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Burning Budgets: Does an Institutional Blank-Check Raise the Severity and Cost of Fighting Wildland Fires?

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BURNING BUDGETS: DOES AN INSTITUTIONAL BLANK-CHECK RAISE THE SEVERITY AND COST OF FIGHTING WILDLAND FIRES?

by

Devin T. Stein

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ABSTRACT

Burning Budgets: Does an Institutional Blank-Check Raise the Severity and Cost of Fighting Wildland Fires?

by

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Utah State University, 2017

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This article uses a public choice perspective to analyze the institutions and incentives that fire managers face. The theoretical framework posited here suggests that a vicious cycle of fire suppression exists in the United States driven by an institutional-blank-check.

The "institutional-blank-check" theory is tested with regression analysis that attempts to explain fire suppression expenditures, the cost per acre of suppression, and the probability of a budget increase for the U.S. Forest Service in the continental United States. The results from these tests suggest that political factors, including injuries from wildfires and the number of politicians from a state sitting on the House of Representatives' Appropriations Committee, the oversight committee tasked with managing wildfire management expenditures for the U.S. Forest Service, do play significant roles in determining the amount spent in each state on fire suppression.

These results suggest that political institutions are decisive in determining how much is spent on suppressing wildfires in the United States. Reforming these institutions could be a key component in improving wildfire and forest management in the United States.

(42 pages)

PUBLIC ABSTRACT

Burning Budgets: Does an Institutional Blank-Check Raise the Severity and Cost of Fighting Wildland Fires?

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In conducting this research, I wanted to explore whether political incentives have a significant effect on wildfire management in the United States. I attempt to answer this question by proving a theoretical justification for why wildfires may become more expensive to fight and severe to manage because of political institutions. I then attempt to provide some hard evidence to support this theory by using regression analysis. My analysis suggests that political factors do matter for wildfire suppression funding, although I was unable to find strong enough evidence to suggest that these political factors are actually driving more severe wildfires.

This research contributes to the literature on public choice theory, a branch of political economy that looks at government from the individual decision makers' level. Additionally, this research contributes to the literature on what affects wildfire suppression effectiveness and funding. This research may contribute to future analyses of the institutions that make U.S. wildland firefighters more or less capable of effectively managing wildfires to protect human lives, property, and forests.

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INTRODUCTION

On October 25, 2003, a fire erupted in San Diego County, California, that destroyed nearly 3,000 buildings and spread at up to 40,000 acres per hour (Lakeside Historical Society, n.d.). The conflagration killed more than a dozen people and injured more than 100 others, which attracted substantial political and media attention. United States House Representative Duncan Hunter's home was threatened by the fire (it eventually would burn), and he called Ray Quintanar, a regional aviation chief for the U.S. Forest Service, demanding that aircraft be dispatched to attack the fire. Quintanar refused because high winds and poor visibility would make use of the aircraft ineffective. But after Hunter called the chairman of the Joint Chiefs of Staff in Washington, D.C., six C-130 Hercules transports were sent to fight the fire (Cart and Boxall, 2008).

Quintanar believed that those planes did very little to control the fire, but he characterized the response as a "political air show," or a "CNN drop." Such political air shows are described by the *Los Angeles Times* as "the high-profile use of expensive aircraft to appease elected officials" (Cart and Boxall, 2008). Despite their ineffectiveness, aerial drops make good television coverage of wildfire responses, which shows the public that their elected leaders are taking immediate and drastic steps to ensure their safety.

This story illustrates the political forces that underlie fire suppression in the United States. Although fire experts generally understand effective wildfire management

strategies, politics often gets in the way. When centralized political forces with no wildfire management experience have greater control of wildfire suppression strategies than the experts, it is unsurprising that larger fire-suppression budgets are not reducing the severity of U.S. wildfires (Brusentsev and Vroman, 2016). This article explores the political factors and institutions that may be reducing the efficiency of managing wildfires.

The technologies and tactics used for wildfire management are improving continually, yet there is no clear evidence that these agencies are getting better results (Ingalsbee, 2010). The annual number of acres burned in wildfires has grown significantly in past decades, and federal fire-suppression expenditures are skyrocketing (Brusentsev and Vroman, 2016). Widespread debate about the causes points generally to past suppression efforts, drought conditions, climate change, and economic development in the wildland-urban interface (Gebert and Black, 2012).

I suggest another cause for more acres burned and larger wildfire suppression costs: an institutional weakness in current fire suppression policy. Although the existing literature looks at individual fire manager behavior and the perverse incentives faced, as well as risk management and decision making under uncertainty, no studies yet have tried to bring an institutional analysis of political processes to bear in explaining fire outcomes. This study will not look at traditional causes of greater wildfire severity and higher costs, but rather suggest that political institutions may be a driving factor.

