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Wildfire cashflow shocks

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Abstract

This paper studies the impact on cashflows and financial decisions of firms affected by wildfires, focusing on the wildfires that occurred in Portugal in 2017. Using establishment-level data from the hotel industry combined with geospatial information on wildfire proximity and land use, we employ a difference-in-differences approach to study both directly and indirectly affected firms. Our findings reveal that firms with direct damages from the wildfires recorded, on average, a 43% drop in revenues in 2018, while indirectly affected firms with a high share of burned area within a 1 km radius suffered a 24% drop. These cashflow shocks triggered distinct financial responses: directly affected hotels increased their reliance on long-term debt and coupled tangible asset investments with additional cash reserves, whereas indirectly affected firms reduced tangible investments and cash holdings. This divergence aligns with both real-options and reference-dependent risk preferences theories, reflecting the option to wait before investing and the shift in business fundamentals relative to the pre-disaster reference points.

JEL classification: G30; G31; G32; G38.

Keywords: climate risk, ecosystem risk, indirect effects, financial decisions.

Non-technical Summary

Wildfires are becoming more frequent and severe as the climate warms, and this trend poses growing challenges for businesses, especially in regions where economic activity depends on natural ecosystems. The 2017 wildfires in Portugal were an extreme example: more land was burned during this event than in any other year in a European country and caused substantial human and economic losses. Tourism, a key sector for Portugal and many other southern European economies, was heavily exposed. Understanding how such disasters affect firms' cashflows and financial decisions is therefore important for assessing economic resilience and for informing policies aimed at strengthening preparedness for climate-related shocks.

This paper studies how hotels in the Centre Region of Portugal were affected by the 2017 wildfires, distinguishing between firms that suffered direct physical damage and those indirectly affected through the destruction of surrounding landscape and natural ecosystems. Using detailed establishment-level data covering 2015–2019, combined with geospatial information on wildfire proximity and land use, the analysis compares affected and unaffected firms through a difference-in-differences approach supported by propensity-score matching. This allows us to isolate the impact of the wildfires on revenues, costs, cashflows, and key financial decisions such as debt structure, cash holdings, and investment in tangible assets.

The results show that the wildfires generated large and immediate cashflow shocks. Hotels with direct physical damage experienced a sharp drop in revenues in 2018 (around 43%), while indirectly affected hotels located near burned areas also saw sizeable revenue losses (around 24% for those with high local burn intensity). These disruptions translated into short-term cashflow declines for both groups, despite cost-cutting efforts and government support measures that helped cushion the impact for directly affected firms.

The financial responses of firms differed markedly depending on the nature of their exposure. Directly affected hotels increased their reliance on long-term bank debt, reinvested in tangible assets, and accumulated cash reserves. These patterns are consistent with firms needing to restore damaged capacity and securing liquidity to manage uncertainty. By contrast, indirectly affected hotels reduced investment in tangible assets and lowered cash holdings, while only marginally increasing short-term debt. This divergence may reflect two underlying mechanisms. First, firms without physical damage retain the option to delay irreversible investment until uncertainty about demand recovery and landscape restoration diminishes, making "waiting" a valuable strategy. Second, behavioural factors matter: firms suffering direct losses appear to take on more risk to recover their previous performance, while those less severely affected behave more cautiously.

These findings have several policy implications. First, the economic impact of wildfires extends beyond firms that suffer direct physical damage. Indirectly affected hotels also face meaningful revenue losses and higher operating costs, suggesting that targeted financial support may be warranted when clear channels of impact can be established. Second, the results further highlight the growing importance of physical climate risks for firms' financial resilience, especially in a context where insurance coverage may become more limited and public budgets more constrained. Finally, the findings underscore the value of investing in wildfire prevention and in the restoration of natural amenities, as damage to landscape and tourist attractions can generate sizeable indirect economic losses for local communities.

