# Fired Up or Burned Down: Wildfires and VC Investment

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**Abstract**

Using granular data on Californian wildfires and smoke, we examine the behavior of venture capitalists (VCs) and VC-backed startups after such events. We find that VCs are more likely to invest in ESG-oriented startups following wildfires, but decrease their average investment amount. We differentiate the effects of wildfires from smoke, uncovering the mechanism of salience bias and mood effects. For VC-backed startups, we observe an increase in green patent production following wildfires, indicating a shift toward more environmentally friendly innovations. While wildfires do not affect startups' near-future financing opportunities, they pose detrimental effects if encountered during the startups' nascent stage.

**Keywords:** Wildfire, Venture Capital, Entrepreneurship, Climate Risks, ESG Investment, Natural Disasters

**JEL Codes:** G24, Q54, M13

# 1 Introduction

Climate change has significantly increased the frequency and scale of wildfires in recent years with severe socioeconomic consequences (Abatzoglou and Williams, 2016; Wang et al., 2021). Over the last forty years, the area burned by wildfires has quadrupled in the United States. On average, 61,410 wildfires have occurred annually in the last decade, burning approximately 7.2 million acres.[1] These wildfires, not confined to forests and wildlands, have increasingly invaded populated areas, posing direct threats to infrastructure and human lives. Moreover, drifting smoke and pollution caused by wildfires can also adversely affect health conditions (Deryugina et al., 2019), infant mortality (Chay and Greenstone, 2003; Jayachandran, 2009), as well as labor supply and productivity (Borgschulte, Molitor, and Zou, 2022; Graff and Neidell, 2012; Hanna and Oliva, 2015). California experiences the most severe impact from wildfires, with more than 4.3 million acres burned in 2020, the largest of any US state. The state's Wildland-Urban Interface (WUI) zones have also expanded significantly, now covering 28.8% of California's area compared to 23.6% nationwide.[2] However, research on the effects of wildfires on investments and businesses remains limited.

We focus on the effects of wildfires and smoke on the venture capital (VC) industry. VCs are critical for entrepreneurial financing, especially for high-growth firms. Since the 1980s, half of public companies have been backed by VCs prior to their initial public offerings (Lerner and Nanda, 2020). One institutional advantage of utilizing venture capitalists is their small size and

[1] Statistics are sourced from the National Interagency Fire Center (NICC) Wildland Fire Summary and Statistics Annual Reports.

[2] See Figure A.1. According to the US Fire Administration, "The WUI is the zone of transition between unoccupied land and human development. It is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels." The expansion of WUI has raised concerns about the increase in wildfires and their increasing impacts on human behaviors and communities.

limited number of decision-makers, making performance easily traceable. Another benefit of this setting is that California, which has the highest wildfire record in all US states, also hosts the largest number of VCs and high tech startups in the United States.

While other climate-change-related disasters, such as extreme temperatures and droughts, tend to impact extensive geographical areas simultaneously, wildfires typically begin in localized areas, but are unique in their potential to unpredictably spread far beyond their origin. Unlike floods and hurricanes, which are confined to specific near-water regions, wildfires are common in Wildland-Urban Interface (WUI) zones—areas of expanding human activity and vegetation. Wildfires elicit warnings, evacuations, work interruptions, and property damage, affecting both immediate burned areas and surrounding regions, and are overall detrimental and intense. The unpredictable and dispersed nature of wildfires, governed by complex meteorological and geographical factors, offers a distinctive context for studying the responses of investors and firms to natural disasters.

Another unique feature of wildfires is that they also produce smoke. The particulate matter and toxic pollutants produced by wildfires disperse into the atmosphere, flowing with the air currents and resulting in smoky weather in remote areas where the actual flames are not visible. Therefore, we can differentiate the direct effects of wildfires and their extended effects through smoke. In comparison to smoke, wildfires have stronger effects on natural ecosystems and communities, promoting a more intense emotional reaction (Knez et al., 2021).[3] In comparison to conventional air pollution, smoke from wildfires can have more serious health risks and cannot be managed and reduced through local regulations and pollution control.

Wildfires and smoke can affect venture capitalists' investment behaviors via several mecha-

[3] Knez et al. (2021) demonstrated that direct exposure to wildfires can lead to more emotionally intense memories and behavioral outcomes.

nisms. The heightened wildfire occurrences can change psychological and behavioral outcomes of individuals (Baker, Bloom, and Terry, 2024; Baylis, 2020; Bourdeau-Brien and Kryzanowski, 2020; Loureiro, Alló, and Coello, 2022). Specifically, wildfires can elicit a cognitive bias known as *salience bias*, which refers to the tendency to overestimate the risk of easily recalled or emotionally impactful events. Experiencing salient events will increase people's perception about the likelihood of these events happening and impact investors' preference (Alok, Kumar, and Wermers, 2020; Bordalo, Gennaioli, and Shleifer, 2012). After experiencing wildfires, VC managers may be swayed by salience bias, leading them to revise their probability estimates for future climate events upward. This shift can alter their beliefs about the prospects of portfolio companies, prompting a greater inclination towards ESG investments (e.g., Choi, Gao, and Jiang, 2020).

In addition, wildfires can provoke responses through the *mood effects* of fear and anxiety. Wildfires can rapidly transform landscapes with little warning. Urgent evacuation notices, frequently issued at the last moment, compound the stress and threat to both property and human life. Sensory details associated with wildfires—such as visual, auditory, and olfactory stimuli—contribute to the formation of traumatic memories and trigger sensory-perceptual re-experiencing (Knez et al., 2021; Loureiro et al., 2022). Studies suggest that fear and anxiety caused by traumatic events, including natural disasters, can make individuals more cautious and conservative in their financial decisions (Guiso, Sapienza, and Zingales, 2018; Kaplanski and Levy, 2010; Wang and Young, 2020). VC managers, influenced by the pervasive sense of danger and insecurity caused by wildfires, may reduce investment levels and approach new ventures with greater caution.

Alternatively, any behavioral change after wildfires can result from a *learning process* in which VCs update their beliefs based on first-hand experiences with wildfires, thus refining their understanding of climate change and natural disasters. As another explanation, wildfire-induced smoke and increased levels of PM 2.5 could affect investors' cognitive abilities and productivity (Chang et al., 2019; Li et al., 2021), altering their decision-making ability and consequently changing investment patterns. Moreover, it is also possible that VC investment strategies remain uninfluenced by wildfires.

In our analysis, we exploit variations in wildfire and smoke incidences to estimate the impacts on VC investor decisions and startup survival located in California. We perform regression analyses to answer these questions. Our research relies on three primary data: wildfire data from the California Fire and Resource Assessment Program (FRAP) Fire History, smoke data from NOAA's Hazard Mapping System (HMS) Fire and Smoke Product, and VC investment and startup data from Crunchbase. With detailed information on each fire's start and end date, cause, affected areas, and daily smoke incidence and density, we construct three groups receiving different shocks post-wildfire: "fire + smoke" group, "smoke only" group, "low-risk" group (control). The settings help isolate the effects of wildfires from smoke and investigate the spatial distribution of wildfires' impacts at the ZCTA (zipcode) level. Outcome variables include the amount of VC investment, whether the VC invests in ESG-oriented startups, and startup outcomes (acquired, IPO, or faded). We control for VC and investment characteristics, the local economic and business outlook, as well as meteorological and environmental factors. Our analysis is conducted at the investor-deal level, with fixed effects applied to control for unobserved factors.

By examining Californian VCs and their deals across the US, our study reveals several key insights. Firstly, VCs react to nearby wildfires and smoke by reducing the amount they invest while simultaneously increasing their likelihood of directing funds toward ESG-oriented companies. Also, wildfires have a more pronounced effect than smoke. Additionally, wildfire-affected VCs show an increased propensity to back startups that eventually progress to an Initial Public Offering (IPO). This alteration in investment behavior, however, is temporary. It becomes noticeable in the first two years after the disaster and then reverts back to the patterns seen before the wildfire in subsequent years. These observations align with the predictions of the salience theory.

We perform a set of robustness tests to validate the results and explore the heterogeneity of the effect by conducting subsample analyses. We exclude areas directly burned by wildfires to rule out the confounding effects of asset loss and recovery subsidies. Next, controlling for other natural disasters, we find that they do not significantly affect investment patterns. Although our analysis focuses primarily on Californian VCs, it encompasses their deals across the entire US. In a robustness test, we further extend our examination to other VC-active states, observing consistent patterns. Furthermore, our findings indicate that the decrease in investment is not due to an increased focus on ESG startups, nor are the results driven by disaster-impacted startups or changes in funding from limited partners (LPs). For cross-sectional variation, we find that the transformation in investment behavior is more perceptible in male-dominated VCs.

We also look into the nuanced relationship between wildfires and the performance of startups, particularly those backed by venture capital. Unlike typical small businesses that may suffer significantly from natural disasters due to physical damage and limited access to capital, VC-backed startups appear less vulnerable in the short term. Focusing on Californian VC-backed startups, we find no immediate negative impact on financing opportunities after a wildfire. We observe an increase in patenting activities, particularly in the area of green technologies, after such events. However, early-stage startups do face challenges, experiencing a decreased likelihood of future successful exits like going public or being acquired if they encounter a wildfire.

Our study builds on the literature on natural disasters and the literature investigating the incorporation of environmental, social, and governance (ESG) factors into investment decisions. In particular, there has been an emerging interest in whether and how the financial market reacts to climate risks (e.g., Barber, Morse, and Yasuda, 2021; Dessaint and Matray, 2017; Krueger, Sautner, and Starks, 2020). Studies have shown how personal experiences associated with climate events alter the financial decision making process for CEOs (Li, Xu, and Zhu, 2021), retail investors (Choi et al., 2020), institutional investors (Dyck et al., 2019), and mutual fund managers (Alok et al., 2020). This study investigates the behavioral change of venture capital after severe climate events.

This study also contributes to the VC literature, and in particular, to studies on the determinants of VC investment and performance (e.g., Bernstein, Korteweg, and Laws, 2017; Calder-Wang and Gompers, 2021; Ewens and Townsend, 2020; Gompers et al., 2020). This study expands the literature by looking at how climate factors affect the decision making and performance of VCs. This paper also examines the determinants of startup success by looking at the effects of natural disasters.

For the effects of wildfires on local socioeconomic conditions, studies have looked at housing price dynamics (Donovan, Champ, and Butry, 2007; McCoy and Walsh, 2018), suppression costs (Baylis and Boomhower, 2023; Gude et al., 2013), expansion of Wildland-Urban Interface (WUI) areas (Radeloff et al., 2018). Griffin, Jiang, and Sun (2023) find that increased cognition of wildfire in financial disclosure for firms located at risk of exposure to wildfires. However, few studies link wildfires to their impact on business activities.

The rest of the paper is organized as follows: Section 2 describes California wildfires; Section 3 describes the data; Section 4 provides our empirical strategies; Sections 5 and 6 present the results on VCs and startups; Section 7 concludes.

## 2 Wildfire in California

The increasing frequency and intensity of wildfires significantly increased the recognition of the wildfire risk in the last two decades. The increasing severity of wildfires and prolonged wildfire seasons can be attributed to three primary factors: elevated temperatures and arid conditions due to global warming (see Figure 1), increased fuel loads from climate change, and the expansion of Wildland-Urban Interface (WUI) areas and human activities (see Figure A.1). Wildfires, characterized by their localized nature and widespread distribution, present an ideal context to study VC investment responses to climate change events. Several features of wildfires support a natural experiment setting in investigating VC's responses to climate change events. The occurrence of wildfires is influenced by a variety of unpredictable factors, making it random and exogenous.[4] Unlike other natural disasters, wildfires not only have a higher frequency but also exhibit considerable variation at the level of small geographic units.[5]

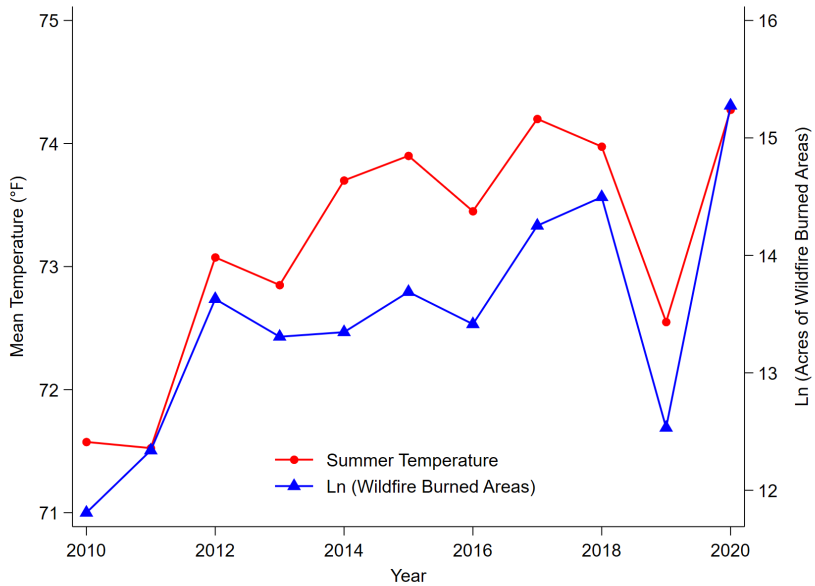
Wildfires emit smoke, which rises into the stratosphere and spreads across regions, causing air pollution in areas far away from the flames and posing further risks. Wildfire smoke has contributed up to 50% of PM 2.5 in the Western United States, reversing decades of policy-driven improvements in air quality. Between 2016 and 2020, residents of areas prone to wildfires experienced a 300% increase in heavy smoke days compared to the period 2009 to 2013.[6] The presence

[4]Figure 2 presents the distribution of wildfires across California, showing the myriad of factors, natural and anthropogenic, that contribute to the genesis of wildfires. The ignition location and time are unpredictable. Second, the trajectory and extent of the spread of wildfires are subject to unpredictable natural elements like wind patterns, topography, and forest distribution. Wildfires, along with the resultant smoke plumes, can traverse vast distances downwind. Third, to address concerns regarding arson, we exclude prescribed fires and those of limited scale, as arson-related fires are typically identified and extinguished promptly, averting escalation into large-scale wildfires.

[5]In California, the average area burned per wildfire was 12.48 $km^2$ during 2010–2020, whereas the impact of hurricanes often extends beyond a county (Hu, 2022). The largest wildfire, the August Complex, burned approximately 4,047 $km^2$ and resulted in one death. In comparison, Hurricane Katrina affected around 233,000 $km^2$ and caused nearly 2,000 deaths (Coussens and Goldman, 2007). More details on the differences between wildfires and other natural disasters can be found in Appendix A.