More expensive and severe wildfires in the United States are an important policy issue because wildfires can damage communities, timber resources, human lives, wildlife, as well as impact soil conditions, watersheds, and water quality. The existing literature

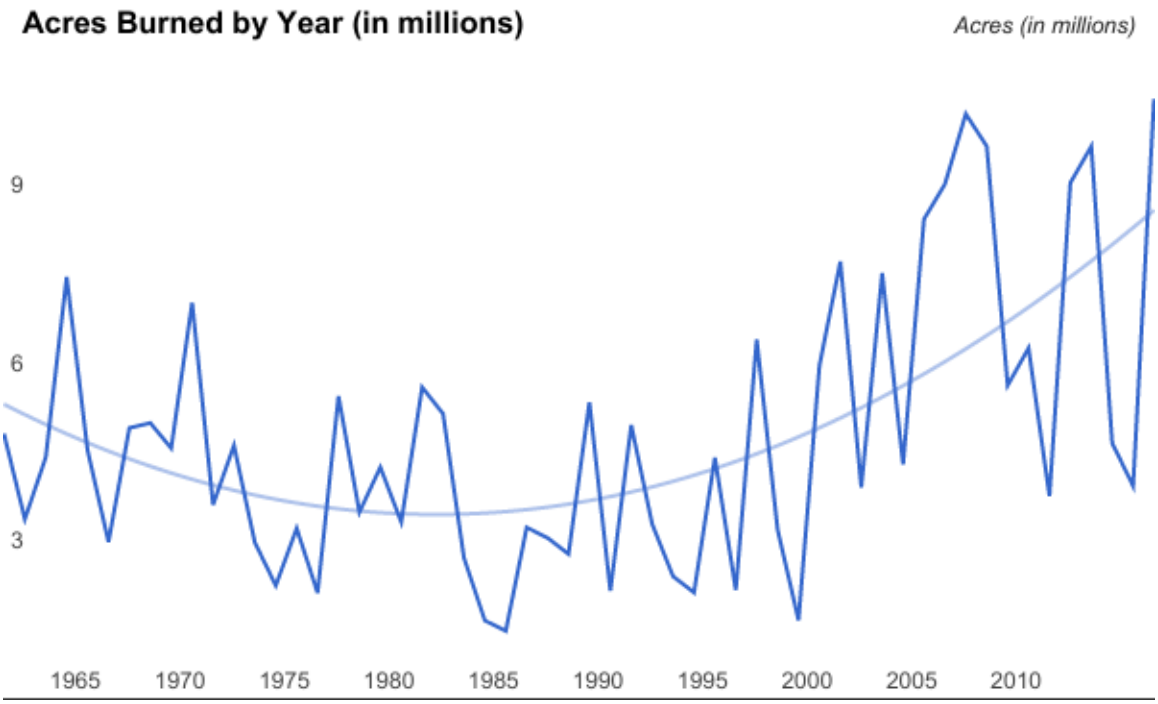
generally attributes the increase in wildfires to past fire suppression efforts and climate change. This paper uses public choice analysis to suggest an alternative hypothesis: that wildfires are becoming more severe in the United States because of political incentives that raise fire-suppression spending. The theory is supported by a series of statistical tests that suggest that political factors do have a significant effect on wildfire suppression expenditures.

BACKGROUND

In 1908, Congress passed the Forest Fires Emergency Act, which allowed the newly created U.S. Forest Service (USFS) to exceed its appropriated budget (i.e., run a deficit) on fire suppression to prevent forest fires from destroying the timber reserves the agency was supposed to protect. Because fires were uncontrollable at the time, budget constraints were considered unthinkable, and a blank-check policy ensured that the USFS would be able to fund fire suppression efforts.

During the early days of the USFS, wildfires were so dangerous that they were viewed as a war on the home front. Any suggestion of actively managing fires using practices like light-burning were considered heresy because these fires would threaten more lives (Pyne, 1996). For the next several decades, wildfire suppression had almost unanimous congressional and public support.

It was not until the 1970s that forest ecologists reached a consensus that many North American forests were fire-adapted ecosystems that actually needed periodic burning. In 1978, Congress repealed the Forest Fires Emergency Act, forcing the USFS to manage fires more holistically and economically. Throughout the 1970s and 1980s, the USFS managed fires cost-effectively, borrowing funding from the agency's reforestation budget for bad fire years and replenishing it on their own in good years (Berry, 2007). Perhaps not surprisingly, those were the years with the fewest number of acres burned in wildfires, as shown in Figure 1, although the period also was wetter than average.



Source: National Interagency Coordination Center.

Figure 1. Acres Burned by Wildfires, 1960-2015.

Then, in 1988, conditions were drier than normal and Yellowstone National Park was experimenting with "let-burn" policies that allowed most naturally caused fires to spread without human control. A series of wildfires erupted, burning more than a third of the park over the course of one summer. As the world's first national park, the Yellowstone fires attracted substantial media attention. The National Park Service, coordinating with the USFS, severely overspent on fire suppression trying to protect Yellowstone. In 1990, following a year of post-fire review, Congress reimbursed the USFS for its suppression expenditures, demonstrating that fire suppression was so politically popular that budget constraints were irrelevant (Berry, 2007). Although formal institutions designed to set budget constraints are in place, the Yellowstone fires may have created an informal regime of congressional acceptance of overspending on

suppression. Because politicians are unlikely to refuse something as politically popular as more funding for fire suppression, USFS officials apparently discovered a reliable way of obtaining additional funding for their objective of managing fires. Thus, the Yellowstone fires may have marked the birth of the institutional blank-check mindset.

As of 2015, more than half of the USFS's budget and workforce is dedicated to fire management (U.S. Forest Service, 2015). The USFS regularly draws from an emergency fund when the costs of suppressing a fire exceed the appropriated sum, and Congress consistently reimburses these expenditures (Hoover and Bracmort, 2015). Although the USFS allows many wildland fires to burn in the backcountry, any fire that risks damage to public lives or property is suppressed regardless of cost. Some estimates suggest that from 50 to 95 percent of firefighting costs are spent exclusively to protect private property (U.S. Department of Agriculture, 2006). This may seem to be laudable use of federal funding, but a 2003 Office of Management and Budget report found that in some areas it would be cheaper to let structures burn and pay the full cost of rebuilding (Office of Management and Budget, 2003).