1. Introduction

Climate change is expected to increase both the frequency and severity of natural disasters (Abatzoglou & Williams, 2016; IPCC, 2021), with wildfires posing growing challenges to businesses in high-risk regions[1]. In some future climate scenarios, insurers may refuse to underwrite certain risks or impose prohibitively high premiums, while governments could face fiscal constraints that limit their ability to continuously subsidize businesses affected by such disasters (FT, 2024; Guardian, 2024). Hence, although physical risks may not yet be perceived as an immediate priority for businesses and creditors – particularly when compared to transition risks – regulatory and supervisory pressures to incorporate climate-related risks into investment and financing decisions have intensified since the 2015 Paris Agreement (NFGS, 2019).

In this context, our study seeks to contribute to the growing body of finance literature that examines the impact of natural disasters on firm performance and subsequent financial decision-making (Collier *et al.*, 2020; Brown, 2021; Roth Tran, 2023; Addoum *et al.*, 2023). Specifically, we aim to estimate both the direct and indirect effects of natural disasters – wherein, according to the literature, the indirect effects, which include the loss of amenities (ecosystem services), such as wildlife and national parks, are considered "less tangible and extremely difficult to quantify" (Thomas *et al.*, 2017: p.39). These indirect effects can be even more material than the direct effects (Wang *et al.*, 2020)[2].

To address this challenge, we focus on the context of the 2017 wildfires in Portugal to examine their effects on cashflows and financial decisions of affected firms operating in the hotel industry. Portugal is a country highly vulnerable to wildfires (Alogoskoufis *et al.*, 2021; Meier *et al.*, 2023), with wildfires recognized as its most significant climate-related physical risk (BdP, 2023, 2024). In 2017, wildfires in Portugal burned almost 540,000 hectares of land,

[1] There is growing consensus that climate change has intensified wildfire frequency and severity. Abatzoglou & Williams (2016) document that from 2000 to 2015, the area of US forests experiencing high fire season fuel dryness increased by 75%, adding nine more high fire risk days per year. Although globally burned areas have declined, this trend largely reflects agricultural expansion into savannahs and grasslands (Smith *et al.*, 2020). In contrast, forest wildfire activity has increased in regions like the western US and southeast Australia. In Europe, while average burned area in wildfire-prone countries (France, Greece, Italy, Portugal, Spain) fell from 509,000 hectares (1981–2000) to 358,000 hectares (2001–2020), the most extreme fire years (e.g., 1985, 2003, 2017) remain spread across decades, suggesting persistent risk.

[2] Effectively, Wang *et al.* (2020) estimate that up to 59% of the economic impacts of California wildfires in 2018 can be attributed to indirect effects related to supply-chain disruptions.

resulted in more than 100 fatalities, and incurred an estimated financial cost of 1 billion euros (Aon, 2018). This event represents the largest annual burned area per country ever recorded in Europe (EEA, 2021). At the sectoral level, tourism – a sector that is both highly exposed to wildfires and strategically important to Portugal – was significantly affected by the 2017 fires (Otrachshenko & Nunes, 2022; Neger *et al.*, 2024). While our study is rooted in a specific context, its insights extend more broadly. Tourism has strong linkages with other sectors (Khanal *et al.*, 2014) and plays a key role in local development (Faber & Gaubert, 2019), amplifying the economic relevance of our setting. Moreover, the region's simultaneous dependence on tourism and high vulnerability to wildfires offers valuable lessons for similar contexts worldwide[3].

In order to precisely identify firm-level effects, we construct a unique dataset matching the establishment-level location of hotels (obtained via Tourism of Portugal), geolocational data on wildfires (Institute for Nature Conservation and Forests), firm-level government support (Centre Region public development entity), and geographic and land-use information (Portuguese Directorate-General for Territory) – spanning the period between 2015 and 2019. Additionally, we identify the firms operating each hotel and match it with financial statements data at the firm-level. Overall, we employ a standard differences-in-differences method wherein, to allow for a meaningful identification of the wildfire effects, we (i) employ a set of criteria to the sample related to location, firm characteristics, and data availability, (ii) apply a set of proximity-based measures to distinguish between directly and indirectly affected hotels and (iii) implement propensity score matching (PSM) to find a suitable sample of comparable firms. Based on this setting, we investigate the impact of the wildfires on financial decisions of affected hotels, including their debt structure (short- vs long-term debt), trade credit, cash holdings, and tangible asset investment. Finally, we perform a set of robustness checks related to the sample (e.g., excluding hotels exposed to pre-2017 fires) as well as the radius threshold used to identify indirectly affected hotels.