[6]According to Petek (2022), the average number of smoke days per year has increased by 500% in San Francisco,

Figure 1. Climate Change Increased Intensity of Wildfires in California: 2010–2020




*Notes*: Figure 1 shows the correlation between temperature and wildfire activity in California from 2010 to 2020. The red line represents the average temperature during the summer months (June to September), while the blue line represents the logarithm of the annual area burned by wildfires.

of one more smoke day leads to an average increase of 2.2 $ug/m^3$ in ground-level PM 2.5 concentrations, and the smoke exposure is estimated to result in an additional 1.518 deaths per million elderly individuals (Borgschulte et al., 2022; Deryugina et al., 2019).

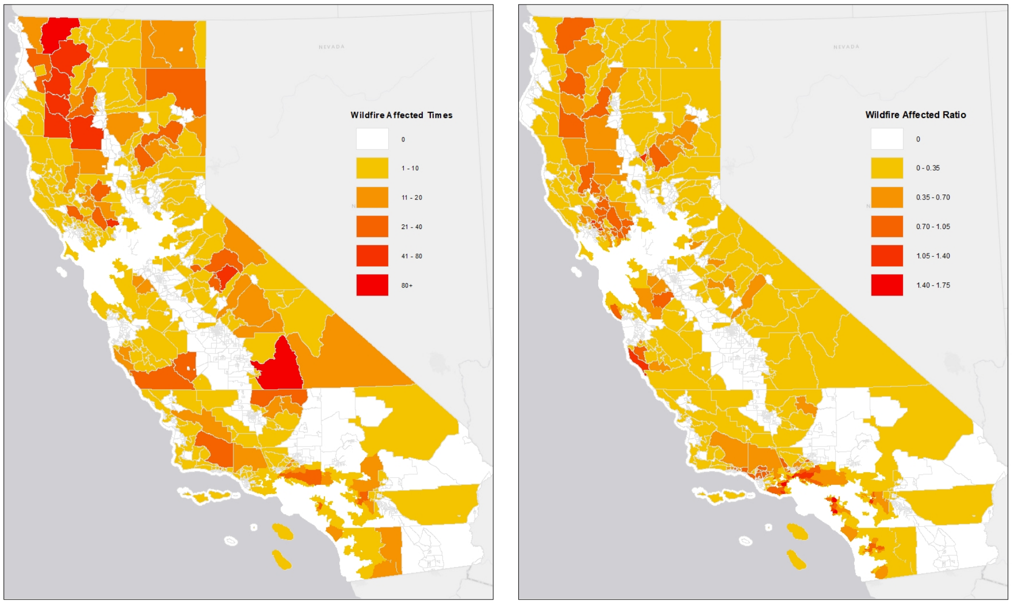
California experienced an unprecedented scale of wildfire devastation in recent years, as shown in Figure 2.[7] In 2018 alone, wildfire damages in California amounted to approximately $148.5 billion, equivalent to around 1.5% of the state's annual GDP. These damages comprised $27.7 billion in capital losses, $32.2 billion in health costs, and $88.6 billion in indirect losses (Wang et al., 2021). In 2022, 6.74% of the total land in California and 45.13% of its housing were prone to wildfire risk (Li et al., 2022). The northern Coast Ranges, Sierra Nevada, and shrublands northwest

356% in Los Angeles, 322% in Long Beach, and 314% in San Diego.

[7]Data from Calfire, available at `https://www.fire.ca.gov/our-impact/statistics`; During the period of 2003 to 2012, the number of wildfires has increased dramatically in the forests of the Northwest (1,000%), Northern Rocky Mountains (889%), Southwest (462%), Southern Rockies (256%), and Sierra Nevada (274%), according to Westerling (2016).

Figure 2. Distribution of Wildfire in California

(a) Frequency of Wildfire Activities (b) Affected Areas of Wildfire Activities




*Notes*: Figure 2 presents the distribution of wildfires from 2005 to 2020 in California at the census tract level. Figure (a) shows the number of wildfire occurrences in each census tract, while Figure (b) illustrates the ratio of the area destroyed by wildfires in each census tract, represented by the burned area divided by the total area of the tract.

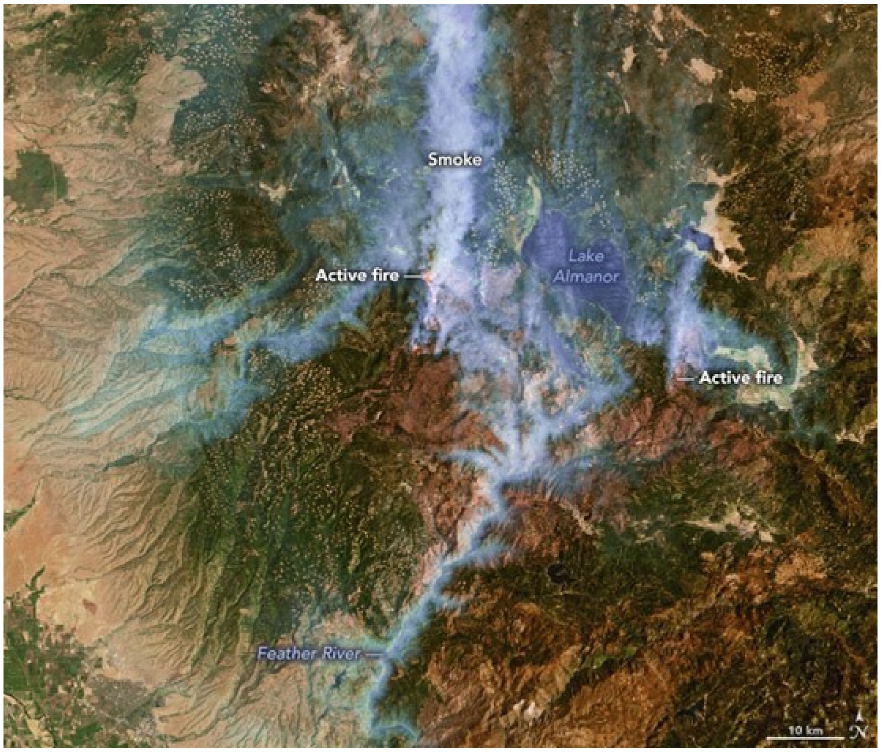
of Los Angeles faced frequent wildfires, while regions like the Central Valley and urban areas experienced smoke exposure due to wind patterns and topography. A notable example is the Dixie fire, California's second-largest wildfire, which sent haze and smoke over 1,100 miles eastward to Salt Lake City and Denver, as illustrated in Figure 3.[8] The impacts of wildfires extended beyond the immediate burn areas, affecting surrounding counties with evacuation orders and property damage. Communities hundreds of miles away, including Sacramento, the San Francisco Bay Area, and parts of Southern California, suffered from poor air quality and increased smoke days, despite the absence of visible flames and smoke columns.

In this paper, we treat wildfires as exogenous shocks. Besides the various unpredictable factors

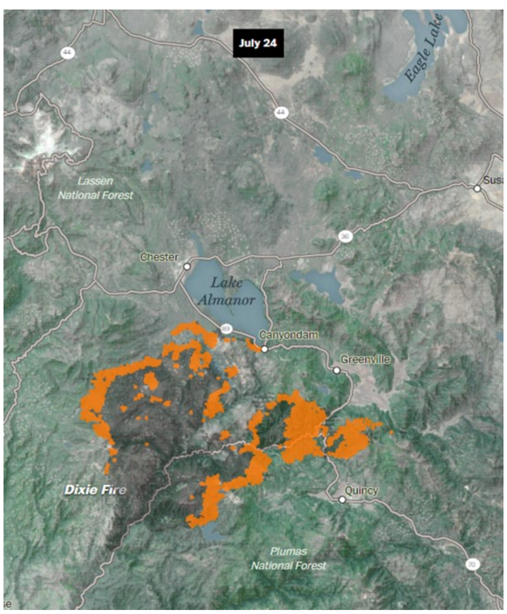
[8]Figure 3 presents satellite imagines acquired on July 24 and September 2, 2021, by GOES-17, operated by the National Oceanic and Atmospheric Administration (NOAA).

Figure 3. Wildfire Evolve and Distant Smoke

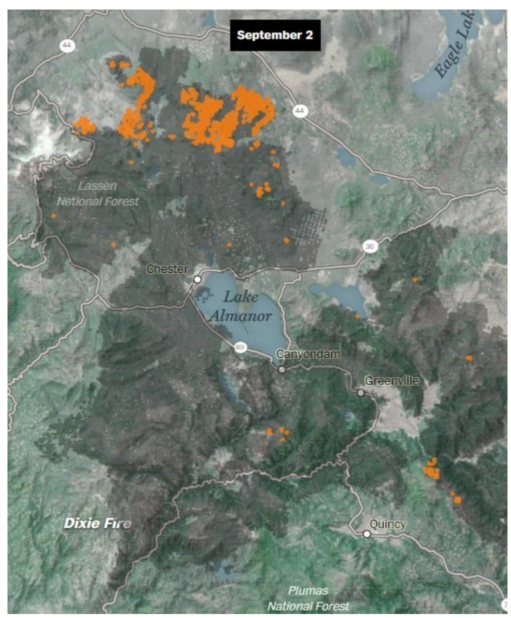
(a) Wildfire Smoke Blowing along the Valley




(b) Evolution of Dixie Wildfire




(c) Evolution of Dixie Wildfire




*Notes*: Figure 3 illustrates the smoke and the evolution of burned areas resulting from the Dixie Wildfire during the summer of 2021. Figure (a) depicts the smoke generated by the Dixie Wildfire, while Figures (b) and (c) display the wildfire's progression on July 24 and September 2, respectively. Gray-black regions represent areas previously destroyed by wildfires, and orange regions indicate newly burned areas.

that influence the occurrence of wildfires, one concern about the exogeneity of wildfires is related to the allocations of wildfire protections and government support. However, research has indicated that wildfire responses and resource allocations are dynamic, complex, and uncertain (Hand et al., 2017; Rossi and Kuusela, 2020). Although governments have increased support for wildfire risk mitigation and invested in public infrastructure recovery, such investments mainly aim to provide public services or individual support. Location-based fixed effects in our analysis further mitigate the concern about selection issues.

# 3 Data

We combine multiple sources of data to support our empirical analysis. Using wildfire and smoke plume data, VC investments and startup data, and publicly available census data, we get a sample of VC investments and startup performances as well as economic characteristics at the ZCTA-month level for California,[9] covering the period from 2011 to 2020.[10] Table 1 shows the summary statistics.

**[Insert Table 1 Here.]**

[9]ZCTAs are generalized areal representations of the United States Postal Service (USPS) ZIP Code service areas, with 1,769 regions for California. For more details, refer to the *US Census* at `https://www.census.gov/programs-surveys/geography/guidance/geo-areas/zctas.html`.

[10]The years following 2010 saw a significant increase in both the number and intensity of wildfires, experiencing some of the largest and most destructive wildfires (e.g., see Figure A.2).

## 3.1 Wildfire

We obtain information on wildfires from the State of California Fire and Resource Assessment Program (FRAP) fire history database, which includes perimeter data for moderate to large fires.[11] It contains more than 20,000 fires in California from 1878 to 2020, with information on each fire's year, cause, start/end date, affected acres, and most importantly, the perimeter of the fire. Adopting the criterion established by Westerling et al. (2006), we calculate the wildfire measurements using wildfires with an affected area of more than 1,000 acres.[12] There were 481 wildfires that affected more than 1,000 acres in California between 2010 and 2020. They were distributed throughout California as shown in Figure 2. We measure wildfires in a geographic unit of ZCTAs. California has 1,769 ZCTAs with no ZCTA established in areas with extremely sparse populations.[13] To capture the far-reaching effects of wildfires beyond the burned areas, we set up a 50 km buffer zone for each wildfire incident and define it as the *wildfire impacted area*.[14] For each ZCTA, we calculate the number of wildfires incurred or affected in the previous six or twelve months.[15]

[11]Wildfire data is available from https://www.fire.ca.gov/what-we-do/fire-resource-assessment-program/fire-perimeters.

[12]We remove wildfires that are prescribed wildfires or too limited in scale to get public attention.

[13]As fires do not burn uniformly, and many factors can influence the distribution of smoke, wildfires at the ZCTA level capture the variations in wildfire intensity, taking account of demographic limitations. Compared to the conventional practice of using counties as the geographic analysis unit in natural disaster literature, our research allows for a more precise estimation of the scope of wildfire impacts.

[14]See Internet Appendix B for more details about buffer zone.

[15]Some studies relied on the Spatial Hazard Events and Losses Database for the United States (SHELDUS) developed by the Hazards and Vulnerability Research Institute at the University of South Carolina. The SHELDUS records various natural disasters and their associated damage from 1960 to the present. It aggregates occurrences of natural disasters at the county level. For California, the SHELDUS data encompasses 58 counties and 268 wildfire incidents, which lack the precision required in our study. Our dataset covers all 481 wildfire incidents larger than 1,000 acres that occurred between 2010 and 2020. Our data have detailed geographical precision, including the paths of wildfire development, durations, and specific dates. This granularity allows our analysis to assess the impact of wildfires on 1,769 ZCTAs.

## 3.2 Smoke Plume

The smoke plume data are from NOAA's Hazard Mapping System (HMS) Fire and Smoke Product.[16] The HMS records smoke originating from wildfires as well as smoke densities on a daily basis. Smoke is categorized into three severity levels: Light, Medium, and Heavy. Data are available from 2010 onward. We measure smoke as the frequency of heavy smoke cases within the previous six or twelve months at the ZCTA level to capture the observable changes in wildfire-induced ambient pollution. Both data and literature reveal that heavy smoke is strongly associated with wildfires (Aguilera et al., 2021; Heft-Neal et al., 2022; Wettstein et al., 2018).

## 3.3 VC and Startup

We obtain information on VCs, funding rounds, and startup firms from Crunchbase. Crunchbase is an online database that provides detailed information on startup firms and their investors. The data is collected by Crunchbase staff, as well as directly by startup firms and investors. The database records information on individual funding rounds, such as the amount raised, date of investment, type of funding, number and identity of investors, as well as information about the startup firms themselves, including the date of founding, number of founders, industry sector, and company description. Registered members can enter information into the database, which Crunchbase staff subsequently reviews. As Crunchbase is linked to several other databases through which investors frequently choose and analyze potential investments, this makes Crunchbase an important source of data for studying startup firms in their early stages.[17]

[16] Smoke data is available from `https://www.ospo.noaa.gov/Products/land/hms.html`

[17] For studies using Crunchbase, see, for example, Conti and Roche (2021); Dalle, Den Besten, and Menon (2017); Edwards and Todtenhaupt (2020); Guzman and Li (2023).