Wildfires nowadays are easy ways for the USFS to expand its budget and bureaucratic purview by creating "political shows" of fire suppression. Even when local fire managers know that efforts to suppress a fire will not work, the fight continues. Not only is some wildfire suppression effectively useless, it also promotes moral hazard by encouraging development in areas that are at risk from wildfires.

Focusing on suppression exclusively takes resources away from proactive management strategies that are more likely to reduce long-term fire risks. Some 230 million acres of Forest Service and Department of Interior lands need to be treated for

their excessive fuel loads. Less than three million acres actually are treated each year, which is insufficient to reduce long-term risk (Gorte, 2013). Although proactive wildfire management is more cost-effective in the long-run, federal fire management agencies have an incentive to fight rather than to manage wildfires.

Gregory Aplet, Senior Science Director for the Wilderness Society, claims that although federal fire management policy strongly supports proactive management, environmental policy "allows for good decisions to be made, but does not require those decisions to be made" (Aplet, 2006). Aplet (2006) claims that attitudinal, institutional, and political disincentives block the adoption of "Wildland Fire Use", a form of proactive fire management. Those disincentives include risk aversion, suppression bias, regulatory burdens, and political opposition from both the public and commercial interests.

THEORY AND HYPOTHESIS

The "institutional blank-check" theory proposed here seeks to address the question: *Do political institutions drive more severe and expensive wildfires?*

I have two hypotheses:

H1: An institutional blank-check for fire-suppression spending supplies incentives for fire managers to exceed their appropriated budgets and then be reimbursed by Congress.

H2: The institutional blank-check contributes to more money being spent on fire suppression and more acres being burned by wildfires.

I hypothesize that an institutional blank-check for the U.S. Forest Service, which as the primary wildfire management agency, is reducing the efficiency of fighting wildfires. For the purpose of this study, I measure the efficiency of fighting wildfires in the inflation-adjusted cost per acre of wildfire suppression. This measure of efficiency is oversimplified, however, because spending nothing on fire suppression for ten years would appear to be a massive increase in efficiency, but would not actually address the problem of actively managing wildfires. For the tests used here, however, this measure is perfectly acceptable because of spending nothing on fire suppression is highly unlikely. Given the political demand, the federal government will continue to spend heavily on fire suppression, so minimizing the cost per acre is a reasonable measure of efficiency.

Future studies might focus on adopting a better, alternative measure of wildfire suppression efficiency by looking at the long-term minimization of property damage, lives lost, money spent, fuel buildup, and acres burned by wildfires, while simultaneously maximizing resource benefits.[1] Data limitations prevent me from using a better measure of efficiency, but even with a simplified measurement this study contributes a new theory to the literature that can be tested in future work on wildfires.

The foregoing hypothesis suggests that, while wildfires are getting more severe and expensive, both changes may be driven by bureaucratic and political inefficiencies rather than just ecological or climatic factors. A larger suppression budget does not necessarily mean that fires are being fought more efficiently. The marginal effect of each additional dollar spent on suppression is subject to diminishing marginal returns. If that is the case, some optimal wildfire suppression budget could be computed.

The theoretical justification for the foregoing hypothesis is illustrated as a vicious cycle in Figure 2. Because fire suppression is in high demand politically, especially in states with lots of private and public development in at-risk areas, Members of Congress are likely to increase funding for fire suppression, regardless of the results of that additional spending. Such a funding mechanism creates an incentive for bureaucrats to focus more on suppression than wildfire prevention because they can maximize agency budgets while minimizing risks to themselves personally. Over time, a focus on suppression leads to more fuel buildup and more severe wildfires, which drives more

[1] A more robust measure that considers many of these factors is the cost plus net-value change model (C + NVC). Owing to data limitations, however, this measurement will not be used. See Lankoande and Yoder (2006), Donovan, Prestemon and Gebert (2011), Clark *et al.,* (2016) and Ellison, Moseley & Bixler (2015).

political demands for suppression. The cycle restarts, and fires increasingly become more expensive and severe.

