0.00438
0.0067	0.047	0.00530	0.028	0.00441
0.011	0.13	0.00589	0.059	0.00457
0.018	0.21	0.00645	0.090	0.00473

References

Mihiar, Christopher, and David J Lewis. 2021. “Climate, adaptation, and the value of forestland: A national Ricardian analysis of the United States.” Land Economics 97 (4): 911–932.

Nguyen, Dung, Erin J Belval, Yu Wei, Karen C Short, and David E Calkin. 2024. “Dataset of United States Incident Management Situation Reports from 2007 to 2021.” Scientific data 11 (1): 23.

St. Denis, Lise A, Karen C Short, Kathryn McConnell, Maxwell C Cook, Nathan P Mietkiewicz, Mollie Buckland, and Jennifer K Balch. 2023. “All-hazards dataset mined from the US National Incident Management System 1999–2020.” Scientific data 10 (1): 112.