[3] Focussing on Europe, the list of countries highly exposed to wildfires includes Greece, Spain, Italy, and France (Alogoskoufis *et al.*, 2021), all of which also record a significant contribution of the tourism sector to GDP: 7.3%, 6.8%, 5.7%, and 4.0%, respectively – which compare with 8.3%, for Portugal (UNWTO, 2024).

We find that directly affected hotels experienced a significant persistent drop in operating revenues following the 2017 wildfires, with a peak of -42.9% in 2018 for hotels with direct damages. These hotels responded by reducing operating costs, particularly staff expenses and external supplies, but such adjustment was insufficient to prevent a cashflow drop in 2018 (-14.0% for hotels with direct damages) – in line with the empirical literature that documents a negative short-term effect of natural disasters on the turnover of affected firms (Collier *et al.*, 2020; Pankratz *et al.*, 2023; Roth Tran, 2023; Addoum *et al.*, 2023; Kong, 2023). This short-term nature of the drop in cashflows is robust across various proxies, while the partial buffering of revenue effects on cashflow could be explained by extensive support measures implemented by the Portuguese government to assist directly affected businesses in the aftermath of the disaster.

Additionally, our findings indicate that indirectly affected hotels also faced a short-term cashflow disruption (-4.9% in 2017 and -6.2% in 2018), which reflects the drop in operating revenues. In 2019, we observe a recovery of revenues which is offset by higher operating costs (+5.1%), largely driven by increased external supply costs. In examining channels through which indirect effects could manifest – landscape destruction and damages to nearby tourist attractions – we find evidence supporting the former, wherein hotels with above median share of burned area in a 1 km radius recorded a decrease of 24.0% in revenues in 2018.

In terms of financial decision making, our results suggest that directly affected hotels responded by increasing their reliance on long-term bank debt (2017: +3.5 pp and 2018: +3.2 pp) and actively managing their working capital. At the same time, directly affected hotels used their funds in a mix of policies: they reinvested in tangible fixed assets (+12.3 pp) and increased cash holdings by 1.5 pp – consistent with the empirical evidence suggesting that in the wake of disasters affected firms turn to debt financing (Cortés *et al.*, 2014; Koetter *et al.*, 2020; Ivanov *et al.*, 2022) to fund recovery capital expenditures (Rao *et al.*, 2022), while also increasing precautionary cash holdings (Huang *et al.*, 2018; Javadi *et al*., 2023; Gounopoulos & Zhang, 2024). By contrast, indirectly affected hotels opted to increase only slightly short-term bank debt and manage working capital, and hence the cashflow effects in 2017 (-7.4%) roughly correspond to the decrease in both tangible assets and cash holdings.

The findings in this paper offer contributions to three strands of the finance literature. The first strand is related to natural disasters and firm cashflows and includes the study of cashflow effects stemming from a variety of acute climate events including severe snow fall (Brown, 2021), heatwaves (Pankratz *et al.*, 2023; Roth Tran, 2023), floods (Noth & Rehbein, 2019), hurricanes (Collier *et al.*, 2020), and wildfires (Addoum *et al.*, 2023). Most developments in this area have focused exclusively on first-order effects of the disasters, i.e., direct damages to affected firms. In our paper we complement this strand by providing evidence on the indirect effects of wildfires. In this regard, the paper closest to ours is by Addoum *et al.* (2023), as it investigates the effects of wildfire exposure on sales –a context in which air quality can be seen as an ecosystem service. Using high frequency sales data for the US, the authors find that local businesses lose around 10% of sales on days of intense wildfire smoke. Our paper differs from Addoum *et al.* (2023) in two main ways. First, our approach allows us to differentiate between direct effects (i.e., direct damages to the hotels) and indirect effects (i.e., damages to the landscape surrounding the affected businesses). Secondly, by focussing on fire damage rather than smoke, we enter the discussion regarding firms' investments decisions in tangible fixed assets – allowing us to test the predictions of real options theory (McDonald & Siegel, 1986; Cooper & Priestley, 2011) and reference-dependent risk preferences theory (Kőszegi & Rabin, 2007) – and relatedly decisions on debt, working capital, and cash holdings.