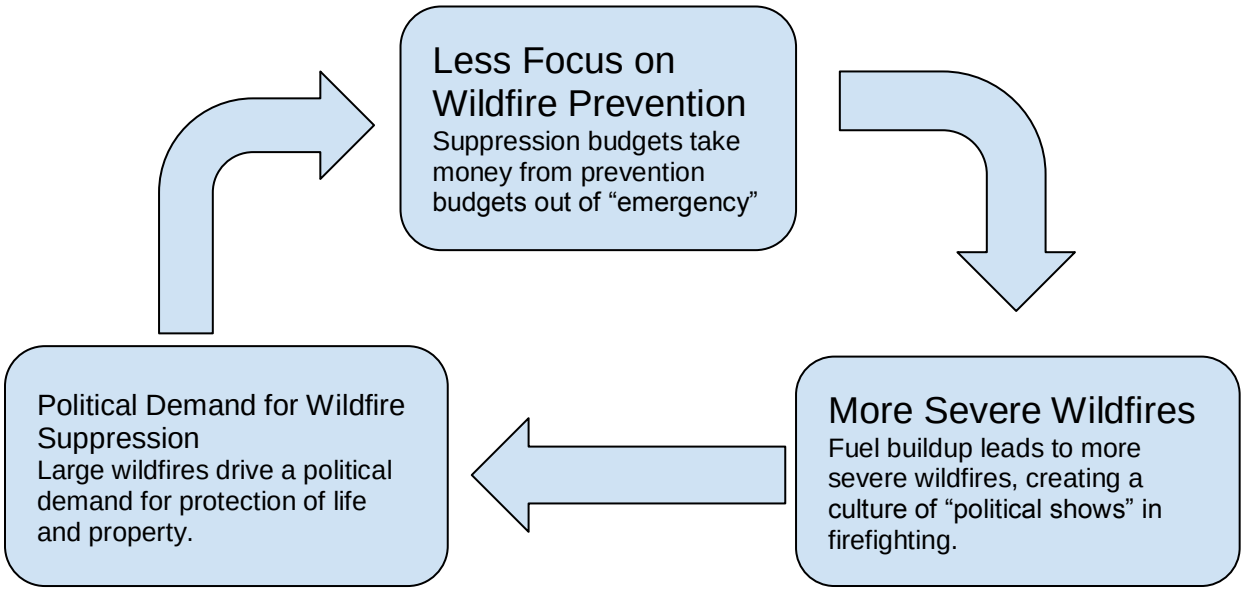


Figure 2. The Institutional Blank-Check.

EXISTING LITERATURE

Existing research suggests that investing in wildfire suppression is less effective than investing in pre-suppression efforts to reduce the value of wildfire losses (Lankoande and Yoder, 2006). Pre-suppression funding, however, often is not allocated on the basis of highest priority needs (Anderson and Anderson, 2012). Similarly, Garrett and Sobel (2003) looked at FEMA disaster payments and found that disaster relief is frequently allocated politically, rather than according to need. Existing studies of suppression and pre-suppression public spending raise concerns about the institutions that may be fueling the recent increases in wildfire severity and the cost of suppressing those wildfires (U.S. Forest Service, 2015). These institutions may be leading the Forest Service to spend more on fire suppression without regard for the monies' actual effectiveness (O'Toole, 2007).

Stephen Pyne's (1982) work on the history of wildfires in America helps set the context for understanding fire regimes and human-wildfire interactions. Pyne suggests that wildfires once were seen as creating important benefits for humans around the world, but they are now seen widely as threats that the U.S. Forest Service, amongst other groups, is tasked with controlling. In the United States, using wildfires for resource benefits actively is being discouraged, despite the recognition that fire is a critical component of many forest ecosystems (van Wagtendonk, 2007). Even Gifford Pinchot, first Chief Forester of the U.S. Forest Service, recognized the role fires had in shaping many North American ecosystems, but still claimed "these facts do not imply any desirability in the fires which are now devastating the West" (Pinchot, 1899).

This article explores questions raised by the literature on wildfires using public choice theory, a field of political economy that uses economic analysis to study political behavior (Shughart, 2008). Public choice theory relies on "methodological individualism," which adopts individuals rather than groups as the unit of analysis (Buchanan and Tullock, 1962). Political actors, whether elected representatives in Congress, appointed officials, bureaucrats, or voters, are not necessarily benevolent people pursuing the public good, but rather self-interested people pursuing more parochial objectives. Sometimes the self-interest is obvious, as when an elected official is trying to stay in office or a bureaucrat is trying to advance his career or obtain a larger budget, but sometimes political actors simply have a biased perception that their job is important enough to disregard or downplay other considerations (Buchanan and Tullock, 1962).

Fire suppression is a noble goal, but many of the political actors involved in shaping public policies may have a biased perception of suppression being the best or only strategy, despite the fact that fire ecologists point to the drawbacks of focusing exclusively on fire suppression. Political actors instead use the political process to obtain the benefits of wildfire suppression for their constituents, while externalizing the costs of such policies to the national taxpayer.

When those living in high-risk wildfire areas have ways of concentrating the benefits on themselves politically, they also have comparative advantages in the political process. Mancur Olson's (1965) seminal work on *The Logic of Collective Action* suggests that a smaller, more cohesive group, such as those living in high-fire-risk areas, can bring more political influence to bear than a large, disorganized public. This theory suggests

that those living in high-risk areas may be more likely to provide Members of Congress with the political support necessary to implement suppression policies they find favorable. Because becoming informed about these issues is costly and the mathematical probability of changing the outcome of an election is close to zero, it is perfectly rational for the average voter to accept the status quo in which "concentrated benefits" dominate "diffuse costs" in the political process (Downs, 1957).

The political process creates a means for people living in high-risk wildfire areas to receive fire suppression without bearing its full cost. By continuing to invest heavily in wildfire suppression, fire managers are promoting more development in these high-risk areas, known as the wildland-urban interface. The wildland-urban interface (WUI) is where development and wildlands meet or intermingle (Stein *et al.*, 2013). Wildfire suppression policies thus promote moral hazard by creating an indirect subsidy for homeowners in the WUI where they do not bear the full cost of protecting property from wildfires (Reilly, 2015; Talberth, Berrens, McKee, and Jones, 2006). This subsidy encourages further development in high-risk areas, which raises the cost of suppression and the damages to lives and property in the event of a wildfire.