We start with startups founded after 2004 from Crunchbase.[18] We keep the principal rounds of venture capital investment, including the seed/angel round and series A to E rounds. Additionally, we exclude investments amounting to less than 1 million USD, as information on smaller-scale investments is more likely to be inaccurate.[19] We focus on investment rounds in the U.S. announced from 2011 through 2020 to match the data availability for wildfire and smoke data. It should be noted that we examine deals nationwide, not just those targeting Californian startups. For the main analysis, California-based VCs are identified by the state, city, postal code, or address information available. We also supplement investment and startup information using CB Insights.

Our final sample consists of 45,614 investments made by 2,038 unique Californian investors, made to 13,031 startup firms during the period 2011–2020. Table 1 presents the descriptive statistics at the investor-deal level.

**ESG Startups** We identify a startup as ESG-oriented using the ESG keywords shown in Table A.2. We use the word list compiled by Barber et al. (2021) and Zhang (2021), which comes from three main sources. First, it uses keywords to identify impact investors used by Barber et al. (2021). Second, the KPMG 2021 UK Mid-market PE Review Report contains a compilation of keywords that can be used to recognize deals with an ESG component. Third, keywords are also obtained from browsing famous impact ventures' websites. A startup is labeled as ESG-oriented if any of the Crunchbase variables in the company description and/or industry contain such keywords.

**Startup Innovation Output** To measure the innovation output of VC-backed startups, we supplement the information on patent applications and granting from IPqwery. The primary advantage

[18] Crunchbase's coverage has been found to be more accurate in recent years (Wu, 2016).

[19] We include samples with investment amount less than 1 million in the appendix as a robustness test, and the main result remains consistent.

of using IPqwery patent data is that it employs a custom algorithm to pinpoint patent owners for companies from Crunchbase and assigns the unique Crunchbase identifier to the patent owner if available. IPqwery data are sourced from several entities: USPTO (United States Patent and Trademark Office), CIPO (Canadian Intellectual Property Office), EUIPO (European Union Intellectual Property Office), and WIPO (World Intellectual Property Office). The dataset covers both active and expired granted patents. It also includes pending, abandoned, rejected, or canceled patent applications. Each record contains a unique patent identifier, assignee details, technology class, application, and grant year. We find that during the period of 2011 to 2022, 2,451 of 14,302 (17.1%) Californian VC-backed startups have patent applications, and 11.6 % of startups have a patent granted. The median number of patents filed each year by startup is one, among the patenting startups.

To identify green patents, we adopt the method developed by Haščič and Migotto (2015) and used by Cohen, Gurun, and Nguyen (2020). This approach identifies green patents based on the Cooperative Patent Classification (CPC) patent classifications developed by the USPTO and the EUIPO.[20] With this classification, patents related to environmental technologies are grouped into various categories of environmental technologies such as environmental management; climate change mitigation technologies related to energy, greenhouse gas treatment, transportation, building, waste management, production of goods and communication; climate change adaptation technologies; and sustainable ocean economy. We identify 1,857 patents that can be classified as green patents out of 31,346 granted patents for the startup sample.

[20] See here for OECD's patent search strategies to identify environment-related technologies (ENV-TECH): https://stats.oecd.org/wbos/fileview2.aspx?IDFile=c5c477c0-d300-42fe-af1f-d4a450c79a39

### 3.4 Supplementary Data

To control regional economic characteristics, we obtain annual business and economic measurements at the ZCTA level from the ZIP Code Business Patterns (ZBP) dataset.[21] The variables include the number of establishments, employment, and annual payroll. We also control wind speed, temperature, and precipitation at the ZCTA-month level to account for meteorological factors. Wind speed and wind direction information are from the North American Regional Reanalysis (NARR) database.[22] Temperature and precipitation data are sourced from Parameter-elevation Regressions on Independent Slopes Model (PRISM).[23] We aggregate the wind, temperature, and precipitation data to the ZCTA level to capture the meteorological features.

## 4 Empirical Strategy

This section introduces our model and provides an overview of the empirical strategies used in our study. We estimate the influence of wildfires and smoke on VC investments, specifically on investment amounts and ESG considerations. We also evaluate the quality of these investments by examining the performance of invested startups, including the probability of IPOs or being acquired in the future. Then, we explore the underlying mechanisms that drive VC decision-making and outcomes.

In the first step, we employ an OLS estimator to estimate the impacts of wildfire or smoke

[21] ZBP is an annual series that provides economic data by ZIP Code. More details about ZBP can be found at https://www.census.gov/data/developers/data-sets/cbp-nonemp-zbp/zbp-api.html

[22] NARR is maintained by the National Centers for Environmental Information. It organizes the United States into 32km × 32km grid cells, and for each grid cell, it supplies data on both the east-west wind vector ("uwind") and the north-south wind vector ("v-wind"). These vectors collectively represent the wind speed and direction. We match the center of each ZCTA to the corresponding grid cell.

[23] PRISM divides the United States into 4km × 4km grids and estimates the temperature and precipitation for each grid.

*separately* on VC investment. The general form of our preliminary specification is shown in the following model:

$$Y_{i,t} = \alpha_0 + \alpha_1 Disaster_{j,t} + \theta_1 X\prime_i + \theta_2 X\prime_j + \eta_j + \delta_t + \gamma_g + \varepsilon_{ijt} \quad (1)$$

In Equation 1, $i$ denotes investor-deal,[24] $t$ denotes year-month, and $j$ denotes the ZCTA. $Y_{i,t}$ represents VC investment outcome measures, and we examine Californian VCs' investment across the entire country. The dummy variable $Disaster_{j,t}$ measures the occurrence of fire or smoke at ZCTA $j$. $Disaster_{j,t}$ indicates a wildfire occurred if the ZCTA $j$ with VC located has been within 50km of the wildfire burning area ("wildfire impacted area") in the past 12 months prior to investment.[25] Alternatively, for smoke, $Disaster_{j,t}$ indicates a smoke incurred if the ZCTA $j$ in which the VC is located had heavy smoke days in the past 12 months prior to investment. We also control VC characteristics, including their age, employment size, investment funding round; local economic conditions, including annual total payroll at ZCTA level, number of establishments; meteorological factors such as temperature at ZCTA level, precipitation, wind direction, and wind speed, as well as ZCTA and year-month fixed effects. To capture the unobserved VC characteristics, we incorporate VC fixed effects and the VC is denoted as $g$.[26]

Wildfires are visually impactful events that come with warnings and evacuations, causing profound emotional and financial repercussions. In contrast, smoke may last for a shorter duration,

[24] In this context, the term *deal* refers to a financing round during which VCs provide funding to a startup. A deal may include multiple VC investors. In our data, we define the unit *investor-deal*, which means that each investment made by an investor within a deal is considered as an observation.

[25] We define the *wildfire impacted areas* to be within 50 km of the wildfire-burned areas. Internet Appendix B further investigates the effects of the wildfires in regions with varied distances from the burned areas. The trigger model, as well as the gravity analysis, justified the scale of 50 km as a representative scale to estimate the effects of wildfires.

[26] In robustness tests in the appendix, we also use VC group fixed effects by grouping VCs based on their age and employee size, to account for cases where some VCs have only one investment or share similar structures, which could otherwise amplify measurement error in cross-sectional analyses.

marked by a few days of heavy smoke without visible flames, and often originates from distant conflagrations. Although smoke contributes to air pollution, its emotional and financial consequences are generally less severe than fires themselves. To examine the effects of wildfires and smoke separately, particularly in distinguishing the impacts between a natural disaster and ambient pollution, we differentiate VCs situated in regions directly affected by visible wildfire flames, and smoke from those located in areas covered by heavy smoke without direct disturbance or perceptible evidence of wildfires. Our main analysis separates the effects of wildfires and smoke, and the regression model is outlined as follows:

$$Y_{i,t} = \alpha_0 + \alpha_1 wildfire_{j,t} + \alpha_2 smoke\_only_{j,t} + \theta_1 X\prime_i + \theta_2 X\prime_j + \eta_j + \delta_t + \gamma_g + \varepsilon_{ijt} \quad (2)$$

$Wildfire_{j,t}$ measures whether the ZCTA $j$ in which a VC is located has been within the wildfire impacted area and heavy smoke area in the past year prior to investment. We also looked at the last six months to examine the shorter-term effects. $Smoke\_only_{j,t}$ measures whether a VC is located outside the area impacted by wildfires but has experienced heavy smoke in the past 6 or 12 months prior to investment. As wildfires emit smoke, $wildfire_{j,t}$ captures wildfires and their surrounding smoke. Residents living in these areas are directly impacted by wildfire-induced warnings, evacuations, displacement, and life-threatening. By doing this, we hope to identify the salience effects of natural disasters by isolating areas with direct disturbance and perceptible wildfires from areas with transported smoke. Similarly to our last specification, we control for VC characteristics, local economic conditions, meteorological factors, as well as ZCTA, investor, and time fixed effects.

# 5 Wildfires and VC Behavior

## 5.1 Main Results: Wildfire and Smoke Exposure

As an initial step, we examine the separate effects of wildfires and smoke on the investment decisions and outcomes of Californian venture capitalists. We assess changes in investor behavior post-wildfire by analyzing investment amounts, targets, and outcomes for startups nationwide. The results are presented in Table A.3.

The odd-numbered columns of Table A.3 show the impact of *wildfires* on VC investment, while the even-numbered columns illustrate the effects of *smoke*. Column (1) shows that for VCs who have encountered wildfires, their investment amounts, on average, witness a decline of 1.043 million within a 12-month period. This decrease represents a 4.19% reduction from the average level of 24.92 million. Furthermore, Column (3) shows that the impacted VCs exhibit a greater inclination (0.54%) to invest in ESG-oriented startups compared to VCs not affected by wildfires. The ratio of ESG investment among all VCs in our sample is 0.039. Our estimate suggests a 13.8% higher ratio of ESG investment for VCs that have been impacted by wildfires (0.54/3.9). Moreover, the startups in which wildfire-exposed VCs invested have a 0.59% higher likelihood of going public within 12 months compared to startups chosen by VCs who do not experience a wildfire, which is about a 16.9% increase from the average level of 3.5%.

To capture the effect of wildfire-induced smoke, the even-numbered columns of Table A.3 explore the impacts of smoke on VC investment decisions and outcomes. As discussed in Section 2, wildfires emit smoke, which rises into the stratosphere and spreads across regions, causing far-reaching increases in air pollution. As wildfire areas also experience heavy smoke, the measurement of smoke areas includes both wildfire areas and distant areas without conflagration but smoke. We observe that VCs adopt a more cautious investment approach, as shown in Column (2) of Table A.3. However, when experiencing smoke in the past 12 months, the VCs' inclination to invest in ESG-oriented startups diminishes, and there are no significant effects of smoke on the performances of startups. These results can be attributed to the ambiguous severity of smoke. Together, Table A.3 suggests that wildfires and smoke can have different impacts on investors' investment behaviors.

Motivated by the preliminary findings in Table A.3, we need to consider both the VCs located in regions directly affected by visible wildfire flames and those located in areas covered by heavy smoke without direct disturbance of the wildfires. We employ the methodology described in Equation 2. The treatment group, referred to as the "wildfire (and smoke)" group, consists of VCs located within the wildfire impacted area, experiencing both visible wildfires and the surrounding heavy smoke. The "smoke only" group comprises VCs located outside the wildfire impacted area, who encounter heavy smoke but are not directly impacted by wildfire disturbances. Additionally, we have a "low-risk" control group as the reference group, consisting of VCs that have experienced neither wildfires nor smoke. This research design allows us to isolate the effects of wildfires from smoke and ambient pollution.

**[Insert Table 2 Here.]**

Table 2 reports our main findings. Odd-numbered columns look at a six-month period, and even-numbered columns look at a longer period of 12 months. Columns (1) and (2) indicate that both wildfires and smoke lead to a significant decline in investment amounts compared to unaffected VCs. VCs who have experienced perceptible wildfires reduce their investment scale more than those who only experienced transported smoke. On average, the investment amounts decline by 10.91% (2.72 million) within a 12-month period of wildfire and decrease by 10.59% (2.64 million) due to smoke exposure. Compared to Table A.3, after controlling for smoke effects, the impact of wildfires on the investment amount is more than double that observed when considering wildfires alone. The results suggest that exposure to wildfires and smoke makes investors more cautious than exposure to smoke alone. Columns (3) and (4) present VCs' decisions on investing in ESG startups after experiencing wildfires or smoke in the past six or 12 months. Although in the short term, both wildfires and smoke exhibit an impact on VCs' ESG decisions, the coefficients in Column (4) imply that wildfires have a larger and more persistent impact on the likelihood of VC investments in ESG companies compared to transported smoke in the longer duration. Column (4) shows that wildfire-affected VCs invest more in ESG-oriented startups by 23.97% (0.00935/0.039). Columns (5) and (6) reveal that only wildfires increase the probability that VC-invested firms eventually go public through an IPO. Column (6) indicates that the startups invested by fire-affected VCs have a 0.59% higher likelihood to eventually go public, which represents 16.86% (0.0059/0.035) higher with average. The probability of the startup being acquired is not affected by wildfires and smoke, as shown in Columns (7) and (8).[27]

The results can be explained by salience and mood effects. VC investors become more risk averse after the fires due to mood effects, leading them to reduce their investment scale after a wildfire shock. The visible connection between wildfires and climate change enhances environmental cognition, thereby encouraging investors to allocate more funds to ESG startups. Additionally, affected VCs exhibit heightened caution in selecting portfolio companies, as evidenced by an increased likelihood of startup IPOs. These findings rule out the possibility that changes in investor behavior are due to cognitive impairments, as demonstrated by the improved IPO rate of startups

[27] For brevity, we omit the insignificant results for I(Startup Acquired) for subsequent tests.

post-fire. The differential impacts of wildfires and smoke further substantiate the mechanisms of salience and mood effects. Wildfires, being more visually pronounced and often accompanied by alerts and evacuations, create a more salient and emotionally charged experience than smoke, leading to more significant changes in investment behavior. These underlying mechanisms will be explored in greater depth in Section 5.2.