Secondly, we aim to contribute to the growing strand of the literature related to ecosystem risk. Our results concerning the indirect effects of wildfires on hotels via the destruction of nearby landscape can be framed as the loss of an ecosystem service, i.e. a benefit that firms derive from natural ecosystems (Pereira *et al.*, 2021). In a similar way, the poor air quality induced by the smoke from wildfires, tested by Addoum *et al.* (2023) and Kong (2023), can be framed as a loss of an ecosystem service (Pereira *et al.*, 2021) that is particularly relevant for some types of businesses. In our paper we extend this line of research to another ecosystem service (nature and landscape) which, when impacted, takes longer to restore, and can therefore also affect firms for longer. This may also have implications for the literature on biodiversity risk (Giglio et al., 2023) and biodiversity finance (Karolyi & Tobin-de la Puente, 2023; Flammer *et al.*, 2025).

The third strand we wish to contribute to delves into how firms affected by severe exogenous nature-related shocks (e.g., natural disasters, climate risk perception) react in terms of financial and real decision-making. Namely, works in this area explore the effects of such shocks on firms' access to debt (e.g., Collier *et al.*, 2020; Huang *et al.*, 2022), their cash-holdings (Gounopoulos & Zhang, 2024), investment decisions (Rao *et al.*, 2022; Wang, 2022) and entry and exit decisions (Addoum *et al.*, 2023). In this domain, our work follows the approach taken by Huang *et al.* (2018), who study a global sample of listed firms and find that the country-level exposure to severe weather is associated with higher cash holdings (to build financial slack), less short-term debt and more long-term debt. While we use a similar scope of dependent measures in this paper, the fact that we pinpoint the establishment-level exposure to the shock and adopt a narrow focus in terms of extreme event (wildfire), industry (hotel) and country (Portugal), allows us to make a notable contribution to the literature in terms of identification/causality.

The remainder of the paper is organised as follows. In **Section 2** we present the literature review with an emphasis on the conceptual framework and empirical works relating physical climate risk and firms' cashflows and financial management. Next, **Section 3** documents the context of 2017 wildfires and the tourism sector in the Centre Region of Portugal. **Section 4** describes the data and methodology used to identify affected and non-affected hotels and assess the impact of the wildfires on the cashflows of hotels. In **Section 5** we present and discuss the results. **Section 6** provides several robustness checks and additional analyses, and **Section 7** summarizes the main conclusions of the paper and derives some policy implications. This paper is accompanied by an appendix.

2. Literature review

2.1. Conceptual framework

Following the framework laid out by the BCBS (2021), firms' exposure to physical climate risks lies in the possibility of facing losses due to the exposure to acute or chronic climate hazards, such as wildfires, heatwaves, floods, storms (acute), droughts, landslides, and sea level rises (chronic)[4]. Such exposures can lead to first-order impacts on the firms' activities and assets (direct exposure) or second-order effects via the firms' relationships with stakeholders or reliance on assets that are beyond their boundaries (indirect exposure), such as natural resources and energy, telecommunication, and transportation systems (Mazzacurati *et al.*, 2018).