Although fire managers recognize the disproportionate amounts of funding going to the WUI, they do not generally advocate for policy reform. Bureaucrats working for the Forest Service want to maximize their discretionary budgets because a larger budget makes it easier to do their jobs, which likewise could make the agency appear more prestigious (Niskanen, 1971). A larger budget means more responsibility, a broader bureaucratic jurisdiction, and a higher likelihood of a larger salary, more bonuses, or other indirect compensation like more workers to reduce an individual's office workload.

Furthermore, even though bureaucrats do not face reelection pressures, they respond to public demands to for their agency's services as well as to please Congress. Members of the House and Senate, especially those serving on committees overseeing the executive branch, reward agencies that help keep them in office (Weignast, 1984).

The Forest Service's incentive to suppress wildfires to please both the public and Congress often leads them to overspend their budget. But when the Forest Service spends all of its budget or overspends, Congress is likely to appropriate more money. Further, Congress regularly appropriates more funding for wildfire management than what is granted in the Interior Department's appropriations bill (Hoover and Bracmort, 2015). Members of Congress generally want to focus on supplying highly visible benefits by suppressing wildfires when needed rather than funding background work that could prevent another disaster (Shughart, 2006). Because of this incentive to create highly visible fire suppression, federal fire managers tend to focus more on suppression than proactive management practices like wildland-fire use.

DATA AND METHODS

To examine the institutional blank-check hypothesis, a combination of statistical tests will attempt to explain the determinants of the efficiency of suppressing wildfires. The population of this study is 42 states for which data are available, covering years from 2009 to 2015. This study relies on data from the U.S. Forest Service for state-by-state fire suppression costs from FY 2009 to FY 2015. Most other data are measured by year, not fiscal year, so the observations do not necessarily coincide perfectly. All costs are rounded to the nearest thousand dollars, and represent estimates only because the Forest Service measures fire expenditures by national forest and region, which often cross state boundaries (K. Carpenter, personal communication, April 6, 2016).

The number of fires and acres burned in wildland fires for each state each year are provided by the National Interagency Coordination Center (NICC), which is responsible for coordinating wildland fire resources throughout the United States. The NICC is a subsidiary of the National Interagency Fire Center (NIFC). The number of fires and acres burned comprise all wildland fires reported by federal, state, and local agencies, as well as private land managers for some states. Each state houses different combinations of federal, state, and local land managers reporting fires, although the observations available for study may reflect the type of land in each state rather than reporting differences. The cost per acre of suppressing wildfires is the total number of acres reported to have burned in wildland fires divided by the suppression expenditures for a given state. Those numbers do not include prescribed burns because this study is concerned only with fire suppression.

The Palmer Drought Severity Index (PDSI) is adopted as a measure of the drought conditions in each state during each year. The PDSI is calculated on the basis of precipitation, temperature, and local soil water contents. The PDSI is a measure of how dry an area is, which provides useful information about how susceptible a forest is to wildfire. A larger PDSI is associated with wetter conditions, while a negative PDSI is associated with drought conditions. All PDSI data come from the National Climatic Data Center (NCDC), a subsidiary of the National Oceanic and Atmospheric Administration (NOAA). For this study, the PDSI is a 12-month average of statewide drought conditions. Although other regional differences affect wildfire susceptibility and severity, no systematic over- or underestimation of drought severity in all states is thought possible.

Lightning data are taken from Vaisala, Inc., a private company under contract with the federal government to operate the National Lightning Detection Network. Vaisala reports the total number of lightning flashes observed in each state, which serves as a proxy for the vulnerability of national forests to lightning strikes. Not all observed flashes are cloud-to-ground strikes, but the number of flashes is assumed to be associated with the total number of such strikes (R. L. Holle, personal communication, February 4, 2016). Lightning strikes are the predominant natural causes of wildfires, so these lightning data provide valuable insights into national forests' susceptibilities to lightning-induced wildfires.

Population estimates are downloaded from the United States Census Bureau. Although the U.S. Census is conducted only once every ten years, the Census Bureau maintains a population estimates program that generates population figures for each year studied herein.

The total number of injuries and deaths from wildland fires are estimated by the NCDC's Storm Events Database. If the institutional blank-check hypothesis holds, injuries and deaths are important components in wildfire-suppression spending decisions. States with more injuries and deaths from wildfires are likely to spend more on suppressing wildfires in the future to protect their citizens and firefighters. Some states consistently report no deaths or injuries, whereas others consistently report many such casualties. Oregon reported no deaths or injuries over the study period, but California reported 203 injuries and 10 deaths. The sources of those numbers are unclear, so the possibility exists of systematic underreporting in some states.

The number of appropriations committee members counts the number of members each state has on the House of Representatives Committee on Appropriations. Because the Committee on Appropriations determines funding for federal agencies' fire suppression, the institutional blank-check hypothesis would suggest that more representatives on this committee could secure more funding for their states. The committee members potentially change biennially, supplying four periods of different committee compositions over this study's time period of focus. California has frequent and massive fires and had anywhere from 5 to 11 representatives sitting on this committee over the analysis period, whereas Indiana has relatively few (and small) fires and had no representatives on this committee. Representatives from states with more wildfires may have stronger incentives to request and be appointed by their party's leadership to seats on that committee so as to influence funding allocations.

The total land area of a state may affect the costs of fighting wildfires because larger states may find it harder to mobilize resources to suppress fires than geographically

smaller state. Area measurements are in square miles and are taken from U.S. Census Bureau reports.