**Robustness Tests** Our findings remain robust in various econometric specifications. In the main analysis, our samples exclude small deals of less than one million USD. Table A.4 demonstrates that our results are consistent even when including smaller deals of less than one million USD. Furthermore, in the spirit of Silva and Tenreyro (2006) and Chen and Roth (2023) for the concerns about "log-like" transformation, as well as for ease of interpretation, we use the investment amount in millions as one of the outcomes in our baseline analysis. In Table A.5, we use the natural logarithm of the investment amount as the robust specification of our outcome variables, and the results remain stable. In addition,Table A.6 incorporates investor group fixed effects by grouping VCs based on their age and employee size,[28] replacing investor fixed effects, and the results are still consistent. We provide more detailed descriptions of other robustness tests conducted in the following paragraphs. Section 5.3 will further investigate the validity of alternative explanations by exploring cross-sectional variations.

**Panel Data Setting** One concern with regard to our estimates arises from VCs' possible strategic risk diversification. VCs may opt to make more frequent investments, but with smaller amounts for each investment. This behavior could result in an overestimation of the impact of wildfires on in-

[28]For employee size, firms are classified into three predefined categories based on the number of employees: "1-10," "11-100," and "above 100."

vestment outcomes. To capture both investment frequency and scale, we also conduct our analysis within a VC-quarter panel data framework. We employ two key measurements for the investment amount: the average value of each VC investment and the sum of investment amounts within a 3-month quarter. Additionally, we introduce a dummy variable to denote whether a VC engages in investments with ESG-oriented companies during a particular quarter, capturing the VC's environmental cognition. We also calculate the average proportion of ESG companies within the VC's investment portfolio for that quarter as a measurement to gauge the intensity of ESG-related investments relative to the overall investment portfolio. The panel estimations are presented in Table A.7. Columns (1) and (2) indicate that VCs exposed to wildfires within a 12-month timeframe experience a reduction in their average investment amount per transaction by $0.67 million, together with a decline of $4.03 million in their total investments per quarter. Columns (3) and (4) reveal the inclination among VCs to intensify their investments in ESG-oriented startups in the aftermath of wildfire exposure. These results show a notable reduction in the scale and frequency of VC investments following a wildfire event, coupled with a shift in investment allocation towards ESG sectors. The panel setting with investor fixed effects confirms our main findings in Table 2.

**Excluding Burnt Areas** Another concern is that physical damage from wildfire may lead to losses in assets and resource redistribution. The decrease in VC investment scale could be associated with their damage rather than changes in their environmental cognition and risk perception (McCoy and Walsh, 2018). To eliminate the confounding effects of asset loss and recovery subsidies, we remove areas where wildfires caused physical damage. Unlike disasters such as hurricanes, in the context of wildfire events, areas burned by wildfires are relatively small in scale.[29] In

[29]When compared to other types of natural disasters, the extent of areas burned by wildfires is relatively limited. On average, a wildfire burns an area of merely 12.48 square kilometers. In contrast, based on flood data provided by

our sample, approximately 0.03%, or 14 out of 45,614, investor deals originated from areas that were directly burned by wildfires in the past six months. After removing observations from burned areas, in Table 3, we still observe significant investment reductions, shifts to ESG-related startups, and generally higher impacts of wildfires compared to smoke.

**[Insert Table 3 Here.]**

**Including Other Natural Disasters** Climate change can intensify the severity of other natural disasters at the same time. This could bias our estimations if other natural disasters occur in the same areas experiencing wildfires. To further substantiate our findings, we incorporate measurements of other natural disasters into our analysis. We acquire county-level Disaster Declaration data from FEMA and match it at the ZCTA level. The list of other disasters can be found in Table A.8. The results, as presented in Table A.9, indicate that our baseline findings remain unchanged with the inclusion of other natural disasters as control variables. These supplementary disasters do not exert a statistically significant influence on the investment amounts and invested startup performances. This may be because other common disasters in California, such as droughts, lack the salient effects of wildfires, resulting in less pronounced mood effects. Over the longer term (12 months), we observe an increased focus on startups with ESG commitments in the aftermath of other natural disasters. Given that these other natural disasters are also indicative of global warming trends, they could also lead to cognitive shifts toward ESG-oriented startups. Wildfires, due to their frequent occurrence, wider distribution, and proximity to areas of commercial activity, have a more pronounced influence on both the amount of investment and the type of startup invested compared to the broader spectrum of natural disasters. See the Internet Appendix A for a more

Tellman et al. (2021), the mean area affected by flood disasters in the United States is 5,832 square kilometers.

detailed description of wildfires versus other disasters.

**Including New York and Massachusetts** In our baseline analysis, we focus on VCs located in California and their domestic investments. This is motivated by the fact that California experiences the highest number of wildfires and is the most active state for VC investment in all states of the United States. Focusing on California rules out the possibility that our results are driven by state-level time-varying factors. There might be questions about whether our findings are applicable to other US states. For example, states such as New York (NY) and Massachusetts (MA) also exhibit substantial VC activity. We argue that this would not be a major concern for our setting. First, California represents approximately 50% of total VC investments, compared to NY and MA's 15% and 7%, respectively. More importantly, unlike California, New York and Massachusetts are not directly affected by severe wildfires.[30] Nevertheless, to ascertain the generalizability of our results, we expand our analysis to include VCs located in New York and Massachusetts. Due to the absence of major wildfires in these two states, we only match smoke data with the two states. Since the effects of different wind directions in the state are likely to have different impacts on air quality (Deryugina et al., 2019), we control for the interaction term between the state and the wind direction. In Table A.10, we observe a consistent pattern: a decrease in investment amounts, a heightened preference for ESG-oriented startups after wildfires, and a more pronounced impact of wildfires compared to smoke.

[30]From 2020 to 2022, NY and MA averaged 1,169 acres burned annually, approximately 0.05% of the area affected by wildfires in California during the same period (NIFC, `https://www.nifc.gov/fire-information/statistics`). However, the expansion of the WUI and climate change increase the vulnerability of New York and Massachusetts to wildfires. In general, there is a growing trend for wildfires in all states, as shown in Figure A.1 and Figure A.2b.

## 5.2 Mechanism: Salience and Mood Effects

Table 2 illustrate the negative impacts of both wildfires and smoke on the VC investment scale, as well as the shift toward ESG-related startups. Wildfires have a more pronounced influence compared to smoke, particularly with regard to ESG investments and startup IPOs. Yet, the specific mechanism underlying the impact of wildfires requires further investigation. Two competing mechanisms come into play.

The first mechanism involves salience bias and mood effects, collectively termed "experience effects." This occurs when wildfires temporarily amplify VCs' perception of future risks (Alok et al., 2020; Bordalo et al., 2012; Choi et al., 2020) and elevate their level of fear (Guiso et al., 2018; Kaplanski and Levy, 2010; Wang and Young, 2020). As a result, VCs shift toward ESG-oriented startups and exercise greater caution in their investments. The second mechanism is a learning process, in which VCs update their beliefs based on their first-hand experiences with wildfires and adjust their understanding of climate change and natural disasters.

A critical distinction between these two mechanisms lies in their temporal dynamics. If salience bias predominates, the impact of wildfires should be transient and diminish over time, whereas the learning mechanism would exhibit more sustained effects. To investigate this, we extend the analysis beyond a 12-month window and examine the impact of wildfires over one, two, and three years. Table 4 reveals a decrease in investment within two years following a wildfire event. Considering VCs' investment horizon from initial screening to closing the deal, we can still observe some effects on investment amount and I(startup IPO) in the second year of the wildfires/smoke. However, the effects dissipate after the second year, suggesting that salience bias may provide an explanation for VC investment changes following wildfire events. The heightened perception of climate change risks and economic uncertainty following wildfires leads VC investors to overestimate the short-term likelihood of disasters, and change their behaviors temporarily.

**[Insert Table 4 Here.]**

Another aspect of these experience effects that can be tested is the hypothesis that people are most profoundly affected by the first occurrence of a disaster when it happens multiple times. As wildfires repeat and become less unusual, the overreaction becomes weaker and the change in investment behavior tends to disappear. Applying this hypothesis to analyze VC investment decisions in our sample, we categorize wildfires as first wildfires or subsequent wildfires. The impact of the first wildfire encountered is expected to be stronger than that of subsequent occurrences. Table A.11 presents the effects of the first and subsequent wildfires on VC investment behavior. The results indicate that only the impacts of the first wildfire are the most significant.[31] The fact that a shift in investment behavior occurs primarily during a firm's initial encounter with a local disaster and not during subsequent incidents indicates that salience biases and mood effects can explain VCs' behavior changes.

To further investigate the mechanisms underlying salience bias and mood effects, particularly investors' risk aversion, we present additional evidence by examining changes in VC investment patterns. If VCs become more cautious in the aftermath of disasters, a reasonable hypothesis is that they are more likely to continue their previous investment choices, favoring companies within familiar sectors rather than venturing into sectors where they have not previously invested. To test this hypothesis, we construct the outcome variable "Invest in the Same Sector," which

[31] Our sample period spans from 2010 to 2020. It is important to acknowledge that wildfires occurred before 2010, and our first recorded wildfire in the sample may not be the first wildfire event ever experienced. However, given the observed increasing trend in wildfire occurrences in the 2000s, as shown in Figure A.2, the first wildfire in our dataset after 2010 can still be considered representative for testing the impact of initial wildfire exposure on investment behavior.

indicates whether the new deal is in the same sector that the VC has invested in before. The regression results, presented in Table 5, provide insight into this analysis. We find that VCs affected by wildfires exhibit an approximate 2.6% increase in the probability of reinvesting in the same sector. This finding suggests that following a wildfire event, VC investment patterns become more cautious and conservative, likely due to mood effects. Consequently, there is a higher likelihood that VCs invest in sectors with which they are already familiar and have previously invested.

**[Insert Table 5 Here.]**

## 5.3 Alternative Explanations

**Investing in ESG Startups** Our main results in Table 2 show a post-fire decrease in investment amounts, attributed to increased risk aversion among VCs. However, alternative explanations exist. For instance, this decline might also be influenced by a shift toward investing in ESG-oriented startups, as shown in the same table. These startups may be smaller in size and require lower investment amounts per round, potentially contributing to the observed decrease.

To explore this explanation, we analyze investment amounts and IPO outcomes for two subsamples of startups: ESG and non-ESG. The results, detailed in Table 6 and grouped by ESG status, provide insight into how the investment behavior of VCs changes following a fire. Specifically, we observe a significant decrease in VC investments in non-ESG startups following wildfires. Also, the likelihood of these non-ESG startups going public increases significantly after the wildfire. In contrast, for ESG-related investments, neither the investment amounts per deal nor the probability of going public show significant changes. This suggests that the overall decline in investment amounts is not primarily due to a shift towards ESG firms.

**[Insert Table 6 Here.]**

**Investing in Affected Startups** Another potential reason for the observed changes in VC investment behavior may stem from wildfire-affected startups, rather than shifts in VCs' perceptions. Consequently, these investment changes might reflect the change in investment opportunities and startup supply within the affected areas. However, our analysis includes investment targets from across the US, not just California. We also conduct additional analyses below to address and potentially rule out this alternative explanation.

**[Insert Table 7 Here.]**

First, we categorize domestic startups into two groups based on whether they are affected by wildfires or smoke. The results of this grouped regression analysis are presented in Table 7. In Columns (1) and (2), we examine the impact on investment amounts and find that investment declines for both affected and nonaffected startups. These findings suggest that changes in investment decisions are not influenced primarily by the startup composition affected by wildfires, but more significantly by shifts in investor perception. There are no statistical differences in the investment behavior of the ESG startup preference and the probability of IPO between affected and unaffected startups.

There is also the question of whether VCs, after experiencing wildfires themselves, shift away from investing in California startups, potentially driving our main results due to differences in startup composition between California and other states. To rule out this possibility, we examine the likelihood of investing in California-based startups post-fire for validation. Table 8 presents the results. We find no evidence that exposure to wildfires decreases the likelihood of VCs investing in Californian startups. Collectively, these findings lead us to conclude that the observed reduction in investment amounts following wildfires is not primarily due to changes in the composition of startups due to fires or VCs' geographical preferences.

**[Insert Table 8 Here.]**

**VC Fundraising** It is also possible that the decrease in VC investment is related to a reduction in funding from limited partners (LPs). Exposure of VCs to wildfires or smoke might generate a negative perception among LPs, which potentially reduces LPs' investment in VCs in the affected regions. Consequently, VCs have a constrained capital pool, and the investment amount will decrease. Nonetheless, this rationale cannot explain the observed increase in ESG startups and startups that go to IPO. To further address this concern, we collect the fund commitment information from VentureXpert covering 2011–2020 to examine the impact of wildfire exposure on VC fundraising. We aggregate the fund data at the ZCTA quarter level. The effect of wildfire and smoke on fundraising is presented in Table A.12. The analysis reveals no significant changes in VCs' fundraising at the ZCTA level after the wildfire, suggesting that the reduction in the investment amount cannot be attributed to the lower LP funds.

## 5.4 Role of Gender

Numerous studies have documented gender differences in social preferences, such as benevolence and universalism, as well as long-term orientation (Adams and Funk, 2012; Croson and Gneezy, 2009; Schwartz and Rubel, 2005; Silverman, 2003). These gender differences have important implications for various aspects of corporate decision-making, including investment choices, financing policies, workplace practices, and corporate social responsibility (Hsu, Li, and Pan, 2022; Levi, Li, and Zhang, 2014; Matsa and Miller, 2013; Tate and Yang, 2015).

In the context of VC responses to wildfires, it is important to consider the differential responses that may arise based on gender. To explore this heterogeneity, we conduct an analysis by separating VCs into two subsamples of female-dominated and male-dominated ones. Using Crunchbase data, we obtain VC employee job positions and gender, matching their corresponding firms. This results in 20,620 employees matched to 1,368 VC firms. The main challenge is identifying the actual leaders within these VCs. We deviate from previous approaches like Snellman and Solal (2023) that identify VC leaders based on the individuals in charge of each investment provided by Crunchbase. We have two reasons for this deviation: First, the large number of missing values in the "person in charge" variable may introduce sample selection bias; Second, investment decisions are more likely driven by a leadership team rather than a single individual. In our regression analysis, we categorize VCs based on whether the proportion of women in management positions exceeds 50%, which accounts for approximately 10% in our sample.