Binary variables are entered for seven U.S. regions (i.e., regional fixed effects): northeast, southeast, mountain west, California, central, southwest, and northwest. The regional dummy variables control for otherwise unexplained geographic differences impacting the USFS's fire-suppression regime.[2]

I rely on Forest Service budgets to generate a binary variable for whether the agency receives a budget increase. All Forest Service budgets come from budget overviews and budget justifications. The Forest Service reports the most recent year's budget online, but for the earlier years in this dataset only U.S. Department of Agriculture reports are available online. Those sources both should contain similar numbers, although they most likely will not be exactly the same because of differences in methodologies. I will be using both data sources despite potential inconsistencies because they are the best data available to me.

Finally, I control for state per capita incomes because wealthier states likely have more resources available locally for wildfire suppression. Wealthier states may have more households located in WUIs, especially as second homes. All of the observations on per capita incomes by state by year are taken from the Bureau of Economic Analysis.

[2] Two additional regions, Alaska and Hawaii, were controlled for originally, but insufficient data were available on those two states for inclusion in the final dataset. Although Alaska and Hawaii remain in the data tables, none of the tests use their information.

Table 1

Summary Statistics

Variable	Observations	Mean	Standard Deviation	Min.	Max.
Suppression Expenditures (2015 $)	287	2.37e+07	6.61e+07	0	5.53e+08
Cost per Acre of Suppression (2015 $)	285	336.822	1,347.701	0	20446.36
Number of Fires	305	1,426.102	1,979.672	1	16,614
Acres Burned	307	147,173.6	435,333	0	5,111,404
Palmer Drought Severity Index	294	0.181	2.346	-5.75	7.38
Lightning Flashes	294	487,459.9	496,075.8	9018	4,071,174
Appropriations Committee Members	308	0.834	1.276	0	11
Per Capita Income	294	41,237.14	6,027.134	28,884	57,705
Injuries	301	1.398	7.474	0	97
Deaths	301	0.159	1.260	0	19
Politicians	308	0.834	1.276	0	11
Land Area (Sq. Miles)	308	84,048.02	99,769.1	9,349.16	665,384
USFS Suppression Budget (2015 $)	308	7.75e+08	2.03e+08	5.10e+08	9.98e+08
Budget Increase (2015 $)	308	-1.97e+07	1.93e+08	-4.58e+08	1.70e+08
Budget Increase Binary	308	0.571	0.495	0	1
Budget Increase Next Year Binary	307	0.713	0.452	0	1

Table 1 summarizes the characteristics of my variables over the period of the sample (FY 2009-2015).

The models I test use a panel dataset of 42 states from 2009 to 2015. The first test seeks to explain the determinants of the cost per acre of suppressing wildfires. After running a standard OLS regression, I found evidence of heteroscedasticity. I use a reiterative Cochrane-Orcutt transformation to account for this heteroscedasticity to estimate:

(i) $y(\text{Cost/Acres Burned}) = \beta(\text{Suppression Expenditures}) + \beta(\text{Number of Fires}) + \beta(\text{Palmer Drought Severity Index}) + \beta(\text{Population}) + \beta(\text{Injuries}) + \beta(\text{Deaths}) + \beta(\text{Politicians}) + \beta(\text{Land Area}) + \beta(\text{Region}) + \beta(\text{Budget Increase}) + \beta(\text{Per Capita Income})$

The second test seeks to explain the determinant of suppression expenditures. I use a random effects model to account for unobserved heterogeneity between the states to estimate:

(ii) $y(\text{Suppression Expenditures}) = \beta(\text{Acres Burned}) + \beta(\text{Acres Burned Last Period}) + \beta(\text{Suppression Expenditures Last Period}) + \beta(\text{Number of Fires}) + \beta(\text{Lightning Flashes}) + \beta(\text{Palmer Drought Severity Index}) + \beta(\text{Population}) + \beta(\text{Injuries}) + \beta(\text{Deaths}) + \beta(\text{Injuries Last Period}) + \beta(\text{Deaths Last Period}) + \beta(\text{Politicians}) + \beta(\text{Land Area}) + \beta(\text{Region}) + \beta(\text{Region*Acres Burned}) + \beta(\text{Per Capita Income})$

The final test estimates a probit model seeking to explain the factors that increase the probability of Forest Service budget increases:

(iii) $y(\text{Probability of a Budget Increase Next Year}) = \beta(\text{Suppression Expenditures}) + \beta(\text{Suppression Expenditures}^2) + \beta(\text{Acres Burned}) + \beta(\text{Lightning Flashes}) + \beta(\text{Palmer Drought Severity Index}) + \beta(\text{Population}) + \beta(\text{Injuries}) + \beta(\text{Deaths}) + \beta(\text{Politicians}) + \beta(\text{Land Area}) + \beta(\text{Region}) + \beta(\text{Region*Acres Burned}) + \beta(\text{Per Capita Income})$