**[Insert Table 9 Here.]**

Table 9 presents the results of this analysis. In Columns (1) and (2), we examine the investment amounts as the outcome variable. The results reveal that only male-dominated VCs experience a significant decline in investment amounts after encountering wildfires. Moving to Columns (3) and (4), which focus on ESG investments, we find that male-dominated VCs increase their investments in ESG companies following wildfires by 0.8%, while female-dominated VCs experience no change. Columns (5) and (6) examine the outcome of IPO and reveal that the effect is greater for male-dominated VCs. Finally, we analyze the investment patterns by looking at whether VCs invest in the same sectors as before. Columns (7) and (8) indicate that male-dominated VCs tend to invest more in familiar sectors.

To further test whether this gender difference is also statistically significant, in Table A.13, we also add interaction terms between wildfire (smoke) and male domination. Our results show that the investment amount of male-dominated VCs decreases more after the wildfire than that of female-dominated VCs.

Our findings suggest that male-dominated VCs exhibit a higher salience bias, leading to more significant changes in investment behavior. Previous studies have found that firms with female executives spend cash more cautiously, make fewer acquisitions, have lower leverage, and have a higher chance of survival (Faccio, Marchica, and Mura, 2016; Huang and Kisgen, 2013). It is possible that women-dominated VCs are more cautious in their investments prior to wildfires and therefore more resilient to adverse situations.

# 6 Wildfires and Startup Performance

In this section, we shift our focus to examining the ramifications of wildfires on the performance of California startup companies, with a particular emphasis on VC-backed startups. Although small businesses in general may be acutely vulnerable to natural disasters—due to factors such as cash flow disruption, limited access to capital, infrastructural damage, and diminished local demand—VC-backed startups could be comparatively insulated from such adverse conditions. These startups often depend less on local banking and credit systems, and because of their technology-intensive nature, they typically possess fewer physical assets. Nonetheless, the actual effects of wildfires on startups need to be tested empirically.

We focus on Californian startups that have secured at least one round of VC investment throughout their operational period. The sample period is again 2011–2020. First, we look at firms' financing opportunities following wildfires in a startup-quarterly panel. We examine both whether the startup receives any investment and the amount of the investment. The results, shown in Table 10, reveal that in the short term following a wildfire, there is no observable negative impact on the financing opportunities for startups within the wildfire zone. Column (1) shows that if a startup has experienced wildfires in the last six months, the probability of receiving additional investment within the future one year from this quarter onward is statistically insignificant from the startups that do not experience any wildfires. Together, the results indicate that, for VC-backed startups, both the likelihood of receiving new investment and the amount of investment are not affected by the wildfire.

**[Insert Table 10 Here.]**

Next, we move on to examine startups' innovation production. Because we focus on VC-backed startups, many of them are patent producers. The analysis is conducted in a panel setting at the startup-quarterly level. The outcome variables are whether the startup files any patents, and in particular, any green patents, conditional on patents being granted, in the next one, two, or three years. We look at this extended time frame due to the inherent lags associated with patent generation. The data source for startups' patent output is described in Section 3.3. The green patent is defined as in Cohen et al. (2020). Specifically, this definition follows the guidelines from the Organization for Economic Co-operation and Development (OECD). Patents that are related to environmental innovations are identified using the Cooperative Patent Classification (CPC) index.[32] The

[32] See Haščič and Migotto (2015) for a detailed explanation of OECD's algorithm.

results are reported in Table 11. We observe an uptick in patenting activities among startups post-wildfire, with a more pronounced effect on green patent production. An examination of Columns (3) and (6) highlights that the probability of filing a patent rises by 1.96% (0.00286/0.1457) from its average level in the subsequent three years, while the probability of filing a green patent increases by 14.9% (0.00233/0.0156). Column (9) highlights that exposure to wildfire increases the ratio of green patents to total patents by approximately 3.59% from its average level over the subsequent three years. This finding suggests that wildfire shocks disproportionately encourage startups to pursue green innovation relative to their general innovation portfolio. The increase in overall patenting activity may indicate a strategic shift towards the accumulation of intangible assets. As the experience of wildfires increases startups' awareness of environmental issues, this leads to a significant increase in green patent filings.

**[Insert Table 11 Here.]**

Although wildfires do not have negative effects on startups in the short term, they can be detrimental to startups when the fires occur during the nascent stages of a startup's lifecycle, as evidenced by a decreased likelihood of successful exits. Table 12 presents these findings. The analysis is conducted at the startup level. Using the startup's founding year information, our variable of interest *wildfire_1(2/3/4)y*, indicates whether the startup is in the wildfire zone within the first, two, three, or four years of its founding date. The results reveal that experiencing a wildfire early in a startup's lifecycle leads to a lower likelihood of going public or being acquired. This negative effect is most pronounced when a wildfire occurs within the first year following the startup's founding.

**[Insert Table 12 Here.]**

In summary, our analysis offers a nuanced understanding of the complex relationship between wildfires and the performance of VC-backed start-ups. Our findings show that wildfires do not necessarily hurt startups in the short term. However, startups that experience wildfires early in their life are less likely to have a successful exit. We also find that startups tend to file more patents, particularly green ones, after experiencing wildfires.

# 7 Conclusion

Overall, this study demonstrates that wildfires and their associated risks have notable implications for VC investment behavior, prompting changes in investment strategies and preferences towards ESG-oriented startups. By unpacking these dynamics, our analysis contributes to a more nuanced understanding of how environmental events intersect with financial decision-making in the realm of entrepreneurial finance.

In light of the increasing severity of wildfires and the costs associated with their management, both government and non-governmental entities face challenges in allocating resources for prevention and mitigating barriers for recovery. Our research provides insights into the impacts of wildfires on venture capital investment and startup performance, revealing a discouraging effect on investment but an enhancement in environmental cognition. To facilitate business recovery and growth, financial mechanisms such as disaster bonds, low-interest loans, tax incentives, and Public-Private Partnerships (PPPs), focused on growth rather than mere reconstruction, can catalyze “creative destruction” or “build back better” scenarios, attracting investment and driving economic growth. Future studies could explore the effectiveness of various financial policies on wildfire recovery and prevention, providing valuable insights for policymakers and stakeholders to address the economic consequences of such natural disasters.

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Table 1. Summary Statistics

| | Mean | Std.Dev | p25 | p50 | p75 |
|---|---|---|---|---|---|
| *N=45,614* | | | | | |
| Investment Amount (*$Mil*) | 24.924 | 41.566 | 4.000 | 10.300 | 26.000 |
| I(ESG Startup) | .039 | .193 | .000 | .000 | .000 |
| I(Startup IPO) | .035 | .185 | .000 | .000 | .000 |
| I(Startup Acquired) | .192 | .394 | .000 | .000 | .000 |
| Wildfire_6m | .156 | .363 | .000 | .000 | .000 |
| Wildfire_12m | .252 | .434 | .000 | .000 | 1.000 |
| Smoke_6m | .344 | .475 | .000 | .000 | 1.000 |
| Smoke_12m | .562 | .496 | .000 | 1.000 | 1.000 |
| ln(Establishments) | 7.293 | .626 | 7.155 | 7.435 | 7.751 |
| ln(Total Wage) | 15.207 | 1.156 | 14.499 | 15.286 | 16.090 |
| Temperature (°*C*) | 15.778 | 3.381 | 13.250 | 15.630 | 18.579 |
| Precipitation (*mm*) | 33.494 | 56.068 | .000 | 4.828 | 43.569 |
| Wind Speed (*m/s*) | 2.187 | .971 | 1.461 | 2.131 | 2.917 |
| VC Age | 13.759 | 14.041 | 4.000 | 8.000 | 19.000 |

This table provides the summary statistics of the investor-deal level VC investment and the corresponding local economic and environmental characteristics. This sample covers VC deals in California from 2011 to 2020. This table reports the deal-level information from Crunchbase, the ZCTA-month level of disaster and weather conditions, and the ZCTA-year level economic characteristics. The sample construction can be found in Section 3 of the paper and variable definitions are in Table A.1.

Table 2. Wildfire, Smoke and VC Investment - Joint Effects

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | | I(Startup Acquired) | |
| wildfire_6m | -2.346*** | | 0.0133*** | | 0.000267 | | -0.00207 | |
| | (0.857) | | (0.00406) | | (0.00408) | | (0.00834) | |
| smoke only_6m | -2.080** | | 0.0123** | | -0.00399 | | -0.000231 | |
| | (0.906) | | (0.00557) | | (0.00559) | | (0.0130) | |
| wildfire_12m | | -2.721*** | | 0.00935*** | | 0.00591** | | 0.00167 |
| | | (0.940) | | (0.00339) | | (0.00250) | | (0.00765) |
| smoke only_12m | | -2.641*** | | 0.00612 | | 6.80e-06 | | 0.00598 |
| | | (0.952) | | (0.00410) | | (0.00416) | | (0.00876) |
| Controls | Y | Y | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 38,866 | 38,866 | 45,614 | 45,614 | 45,614 | 45,614 | 45,614 | 45,614 |
| R-squared | 0.486 | 0.486 | 0.108 | 0.108 | 0.220 | 0.220 | 0.214 | 0.214 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. In Columns (7) and (8), the dependent variable is *I(Startup Acquired)*, which denotes whether the invested startup is acquired eventually. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3. Wildfire, Smoke and VC Investment - Excluding Burnt Areas

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| wildfire_6m | -2.263*** | | 0.0133*** | | 0.000188 | |
| | (0.864) | | (0.00405) | | (0.00406) | |
| smoke only_6m | -2.048** | | 0.0122** | | -0.00383 | |
| | (0.910) | | (0.00557) | | (0.00554) | |
| wildfire_12m | | -2.645*** | | 0.00932*** | | 0.00575** |
| | | (0.957) | | (0.00339) | | (0.00251) |
| smoke only_12m | | -2.610*** | | 0.00601 | | 0.000131 |
| | | (0.962) | | (0.00411) | | (0.00410) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y |
| Observations | 38,854 | 38,846 | 45,600 | 45,587 | 45,600 | 45,587 |
| R-squared | 0.486 | 0.486 | 0.108 | 0.108 | 0.220 | 0.220 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes, excluding the fire burnt areas. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4. Wildfire and VC Investment - Long-term Effects

| | (1)<br>Investment Amount | (2)<br>I(ESG Startup) | (3)<br>I(Startup IPO) |
|---|---|---|---|
| wildfire_0-12m | -1.767** | 0.00579** | 0.00884*** |
| | (0.682) | (0.00279) | (0.00310) |
| wildfire_13-24m | -2.299*** | 0.000498 | 0.0104*** |
| | (0.683) | (0.00291) | (0.00326) |
| wildfire_25-36m | -0.936 | 0.00226 | 0.00292 |
| | (0.576) | (0.00355) | (0.00245) |
| Controls | Y | Y | Y |
| Year*Month FE | Y | Y | Y |
| ZCTA FE | Y | Y | Y |
| Investor FE | Y | Y | Y |
| Observations | 38,866 | 45,614 | 45,614 |
| R-squared | 0.486 | 0.108 | 0.221 |

This table looks at the long-term effect of wildfire on VC investment decisions and outcomes. The sample is at investor-deal level and the sample period is 2011–2020. In Column (1), the dependent variable is deal-level *Investment Amount*. In Column (2), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Column (3), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. Independent variable *wildfire_0-12(13-24 / 25-36)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 0 to 12 (13 to 24 / 25 to 36) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5. Wildfire, Smoke and VC Investment - Investment Pattern

| | (1) | (2) |
|---|---|---|
| | Invest in the Same Sector | |
| wildfire_6m | 0.0260*** | |
| | (0.00615) | |
| smoke only_6m | 0.0111 | |
| | (0.00701) | |
| wildfire_12m | | 0.0214*** |
| | | (0.00545) |
| smoke only_12m | | 0.00968* |
| | | (0.00552) |
| Controls | Y | Y |
| Year*Month FE | Y | Y |
| ZCTA FE | Y | Y |
| Investor FE | Y | Y |
| Observations | 45,614 | 45,614 |
| R-squared | 0.251 | 0.251 |

This table looks at the effect of wildfire and smoke on VC investment patterns. The sample is at investor-deal level and the sample period is 2011–2020. The dependent variable is *Invest in the Same Sector*, which is an indicator variable of whether the VC has invested in this sector before. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6. Wildfire, Smoke and VC Investment - Investment in ESG Firms

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Investment Amount | | I(Startup IPO) | |
| | Non-ESG | ESG | Non-ESG | ESG |
| wildfire_12m | -2.811*** | -0.560 | 0.00523* | 0.00213 |
| | (1.006) | (2.083) | (0.00267) | (0.0114) |
| smoke only_12m | -2.637*** | -1.436 | -0.000313 | -0.00156 |
| | (0.959) | (1.640) | (0.00417) | (0.0116) |
| Controls | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y |
| Observations | 37,394 | 1,472 | 43,840 | 1,774 |
| R-squared | 0.489 | 0.693 | 0.221 | 0.666 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes, conditional on whether the invested startup is an ESG-oriented startup. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) to (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) to (4), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. Independent variable *wildfire_12m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 12 months prior to investment. *smoke only_12m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 12 months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7. Wildfire, Smoke and VC Investment - Affected and Non-affected Startups

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| | Affected | Non-affected | Affected | Non-affected | Affected | Non-affected |
| wildfire_12m | -3.200*** | -1.709* | 0.00456 | 0.00713 | 0.000899 | 0.00553 |
| | (1.215) | (0.901) | (0.00621) | (0.00464) | (0.00469) | (0.00375) |
| smoke only_12m | -3.555*** | -1.308 | 0.00528 | -0.000794 | -0.00459 | 0.00371 |
| | (1.124) | (1.332) | (0.00675) | (0.00591) | (0.00474) | (0.00578) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y |
| Observations | 20,512 | 16,514 | 23,639 | 18,892 | 23,639 | 18,892 |
| R-squared | 0.504 | 0.505 | 0.134 | 0.150 | 0.254 | 0.250 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes, conditional on whether the startups are affected by wildfire or smoke themselves. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. Independent variable *wildfire_12m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 12 months prior to investment. *smoke only_12m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 12 months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8. Wildfire, Smoke and VC Investment - Decision on Investing in Californian Startups

| | (1) | (2) |
|---|---|---|
| | I(Portfolio is in California) | |
| wildfire_6m | 0.00226 | |
| | (0.00800) | |
| smoke only_6m | 0.0163* | |
| | (0.00844) | |
| wildfire_12m | | -0.000592 |
| | | (0.00713) |
| smoke only_12m | | 0.0110 |
| | | (0.00742) |
| Controls | Y | Y |
| Year*Month FE | Y | Y |
| ZCTA FE | Y | Y |
| Investor FE | Y | Y |
| Observations | 45,614 | 45,614 |
| R-squared | 0.122 | 0.123 |

This table looks at the effect of wildfire and smoke on VC investment decisions to invest in Californian startups. The sample is at investor-deal level and the sample period is 2011–2020. The dependent variable *I(Portfolio is in California)*, is an indicator variable of whether the portfolio company is in California. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9. Wildfire, Smoke and VC Investment - Role of Gender

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | | I(Invest Same Sector) | |
| | More Female | Less Famle | More Female | Less Female | More Female | Less Female | More Female | Less Female |
| wildfire_12m | 1.360 | -2.959*** | 0.00164 | 0.00801** | -0.0111 | 0.00674** | 0.0308 | 0.0220*** |
| | (1.772) | (0.938) | (0.0104) | (0.00386) | (0.0105) | (0.00285) | (0.0222) | (0.00589) |
| smoke only_12m | 0.255 | -2.837*** | 0.00756 | 0.00444 | -0.0157 | 0.00203 | 0.00684 | 0.0118* |
| | (1.791) | (0.978) | (0.0105) | (0.00440) | (0.0101) | (0.00419) | (0.0210) | (0.00610) |
| Controls | Y | Y | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 3,569 | 33,227 | 4,410 | 38,435 | 4,410 | 38,435 | 4,410 | 38,435 |
| R-squared | 0.469 | 0.480 | 0.182 | 0.090 | 0.216 | 0.210 | 0.221 | 0.207 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes, conditional on whether the VC is dominated (50% as the threshold) by females. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. In Columns (7) and (8), the dependent variable is *I(Invest in the Same Sector)*, which denotes whether VC has invested in this sector before. Independent variable *wildfire_12m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 12 months prior to investment. *smoke only_12m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 12 months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10. Wildfire and Startups - Financing Opportunities

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | In 1 Year | | | |
| | I(Investment) | Investment Amount | I(Investment) | Investment Amount |
| wildfire_6m | 0.00139 | 0.130 | | |
| | (0.00330) | (0.241) | | |
| wildfire_12m | | | 0.000415 | 0.150 |
| | | | (0.00331) | (0.259) |
| Controls | Y | Y | Y | Y |
| Year*Quarter FE | Y | Y | Y | Y |
| Startup FE | Y | Y | Y | Y |
| Observations | 314,563 | 314,563 | 314,563 | 314,563 |
| R-squared | 0.391 | 0.385 | 0.391 | 0.385 |

This table looks at the effect of wildfire on startup financing outcomes. The sample is at the startup-quarter level and the sample period is 2011–2020. In Columns (1) and (3), the dependent variable is *I(Investment) in 1 year*, which is whether the startup receives any investment in one year; in Columns (2) and (4), the dependent variable is *Investment Amount in 1 year*, which denotes the investment amount received in one year. Independent variables *wildfire_6(12)m* denote whether the ZCTA that the startup located has been within the wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. Startup fixed effects and year-quarter fixed effects are also included. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 11. Wildfire and Startups - Patent Production

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | | I(Patent) | | | I(Green Patent) | | | I(Green Patent Ratio) | |
| | 1 year | 2 years | 3 years | 1 year | 2 years | 3 years | 1 year | 2 years | 3 years |
| wildfire_12m | 0.00137 | 0.00274* | 0.00286** | 0.000345 | 0.00225*** | 0.00233*** | 0.00207 | 0.00380* | 0.00359** |
| | (0.00157) | (0.00140) | (0.00138) | (0.000689) | (0.000794) | (0.000762) | (0.00269) | (0.00215) | (0.00167) |
| Controls | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Year*Quarter FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Startup FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 314,563 | 314,563 | 258,675 | 314,563 | 314,563 | 258,675 | 33,935 | 41,223 | 37,767 |
| R-squared | 0.726 | 0.815 | 0.869 | 0.550 | 0.633 | 0.763 | 0.650 | 0.695 | 0.775 |

This table looks at the effect of wildfire on startups' patent production. The sample is at the startup-quarter level and the sample period is 2011–2020. In Columns (1) to (3), the dependent variable is whether the startup has any patents produced in the next one, two, or three years. In Columns (4) to (6), the dependent variable is an indicator variable of whether the startup has any green patents produced in the next one, two, or three years. Green patent is defined as in Cohen et al. (2020). In Columns (7) to (9), the dependent variable is the ratio of green patents to all patents in the next one, two, or three years. Independent variables *wildfire_12m* denote whether the ZCTA that the startup located has been within the wildfire impacted area in the past 12 months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. Startup fixed effects and year-quarter fixed effects are also included. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 12. Wildfire and Startups - Early Year Fire Exposure and Exits

| | (1) IPO | (2) Acquired | (3) IPO | (4) Acquired | (5) IPO | (6) Acquired | (7) IPO | (8) Acquired |
|---|---|---|---|---|---|---|---|---|
| wildfire_1y | -0.00373*** | -0.0549*** | | | | | | |
| | (0.00107) | (0.00542) | | | | | | |
| wildfire_2y | | | -0.00263*** | -0.0496*** | | | | |
| | | | (0.000852) | (0.00534) | | | | |
| wildfire_3y | | | | | -0.00227*** | -0.0411*** | | |
| | | | | | (0.000711) | (0.00476) | | |
| wildfire_4y | | | | | | | -0.00225*** | -0.0345*** |
| | | | | | | | (0.000691) | (0.00414) |
| Controls | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 14,917 | 14,917 | 14,917 | 14,917 | 14,917 | 14,917 | 14,917 | 14,917 |
| R-squared | 0.152 | 0.084 | 0.152 | 0.090 | 0.152 | 0.091 | 0.153 | 0.089 |

This table looks at the effect of wildfire during startups' earlier life on startups' future exits. The sample is at startup level and the sample period is 2011–2020. The dependent variables are the indicator variables of whether the startup eventually goes public or is acquired. The independent variables *wildfire_1(2/3/4)y*, denote the number of wildfires within the wildfire impacted area of the startup's location in the ZCTA in the first one, two, three, or four years following the foundation of the startup. ZCTA is ZIP Code Tabulation Area. Controls include the total amount of funding received by the startup in its lifetime. ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. Year-quarter fixed effects are also included. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

# Internet Appendix

## A Wildfire versus Other Natural Disasters

Climate change not only exacerbates the severity of wildfires but also amplifies the intensity of other natural disasters, such as hurricanes and flooding. In this study, we focus on investigating the effects of wildfires for several reasons. Firstly, the localized scale of wildfires, as well as their spatial variations over time, provides a distinctive framework for evaluating the impacts of "disaster-driven shifts" on VC investments and startup performance. Table A.8 presents the historical occurrences of various disaster types in the US since 1953, drawing from data sourced from the Federal Emergency Management Agency (FEMA). Notably, wildfires emerge as the most frequently declared disasters, with a total of 1,565 documented incidents (averaging 22 wildfires annually).[33] Despite their prominent occurrence in declarations, wildfires have had a relatively limited geographical impact compared to other natural disasters, affecting an average of only 2.32 counties per incident. In contrast, severe storms, the second most frequent disasters, occurred in the US on 1,043 occasions and, on average, impacted 17.01 counties. Hurricanes and ice storms affected an average of more than 30 counties per incident. Given the extensive reach of storms and hurricanes, the effects of these other natural disasters on businesses can be confounded by macroeconomic adjustments and associated recovery plans.

Secondly, when comparing wildfires to other natural disasters, such as hurricanes and flooding, it is essential to recognize their distinct characteristics. Unlike wildfires, which can engulf exten-

[33] According to statistics from the National Interagency Fire Center (NIFC), there were a total of 2.799 million wildfires recorded from 1983 to 2022. However, fewer than 0.05% of these wildfires met the criteria for a declaration. The wildfires recorded but not declared are those that caused limited damage with a small scale of burnt areas and were extinguished in a short period of time.

sive areas with vegetation and impose substantial risks on households in Wildland-Urban Interface (WUI) zones, directly impacting human communities by destroying homes and infrastructure while posing health hazards through smoke inhalation, the latter disasters are often confined by their proximity to coastal areas or river networks. Each of these natural calamities exhibits unique patterns in their affected properties and trajectories. Wildfires, in particular, carry the potential for long-term environmental effects, affecting local air quality and ecosystems. Notably, wildfires possess the characteristic of causing localized damage within the path of the fire, resulting in specific communities or regions experiencing severe consequences, while nearby areas may remain relatively unscathed physically but are still affected by air pollution. In contrast, disasters such as hurricanes or earthquakes typically engender immediate and catastrophic damage but often do not entail enduring harm or pollution that continues to spread to undamaged areas.

Figure A.3 illustrates the spatial distribution of wildfires in comparison to other natural disasters declared by FEMA, revealing that the areas affected by wildfires are not concentrated in counties also susceptible to other severe natural disasters. To further substantiate our findings, we conduct a robustness check by incorporating additional categories of natural disasters into our analysis. We acquire county-level Disaster Declaration data from FEMA and match it at the ZCTA level using the same measurements employed for wildfires. The results, as presented in Table A.9, indicate that our baseline findings remain unaltered with the inclusion of other natural disasters as control variables.

# B Wildfire Buffer

Wildfires, with a smaller spatial footprint, have the capacity to cause significant damage to local communities and affect areas extending over tens of kilometers. Recognizing the potential for measurement error from minor events like small bonfires, our analysis exclusively considers significant wildfires — those that prompt warnings and evacuations — as events of interest. On average, the affected areas resulting from the wildfires within our defined criteria, as per statistics from the FRAP, cover an approximate expanse of 1,000 acres. The impact of wildfires on local residents is multifaceted, involving physical damage, evacuations, and warning systems. To comprehensively capture these effects, we employ a trigger model based on the research of Li, Cova, and Dennison (2015) and Katzilieris, Vlahogianni, and Wang (2022) to gauge the extent of influence exerted by each wildfire incident, subsequently calculating our wildfire buffer. This model incorporates wind speed data from the National Oceanic and Atmospheric Administration (NOAA),[34] with an average speed of 10.27 km/h in California, projecting that the affected area could extend up to 50 km from the source of the wildfire. To validate the robustness of our measurements, we conduct a sensitivity analysis using the gravity model to explore alternative buffer sizes ranging from 10 km to 100 km.[35]

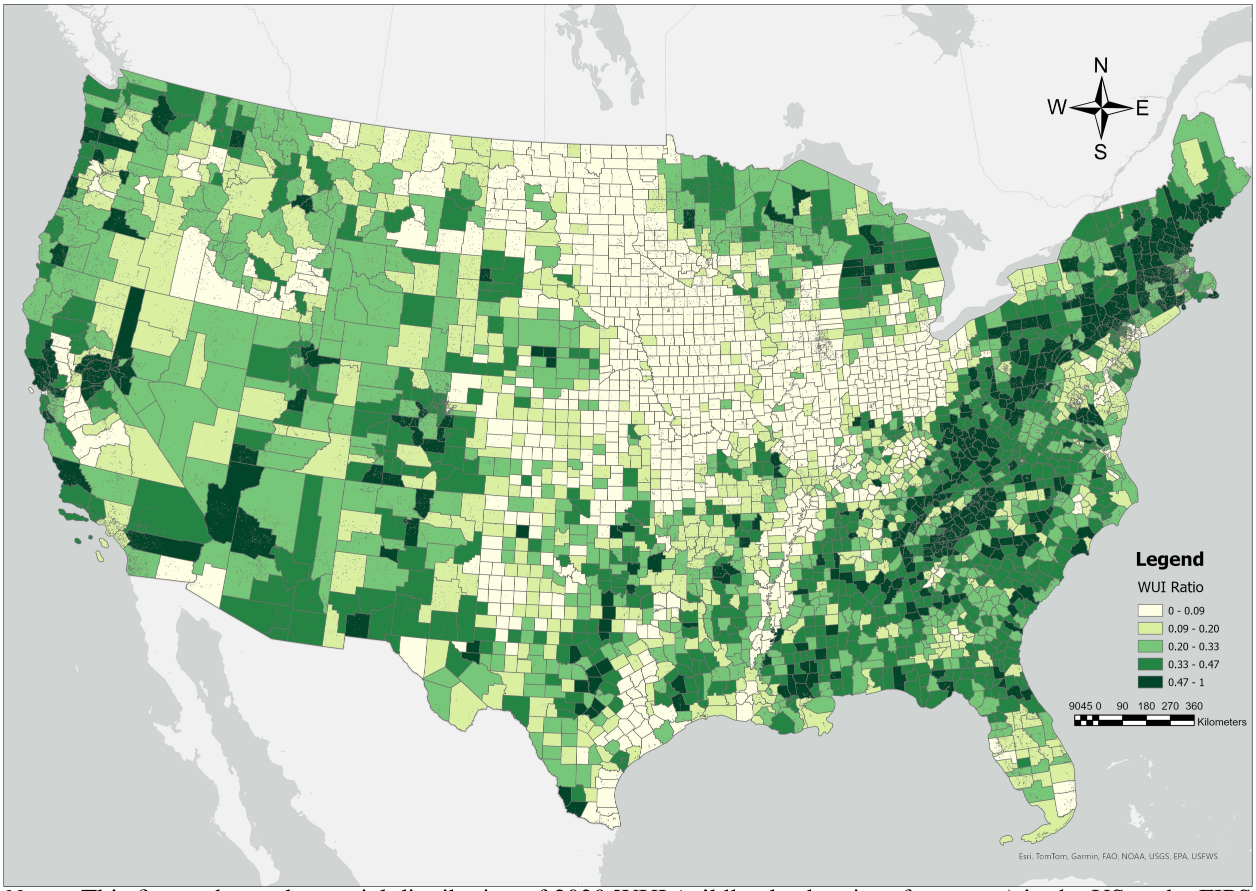
Isard (1954) posits that "the distance variables act in much the same manner with respect to the social world as to the natural world." Our models, embracing this concept, assess the impact of wildfires on financial activities by considering both natural disturbances (areas affected by wild-

[34] Data from NOAA, accessible at https://www.ncei.noaa.gov/pub/data/ccd-data/wndspd20.dat

[35] The gravity model is one of the most robust empirical methods for estimating models with bilateral changes, such as capturing the fact that bilateral trade between two countries is inversely proportionate to their distance in international trade (Chaney, 2018). In the wildfire story, distance may explain and predict wildfire's effects through two channels: the distance-based treatment intensity and the gross domestic social activities and communities located in affected areas.

fires) and social dynamics (community responses and locations). As the distance suggests the effects can incorporate "gravitational" variations, we explore how these effects vary regionally due to "gravitational" differences in distance from the burned areas. Figure A.4 demonstrates that the impact of wildfires on VC investment amount varies by the distance to wildfire. The magnitude of wildfire's effects convexly correlated to the distance and is significantly negative across the distance of 30 km to 80 km. For regions immediately adjacent to burned areas, we observe an insignificant negative impact on investment amount, likely due to the limited business activities in forest-adjacent zones. Wildfires' effects on this region can also be confounded by other factors like asset loss or recovery support. When we further investigate the areas affected but not immediately adjacent to physical damages, wildfires exert their influence by progressively deteriorating the assets, environments, cognition, and investment behaviors of communities. Empirically, we observe that: (i) the effects of the wildfires are confounded by limited social activities within 20 km, (ii) there is a large negative effect across the regions 30km to 80 km from the burned areas, where residential and commercial activities are frequent; (iii) beyond 80 km, the immediate impact diminishes, yet the relocation of businesses from closer wildfire-affected areas can positively influence local investment dynamics. Supported by the trigger model and gravity-based geographic distribution studies, our analysis highlights the significant effects of wildfires within a 50 km radius of the affected areas.