RESULTS AND ANALYSIS

Table 2

Regression Output Summary

	(i) Cost per Acre	(ii) Suppression Expenditures	(iii) Probability of a Budget Increase
Suppression Expenditures	1.41e-07 (3.00e-06)		-1.48e-08 (1.24e-08)
Suppression Expenditures Last Period		0.140 (0.032)***	
Number of Fires	-0.1685141 (0.0972761)*	807.972 (1109.349)	
Acres Burned		372.580 (28.593)***	0.0000199 (0.0017968)
Acres Burned Last Period		13.776 (6.559)**	
Palmer Drought Severity Index	3.955566 (58.11045)	-2,032,992 (653,408.6)***	-0.099361 (0.0481496)**
Population	-0.0000212 (0.0000368)	-0.335 (0.416)	1.59e-08 (2.73e-08)
Injuries	-11.51143 (20.96077)	647,225.5 (280,764.9)**	-0.0046924 (0.0445119)
Injuries Last Period		-778,323.3 (233,257.8)***	
Deaths	9.623928 (73.64988)	1,201,302 (1,016,825)	0.4372841 (0.5403693)
Deaths Last Period		-348.578.4 (973,013)	
Appropriations Committee Members	17.3514 (156.5624)	4,269,929 (1,794,452)**	-0.0549231 (0.1268221)

Table Continues

Land Area	0.0039467 (0.0044714)	-26.655 (59.987)	4.22e-06 (4.19e-06)
Per Capita Income	-0.0207793 (0.0243824)	-482.323 (248.572)*	-0.0000328 (0.0000175)*
Budget Increase	-1.90e-07 (5.55e-07)		
Obs. Adj. R^2	n=234 -0.0434	n=270 0.9255	n=277 Pseudo R^2=0.1030
F-Stat Prob > F	0.38 0.9862	Wald chi2=3020.27 Prob>chi2=0.0000***	LR chi2=34.47 Prob>chi2=0.0440**

Model (ii) was tested for heteroscedasticity using the Breusch-Pagan test, which generated high Chi-squared values. The model was re-estimated by a reiterative Cochrane-Orcutt procedure.
Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

The first regression does not provide adequate evidence to support the hypothesis that increasing suppression expenditures increases the cost per acre of suppressing wildfires. The only statistically significant variable explaining the cost per acre of suppressing wildfires is the total number of fires. According to this model, each additional declared wildfire is associated with a $0.17 reduction in the cost per acre of suppression. One potential explanation is that additional fires can make use of the same resources, which reduces the cost of suppressing them (i.e., fire suppression efforts are subject to economies of scale). Many of these fires may be suppressed with the same efforts, but this result ultimately tells us little about the institutional blank-check hypothesis. The negative adjusted R-squared (-0.0434) suggests that this model is not explaining almost anything that affects the cost per acre of wildfire suppression.

The second model appears to be much more robust with a substantially larger adjusted R-squared (0.9255). This model provides much more compelling evidence supporting the hypothesis. Relevant explanatory variables that are statistically significant include suppression expenditures from the previous year, acres burned, acres burned from the previous year, PDSI, injuries from wildfires, injuries from wildfires last year, the number of politicians sitting on the House of Representatives Appropriations Committee, and state per capita income. For this model, explanatory variables try to explain the total suppression expenditures for a given state. The coefficient on PDSI (-$2,032,992) is intuitive: drier climates produce more wildfires and, hence, greater suppression efforts. Holding the other variables constant, each additional point on the PDSI scale, indicating wetter conditions, is associated with $2,032,992 less in suppression expenditures.

More interesting in this second model are the variables suggesting political influences on wildfire suppression funding. Each additional dollar spent on fire suppression in the past time period is associated with about $0.14 more in suppression expenditures in the current time period holding other explanatory variables constant. This provides some evidence to support the institutional blank-check, whereby spending more in one time period is likely to be associated with spending more the next time period. Acres burned in both the current and past time period are significantly and positively associated with suppression expenditures. Injuries in the current time period are positively and significantly associated with higher suppression expenditures, with each additional injury associated with about $647,000 more in suppression expenditures. Injuries likely promote a political response that elicits more demand for wildfire suppression, although injuries may also reflect the severity of a wildfire. Interestingly,

injuries in the past time period are significant and negatively associated with suppression expenditures. This suggests that an injury in the previous fire season is associated with spending $778,000 less on fire suppression holding other explanatory variables constant. One potential explanation could be that fire managers are less likely to aggressively fight fires if they think this strategy could jeopardize firefighters' lives.

The coefficient on the number of representatives who sit on the House Natural Resources Appropriations Committee is also positive and significantly associated with suppression expenditures. The results from this test suggest that each additional appropriations committee member is associated with about $4.3 million more in fire suppression, holding other explanatory variables constant. This marginal effect of a state having a representative on the Appropriations Committee strongly suggests political motives behind fire suppression.

The coefficient on per capita income is significant at the 10 percent level in this model, but the coefficient is negative. This may suggest that wealthier states are less likely to spend more on fire suppression, although this may also reflect differences in where wealthier households live.

The final probit regression does not provide adequate evidence to support the hypothesis. The only statistically significant explanatory variables are the PDSI and per capita income. The model fails to provide enough evidence to suggest that larger suppression expenditures will increase the probability of the Forest Service receiving a larger budget the following year. Interestingly, per capita income is statistically significant at the 10 percent level with a negative coefficient (-0.0000328). Although the

coefficient is very small, this finding suggests that states with higher per capita incomes actually have a smaller probability of increasing Forest Service budgets.

DISCUSSION

The results of these regression analyses provide some evidence to support the hypothesis that politics drives wildfire suppression efforts. The strongest finding suggests that, holding acres burned, drought conditions, number of fires, and other control variables constant, a state with more representatives sitting on the House Committee of Natural Resources is associated with higher levels of spending on wildfire suppression. These politicians face public pressures to protect their constituents' private property using federal funding regardless of cost, which raises the cost of managing wildfires.