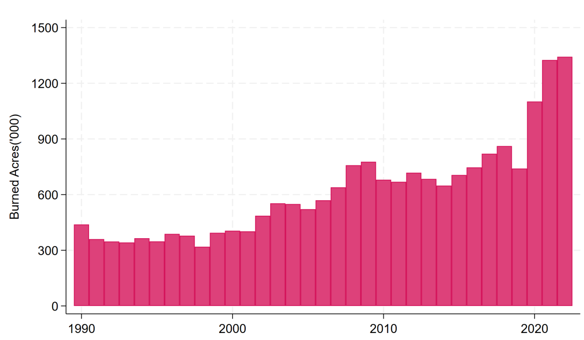
Figure A.1. WUI Distribution



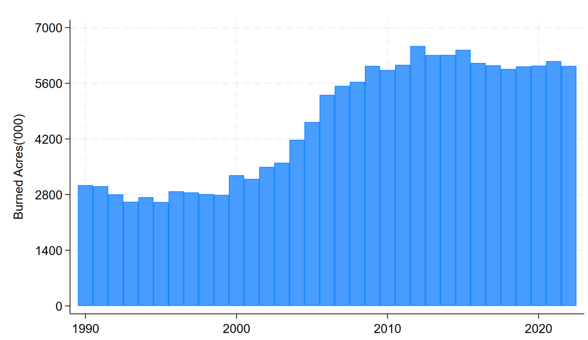

*Notes*: This figure shows the spatial distribution of 2020 WUI (wildland-urban interface areas) in the US at the FIPS (Federal Information Processing Standard) level.

Figure A.2. Intensity of Wildfires in CA and outside CA: 1990-2022

(a) Wildfire Affect Area - CA

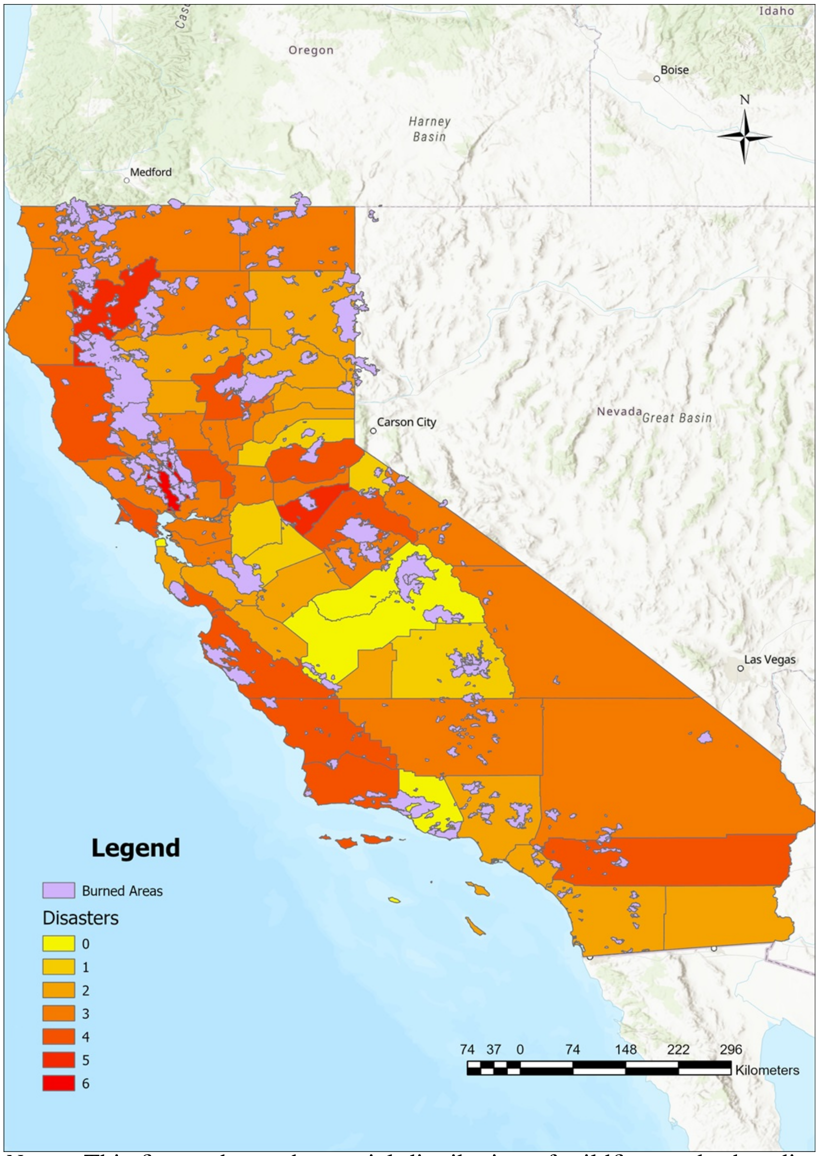



(b) Wildfire Affect Area - Outside CA



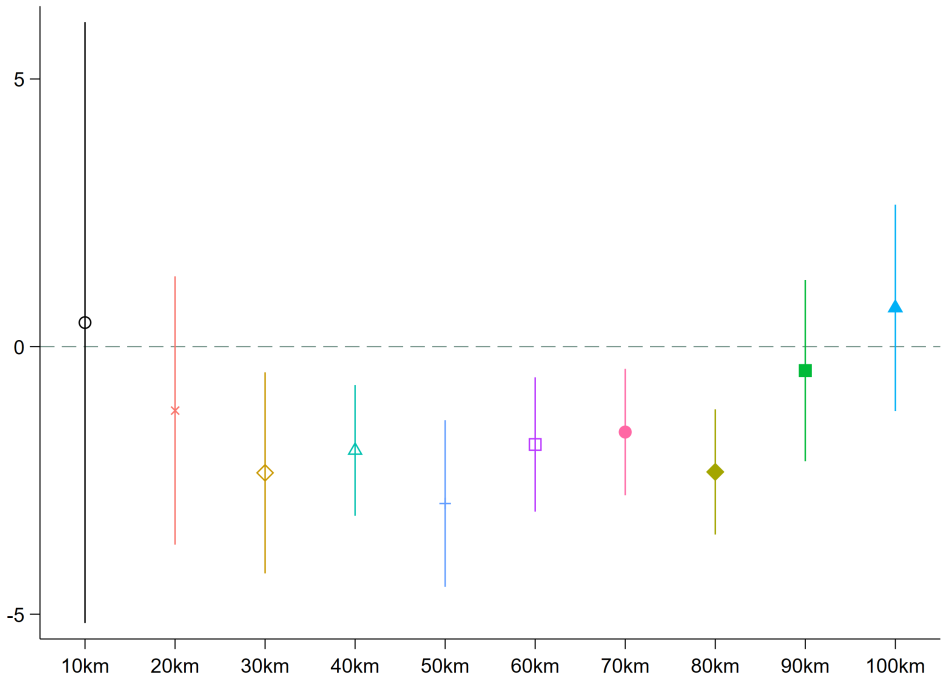

*Notes*: This figure presents the intensity of wildfires from 1990 to 2022 in California and outside California. Figure (a) shows the number of acres burned by wildfire by year in California, while Figure (b) shows the number of acres burned by wildfire by year outside California. Both figures use a ten-year rolling average. Data from National Interagency Fire Center and Calfire.

Figure A.3. Wildfire and Other Disasters




*Notes*: This figure shows the spatial distribution of wildfires and other disasters in California from 2010 to 2020. The purple area indicates the region burned by wildfires. The base colors represent the number of other disasters that each county has experienced.

Figure A.4. Coefficient of Wildfire on Investment Amount by Distance




*Notes*: This figure shows the coefficient of wildfires on investment amounts within a distance range of 0 to 100 kilometers, with each 10-kilometer increment marking a boundary. The buffers are cumulative, meaning that larger distance ranges include all wildfires from the smaller intervals. For instance, the data for the 10-kilometer range only considers the impact of wildfires within 10 kilometers of the VC, while the data for the 50-kilometer range includes all wildfires within a 50-kilometer radius of the VC.

Table A.1. Key Variable Definitions

| Variable | Definition and Construction |
|---|---|
| | Outcome variables |
| Investment Amount | Deal-level investment amount in millions of US dollars. Data from Crunchbase. |
| I(ESG Startup) | An indicator variable that takes a value of one if the invested startup is an ESG-oriented company, measured by keywords in company and/or industry descriptions. Data from Crunchbase. |
| I(Startup IPO) | An indicator variable that takes a value of one if the invested startup eventually goes public. Data from Crunchbase. |
| I(Startup Acquired) | An indicator variable that takes a value of one if the invested startup is eventually acquired. Data from Crunchbase. |
| I(Invest Same Sector) | An indicator variable that takes a value of one if VC has invested in this sector before. Data from Crunchbase. |
| I(Portfolio in California) | An indicator variable that takes a value of one if the portfolio company is in California. Data from Crunchbase. |
| I(Patent) | An indicator variable that takes a value of one if the startup has any patents produced in the next one, two, or three years. Data from IPQuery. |
| I(Green Patent) | An indicator variable that takes a value of one if the startup has any green patents produced in the next one, two, or three years. Green Patents are identified as in Cohen et al. (2020). |
| | Disaster variables |
| Wildfire_6m | An indicator variable that takes a value of one if the ZCTA that VC is within 50km of the wildfire burning area ("wildfire impacted area") in the past 6 months prior to investment. Data from Calfire. |
| Wildfire_12m | An indicator variable that takes a value of one if the ZCTA that VC is located has been within the wildfire impacted area in the past 12 months prior to investment. Data from Calfire. |
| Smoke_6m | An indicator variable that takes a value of one if the ZCTA that VC is located has heavy smoke days in the past 6 months prior to investment. Data from NOAA. |
| Smoke_12m | An indicator variable that takes a value of one if the ZCTA that VC is located has heavy smoke days in the past 12 months prior to investment. Data from NOAA. |
| Smoke Only_6m | An indicator variable that takes a value of one if the ZCTA that VC is located has heavy smoke days but has not been within the wildfire impacted area in the past 6 months prior to investment. |
| Smoke Only_12m | An indicator variable that takes a value of one if the ZCTA that VC is located has heavy smoke days but has not been within the wildfire impacted area in the past 12 months prior to investment. |
| | Other variables |
| VC Age | The difference between investment year and the founding year. Data from Crunchbase. |

| | |
|---|---|
| VC Employment | Number of employees in VC (predefined categorical variable). Data from Crunchbase. |
| Investment Round | Indicator variables of VC investment rounds. Data from Crunchbase. |
| ln(Establishments) | Log form of number of establishments at the ZCTA level. Data from Zipcode Business Patterns (ZBP). |
| ln(Total Wage) | Log form of number of total payroll at the ZCTA level. Data from Zipcode Business Patterns (ZBP). |
| Temperature | Average temperature at the ZCTA level (unit: °C ). Data from PRISM Climate Data. |
| Precipitation | Average precipitation at the ZCTA level (unit: mm). Data from PRISM Climate Data. |
| Wind Speed | Average wind speed at the ZCTA level (unit: m/s). Data from NARR. |
| Wind Direction | There are 8 binary indicators. The indicator equals 1 if the daily average wind direction in ZCTA falls in the 45-degree interval[45x, 45x + 45) and 0 otherwise. Data from NARR. |

Table A.2. List of ESG Core Words

| | | |
|---|---|---|
| any else in the tribe | bio-remediation | clean |
| crop enhancement | donate | eco-friendly |
| employee benefits | environmental impact | esg |
| food waste | gasification | hydrogen |
| invest ethical | low carbon | minerals |
| mission-driven | ocean conditions | poverty |
| recycling technology | social challenge | socially conscious |
| solar | sustainable development | sustainable investment |
| underrepresented | waste services | water efficiency |
| water waste | air filtration | argi-tech |
| bioenergy | clean air | clean-tech |
| crop yield optimization | donation | elderly care |
| energy conservation | environmentally clean | ethically conscious |
| fossil fuel-free | green energy | impact investing |
| leak detection | low-carbon | minority-owned |
| natural ingredients | oil spill | pre-owned |
| regulatory compliance tech | social finance | socially responsible |
| surplus products | sustainable economic development | sustainable water |
| underserved | wastewater | water footprint |
| wind farms | air pollution | base of the pyramid |
| biomass | clean energy | climate |
| disabilities | driving hazards | electric vehicle charging |
| energy monitoring | environmentally conscious | fight hunger |
| fuel cells | greenhouse | impact investment |
| leather substitute | low-income | mission driven |
| nonprofit | organic | purpose-driven |
| renewable | social good | soil cleanup |
| sustainable | sustainable farming | tidal power |
| used items | wastewater treatment | water management |
| women business | | |

The list of keywords utilized to identify ESG companies is sourced from Barber et al. (2021) and Zhang (2021).