Emphasizing wildfire suppression regardless of cost creates an indirect subsidy for property owners living in the WUI. The subsidy promotes moral hazard by encouraging more development in at-risk areas, which leads to more need for costly and inefficient suppression. Local communities that are in charge of zoning are not incentivized to discourage development in at-risk areas, and instead allow development to collect the increased revenues knowing they do not need to pay the cost of protecting these properties. A disproportionate number of homes built in these areas are actually second-homes, suggesting that this is not only an indirect subsidy to property owners, but an indirect subsidy to wealthy property owners who can likely afford the cost of insuring their homes for wildfire risks (Headwaters Economics, 2009). This subsidy is likely driving up the cost of suppressing wildfires, as the Forest Service spends more each year on protecting these properties.

If the cost were shifted to the local communities and people living in at-risk areas, there would be more incentive to construct homes in a way to minimize the risk of damage from wildfires. Because land use planning is a local government responsibility and the cost of defending homes is a state and federal burden, local governments tend to allow development in risky areas and promote moral hazard. These local communities keep the revenues from development without paying the cost to protect these developments.

One option to reduce wildfire suppression expenditures is to create more fire adapted communities. Property owners can develop the WUI with minimal risk of wildfire damage by implementing certain practices. The USFS's FIREWISE program provides guidelines for how to minimize this risk, but only some two percent of the 70,000 at-risk communities undergo this certification (Rasker, 2015). Further, wildfire risk is not fully assessed by insurance companies, which have inspected less than three percent of the 46 million at-risk homes for wildfire survivability.

Although USFS employees have the best intentions, the bureaucracy's institutional realities have been driving bad outcomes in wildfire management in the United States. Fire managers can be disciplined and even fired for escaped prescribed fires or wildland fire use, but there is virtually no risk of losing a job by overspending on fire suppression. When combined with regulatory burdens to proactive management, including provisions of the Clean Air Act that discourage prescribed burning, fire managers find it much easier to suppress a fire than to manage a forest to prevent future fires (Weisz, n.d.). Knowing that there are minimal budget constraints to fire suppression,

most fire managers face an incentive to spend exorbitantly on fire suppression to create a political show of public benefits. These political shows and public benefits create an image of the USFS as protector of the forest and human life and property, which maintains public support for the agency. As far as congressional funding goes, when managers have a good fire season they can point to their successes and request similar levels of funding the following year. When managers have a bad fire season, they can argue they did not have enough funding and request additional funding. Wildfire suppression budgets keep increasing, but there is never any check on USFS power to make sure these budget increases are actually effective.

Fire managers are risk averse towards prescribed fires, one of the most effective methods for proactively mitigating wildfire risk (Maguire and Albright, 2005). Mental shortcuts tend to bias fire management decision-making towards risk aversion. For example, because prescribed fires have the potential to escape and become wildland fires, fire managers often abide by a precautionary principle, preferring the certainty of "no fire" to an alternative risk of escaped fires on the manager's watch.

Although risk aversion plagues all fire managers, government is particularly bad at responding to disasters like wildfires. Government fails to adequately handle disaster relief for three primary reasons (Shughart, 2006). First, politicians and bureaucrats are incentivized to make decisions with highly visible results that they can take credit for, so government officials tend to under-prepare for emergencies instead focusing on post-disaster response. Second, each level of government tries to control the one below it by imposing detailed rules to restrict discretionary authority. Fire managers on the ground who know what needs to be done are often separated by multiple levels of bureaucracy

from the decision makers. Finally, government disaster relief is subject to high levels of corruption and bureaucratic waste because of a general lack of oversight and accountability.

Responding to a wildfire is ultimately a question of how best to allocate resources to where they are needed most. Central authorities are inefficient at finding ways to mobilize firefighters, aircraft, shelters, and other resources needed during a severe wildfire. The solution to this problem is to utilize dispersed knowledge, allowing individual actors to coordinate with each other through pricing mechanisms (Hayek, 1945). Without price distortions from government control, insurance companies, firefighting groups, residential developments, and all forms of disaster relief could find an optimal supply of their goods and services to mitigate the risk of wildfires, as well as respond to them appropriately.

Past fire suppression and fuel buildup from declining timber harvest from environmental policies like the Endangered Species Act makes current fire management more expensive and dangerous. But after decades of supposed fuels management, one would expect forests are becoming less dangerous to manage. The USFS still struggles to proactively manage fires because the agency has always focused more on suppression than reducing fuel buildup. Even if the agency did consistently manage a few million acres each year to reduce fuel buildup, the tens of millions of acres managed by the USFS would never have all of its fuel buildup removed.

Smokey Bear's adage "Only you can prevent wildfires" is a naive reflection of a widespread belief that we can control a natural phenomenon. Wildfires, just like tornadoes, hurricanes, earthquakes, and flash floods, have existed since before written

history, and will long outlast any person. Wildfires are unique, however, in that they are not solely the result of atmospheric conditions, but have also been started and managed by humans. Rather than try to abolish all wildfires, we have the tools to manage them for resource benefits and minimize the damages inflicted from wildfires. By reforming the institutions, incentives, and regulatory burdens that fire managers and developers face, the costs of managing and living with wildfires will fall and the severity of those wildfires will likely follow.

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