Table A.3. Wildfire, Smoke and VC Investment - Separate Effects

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| wildfire_12m | -1.043* | | 0.00544** | | 0.00590* | |
| | (0.533) | | (0.00228) | | (0.00325) | |
| smoke_12m | | -1.927*** | | 0.00614 | | 0.000713 |
| | | (0.541) | | (0.00405) | | (0.00303) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y |
| Observations | 38,866 | 38,866 | 45,614 | 45,614 | 45,614 | 45,614 |
| R-squared | 0.486 | 0.486 | 0.108 | 0.108 | 0.220 | 0.220 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)*, which denotes whether invested startup is eventually going public. Independent variable *wildfire_12m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 12 months prior to investment. *smoke_12m* denotes whether the ZCTA that the VC located has had heavy smoke days in the past 12 months prior to investment. ZCTA is ZIP Code Tabulation Area. Investor Group fixed effects are applied based on VCs grouped by age quantiles and by categories of the number of employees. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.4. Wildfire, Smoke and VC Investment - Keep Smaller Investments

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| wildfire_6m | -2.309*** | | 0.0135*** | | 0.000900 | |
| | (0.884) | | (0.00395) | | (0.00365) | |
| smoke only_6m | -1.872** | | 0.0116** | | -0.00257 | |
| | (0.913) | | (0.00547) | | (0.00505) | |
| wildfire_12m | | -2.708*** | | 0.00813** | | 0.00559** |
| | | (1.024) | | (0.00316) | | (0.00224) |
| smoke only_12m | | -2.477** | | 0.00489 | | 0.000376 |
| | | (0.980) | | (0.00352) | | (0.00403) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y |
| Observations | 43,714 | 43,714 | 50,462 | 50,462 | 50,462 | 50,462 |
| R-squared | 0.501 | 0.501 | 0.103 | 0.102 | 0.221 | 0.221 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes, which also includes the deal in which the investment amount is less than 1 million dollars. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.5. Wildfire, Smoke and VC Investment - Log (Investment Amount)

| | (1) | (2) |
|---|---|---|
| | Log (Investment Amount) | |
| wildfire_6m | -0.0482*** | |
| | (0.0154) | |
| smoke only_6m | -0.0331** | |
| | (0.0144) | |
| wildfire_12m | | -0.0352*** |
| | | (0.0128) |
| smoke only_12m | | -0.0348*** |
| | | (0.0121) |
| Controls | Y | Y |
| Year*Month FE | Y | Y |
| ZCTA FE | Y | Y |
| Investor FE | Y | Y |
| Observations | 38,866 | 38,866 |
| R-squared | 0.754 | 0.754 |

This table looks at the effect of wildfire and smoke on VC investment decisions, which is measured by logarithmic investment amount. The sample is at investor-deal level and the sample period is 2011–2020. The dependent variable is deal-level *Log(Investment Amount)*. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.6. Wildfire, Smoke and VC Investment - Investor Group Fixed Effects

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| wildfire_6m | -2.605*** | | 0.0118*** | | 0.00188 | |
| | (0.734) | | (0.00398) | | (0.00371) | |
| smoke only_6m | -1.792** | | 0.0118** | | -0.00243 | |
| | (0.864) | | (0.00576) | | (0.00516) | |
| wildfire_12m | | -2.932*** | | 0.00923*** | | 0.00655** |
| | | (0.790) | | (0.00338) | | (0.00269) |
| smoke only_12m | | -2.457*** | | 0.00640 | | 0.000919 |
| | | (0.911) | | (0.00416) | | (0.00435) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y |
| Investor Group FE | Y | Y | Y | Y | Y | Y |
| Observations | 38,866 | 38,866 | 45,614 | 45,614 | 45,614 | 45,614 |
| R-squared | 0.422 | 0.422 | 0.033 | 0.033 | 0.111 | 0.111 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)*, which denotes whether invested startup is eventually going public. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has had heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Investor Group fixed effects are applied based on VCs grouped by age quantiles and by categories of the number of employees. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.7. Wildfire, Smoke and VC Investment - Panel Data

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| | Mean | Sum | Mean | Dummy | Mean | Dummy |
| wildfire_12m | -0.669** | -4.033** | 0.00306*** | 0.00533** | 0.00204* | 0.00397* |
| | (0.289) | (1.719) | (0.00114) | (0.00224) | (0.00111) | (0.00236) |
| smoke only_12m | -0.620** | -3.153*** | 0.00116 | 0.00383* | 0.000780 | 0.00200 |
| | (0.314) | (1.207) | (0.00118) | (0.00208) | (0.00146) | (0.00249) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Quarter FE | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y |
| Observations | 66,700 | 66,700 | 66,700 | 66,700 | 66,700 | 66,700 |
| R-squared | 0.314 | 0.646 | 0.091 | 0.199 | 0.195 | 0.275 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes. The sample is at investor-quarter level panel and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)* , which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. The mean in Column (1) is the average amount for each investment, and the sum in Column (2) is the total investment amount. The mean in Column (3) is the proportion of investments in ESG-oriented companies, and the dummy in Column (4) denotes whether an investment has been made in an ESG-oriented company. The mean in Column (5) is the percentage of investments that are in an eventually-going-public startup, and the dummy in Column (6) denotes whether an investment has been made in an eventually-going-public startup. Independent variable *wildfire_12m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 12 months prior to investment. *smoke only_12m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 12 months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include investor level control: the number of quarterly deals; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; Weather controls: temperature, precipitation, wind speed and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.8. Frequency of Natural Disasters in the US

| Incident Type | Total Affected Counties | Events | Average Affected Counties |
|---|---|---|---|
| Fire | 3,631 | 1,565 | 2.32 |
| Earthquake | 228 | 36 | 6.33 |
| Tornado | 1,572 | 178 | 8.83 |
| Other | 307 | 32 | 9.59 |
| Flood | 10,814 | 869 | 12.44 |
| Freezing | 301 | 18 | 16.72 |
| Severe Storm | 17,737 | 1,043 | 17.01 |
| Coastal Storm | 637 | 31 | 20.55 |
| Snowstorm | 3,707 | 171 | 21.68 |
| Drought | 1,292 | 46 | 28.09 |
| Hurricane | 13,046 | 435 | 29.99 |
| Severe Ice Storm | 2,942 | 74 | 39.76 |

The data is sourced from FEMA, spanning from the year 1953 to 2023.

Table A.9. Wildfire and VC Investment - Control for Other Disasters

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| wildfire_6m | -1.244** | | 0.00674** | | 0.00219 | |
| | (0.524) | | (0.00328) | | (0.00508) | |
| other disaster_6m | 0.111 | | -0.0359 | | -0.0141 | |
| | (5.795) | | (0.0361) | | (0.0888) | |
| wildfire_12m | | -1.017* | | 0.00557** | | 0.00556* |
| | | (0.542) | | (0.00229) | | (0.00315) |
| other disaster_12m | | 2.268 | | 0.0836* | | -0.0430 |
| | | (4.732) | | (0.0455) | | (0.0821) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y |
| Observations | 38,866 | 38,866 | 45,614 | 45,614 | 45,614 | 45,614 |
| R-squared | 0.486 | 0.486 | 0.108 | 0.108 | 0.220 | 0.220 |

This table looks at the effect of wildfire and other disasters on VC investment decisions and outcomes. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *Disaster_6(12)m* denotes whether the ZCTA that the VC located has had other disasters in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Investor Group fixed effects are applied based on VCs grouped by age quantiles and by categories of the number of employees. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. Standard errors are clustered at ZCTA-level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.10. Wildfire, Smoke and VC Investment - Include NY and MA

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| wildfire_6m | -2.037*** | | 0.00670** | | 0.00296 | |
| | (0.553) | | (0.00305) | | (0.00492) | |
| smoke only_6m | -1.044** | | 0.00432 | | -0.00352 | |
| | (0.490) | | (0.00325) | | (0.00301) | |
| wildfire_12m | | -1.489** | | 0.00484* | | 0.00546* |
| | | (0.583) | | (0.00269) | | (0.00309) |
| smoke only_12m | | -0.882* | | 0.000407 | | -0.00255 |
| | | (0.528) | | (0.00281) | | (0.00283) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y |
| Observations | 53,864 | 53,864 | 62,524 | 62,524 | 62,524 | 62,524 |
| R-squared | 0.505 | 0.505 | 0.115 | 0.115 | 0.272 | 0.273 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes, including two more states: New York and Massachusetts. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and the interaction between wind direction dummy and state dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.11. Wildfire and VC Investment - First and Later Fire

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | |
| first fire_6m | -1.687*** | | 0.0103*** | | 0.00441 | |
| | (0.605) | | (0.00341) | | (0.00435) | |
| later fire_6m | -0.484 | | 0.000870 | | -0.00150 | |
| | (0.847) | | (0.00500) | | (0.00835) | |
| first fire_12m | | -1.466* | | 0.00867*** | | 0.00611** |
| | | (0.789) | | (0.00238) | | (0.00293) |
| later fire_12m | | 0.150 | | -0.00315 | | 0.00455 |
| | | (0.773) | | (0.00358) | | (0.00659) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y |
| Observations | 38,866 | 38,866 | 45,614 | 45,614 | 45,614 | 45,614 |
| R-squared | 0.486 | 0.486 | 0.108 | 0.108 | 0.220 | 0.220 |

This table looks at the effect of first and later wildfires on VC investment decisions and outcomes. The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. Independent variable *first fire_6(12)m* denotes whether the ZCTA that the VC located has been within the first wildfire impacted area in the past 6(12) months prior to investment. *later fire_6(12)m* denotes whether the ZCTA that the VC located has been within the later wildfire impacted area in the past 6(12) months prior to investment. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.12. Wildfire, Smoke and Fund Raising

| | (1) Amount_1year | (2) Amount_2year | (3) Ratio_1year | (4) Ratio_2year | (5) Amount_1year | (6) Amount_2year | (7) Ratio_1year | (8) Ratio_2year |
|---|---|---|---|---|---|---|---|---|
| wildfire_6m | -37.85 | -78.33 | 0.000342 | 0.000266 | | | | |
| | (33.42) | (59.29) | (0.000533) | (0.000345) | | | | |
| smoke only_6m | -32.56 | -13.72 | 0.000487 | 0.000678 | | | | |
| | (36.95) | (22.42) | (0.000592) | (0.000825) | | | | |
| wildfire_12m | | | | | -74.79 | -103.9 | 0.000162 | 0.000307 |
| | | | | | (61.02) | (86.65) | (0.000653) | (0.000334) |
| smoke only_12m | | | | | -69.72 | -41.06 | 0.000597 | 0.000675 |
| | | | | | (57.79) | (38.42) | (0.000939) | (0.000910) |
| Controls | Y | Y | Y | Y | Y | Y | Y | Y |
| Year*Quarter | Y | Y | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 7,368 | 6,628 | 7,368 | 6,628 | 7,368 | 6,628 | 7,368 | 6,628 |
| R-squared | 0.690 | 0.802 | 0.906 | 0.949 | 0.691 | 0.802 | 0.906 | 0.949 |

This table looks at the effect of wildfire and smoke on fund-raising. The sample is at ZCTA-quarter level and the sample period is 2011–2020. Fund raising data is from VentureXpert. In Columns (1)(2) and (5)(6), the dependent variable is *Amount 1(2) year*, which denotes the deal-level amount of raised money at ZCTA level in the next one or two years. In Columns (3)(4) and (7)(8), the dependent variable is *Ratio 1(2) year*, which denotes the ratio of money raised in that ZCTA relative to the aggregated total amount in the next one or two years in total amount. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. Controls include ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A.13. Wildfire, Smoke and VC Investment - Interaction Term for Gender

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Investment Amount | | I(ESG Startup) | | I(Startup IPO) | | I(Invest Same Sector) | |
| wildfire_6m*male | -4.426** | | -0.0178* | | -0.00123 | | 0.00585 | |
| | (1.741) | | (0.0107) | | (0.0120) | | (0.0283) | |
| smoke only_6m*male | -1.048 | | -0.0246 | | 0.00209 | | 0.0195 | |
| | (1.788) | | (0.0151) | | (0.0119) | | (0.0298) | |
| wildfire_6m | 1.689 | | 0.0274*** | | 0.000661 | | 0.0241 | |
| | (1.643) | | (0.0102) | | (0.0113) | | (0.0266) | |
| smoke only_6m | -1.340 | | 0.0330** | | -0.00534 | | -0.00244 | |
| | (2.048) | | (0.0152) | | (0.0116) | | (0.0283) | |
| wildfire_12m*male | | -4.318*** | | 0.00637 | | 0.0178 | | -0.00877 |
| | | (1.275) | | (0.0113) | | (0.0113) | | (0.0230) |
| smoke only_12m*male | | -3.092** | | -0.00313 | | 0.0177 | | 0.00497 |
| | | (1.529) | | (0.0109) | | (0.0112) | | (0.0222) |
| wildfire_12m | | 1.360 | | 0.00164 | | -0.0111 | | 0.0308 |
| | | (1.731) | | (0.0102) | | (0.0103) | | (0.0217) |
| smoke only_12m | | 0.255 | | 0.00756 | | -0.0157 | | 0.00684 |
| | | (1.749) | | (0.0103) | | (0.00995) | | (0.0206) |
| Controls | Y | Y | Y | Y | Y | Y | Y | Y |
| Year*Month FE | Y | Y | Y | Y | Y | Y | Y | Y |
| ZCTA FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Investor FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 36,796 | 36,796 | 42,845 | 42,845 | 42,845 | 42,845 | 42,845 | 42,845 |
| R-squared | 0.481 | 0.481 | 0.103 | 0.103 | 0.211 | 0.211 | 0.211 | 0.211 |

This table looks at the effect of wildfire and smoke on VC investment decisions and outcomes, conditional on whether the VC is dominated by males (50% as the threshold). The sample is at investor-deal level and the sample period is 2011–2020. In Columns (1) and (2), the dependent variable is deal-level *Investment Amount*. In Columns (3) and (4), the dependent variable is *I(ESG Startup)*, which denotes whether the invested startup is an ESG-oriented company (defined in Section 3). In Columns (5) and (6), the dependent variable is *I(Startup IPO)* , which denotes whether invested startup is eventually going public. In Columns (7) and (8), the dependent variable is *I(Invest in the Same Sector)*, which denotes whether VC has invested in this sector before. Independent variable *wildfire_6(12)m* denotes whether the ZCTA that the VC located has been within the wildfire impacted area in the past 6(12) months prior to investment. *smoke only_6(12)m* denotes whether the ZCTA that the VC located has heavy smoke days but has not been within the wildfire impacted area in the past 6(12) months prior to investment. *Male* denotes whether the proportion of male people in the VC is higher than 50%. ZCTA is ZIP Code Tabulation Area. Controls include deal level controls: VC's age, employment size, and investment round; ZCTA-level economic controls: log form of number of establishments and total payroll at the ZCTA level; weather controls: temperature, precipitation, wind speed, and wind direction dummy. The standard errors clustered at ZCTA-level are displayed in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.