In the face of an increased frequency and severity of extreme weather and climate events (IPCC, 2021), larger firms in Europe are now required to assess the materiality and disclose their exposure to physical climate risk[5], and provide adaptation plans and measures, if deemed material (e.g., using wildfire resistant materials, changing to elevated locations in flood-prone areas, and implementing underground power lines in high wildfire risk areas). This aligns with Linnenluecke & Griffiths (2010), who argue that firms can become resilient to physical climate risks by adopting managerial practices that allow them to systematically anticipate, absorb, accommodate and recover from acute climate events.

2.2. Physical climate risk and firms' performance

Recent literature has focused on the impact of a variety of extreme weather events on the performance of firms. In general, the findings suggest that acute physical events negatively impact firms' sales and cashflows, but effects vary by hazard and context. Snowfall reduces daily sales of outdoor outlets by 10-20% (Roth Tran, 2023) and raises operating costs (Brown *et al.*, 2021). Heatwaves lower short-term operating income (-1.3% per SD increase in hot days) (Pankratz *et al.*, 2023). Moreover, 82% of SMEs affected by 2012 Hurricane Sandy in New York reported revenue losses, largely due to customer displacement and asset damage (Collier *et al.*, 2020). Floods and rainfall variability produce mixed effects: while some firms benefit from capital upgrading in developed economies (Noth & Rehbein, 2019), sectoral shifts likely drive this pattern, and broader studies show affected firms suffer persistent sales declines (-3.3 pp and -4.5 pp in the first and third post-event quarters) (Barrot & Sauvagnat, 2016).

[4] The BCBS (2021) also includes earthquakes as examples of acute events (Hosono *et al.*, 2016; Cainelli *et al.*, 2018; Wang, 2022). In this paper, however, we focus exclusively on weather-related acute physical events.

[5] For instance, under the Corporate Sustainability Reporting Directive (CSRD), firms are since January 2023 required to report their exposure to physical risks.

Additionally, Indian firms sensitive to excess or deficit rainfall exhibit lower market-to-book ratios post-monsoon (Rao *et al.*, 2022).

Specifically for wildfires, Addoum *et al.* (2023) and Kong (2023) study the impact of wildfire smoke on the sales of affected firms. Addoum *et al.* (2023) document that a one standard deviation increase in the fraction of smoke days reduces establishment's annual sales by ca. 0.3%, and such effect is seen to be twice as strong for consumer-oriented establishments. Kong (2023) performs a similar analysis but using firms' headquarters. Both studies provide important evidence on the second-order effects of wildfires on businesses. As we review below, one can think of air quality as an ecosystem service (Pereira *et al.*, 2021) that is particularly relevant for some types of businesses. In our paper we aim to extend this line of research to another ecosystem service (nature and landscape).

In general, this strand of the literature showcases the importance of hazard and context specific information, the existence of a gap in the literature on firms' exposures to physical risks in Europe, and the need for high quality microdata, preferably at the establishment-level, to get a good estimate of cashflows effects of physical risks.

2.3. Physical climate risk and firms' financial decisions

When firms are exposed to cashflow shocks, this can require them to take relevant financial decisions, for instance related to the choice of (i) debt amount and maturity, (ii) cash-holdings and (iii) investment in tangible assets. For each of these decisions, we provide a brief overview of theoretical literature and empirical works focused on physical climate risk as the trigger for firms' financial decisions.

2.3.1. Debt

Regarding debt decisions, Diamond (1991) posits that firms with higher liquidation risk will tend to contract long-term debt to fend off short-term liquidity concerns. In a similar vein, Custodio *et al.* (2013) argue that firms with more short-term debt face more frequent renegotiation and are therefore more likely to be affected by a credit supply shock. On the other hand, Ivanov *et al.* (2022) propose that firms affected by natural disasters may use short-term debt to bridge short-run liquidity needs that can be overcome with delayed insurance payouts or government aid.

Overall, the empirical evidence suggests that firms often turn to debt financing in the wake of disasters, seeking liquidity to rebuild and recover (Cortés *et al.*, 2014; Koetter *et al.*, 2020; Ivanov *et al.*, 2022). Effectively Cortés *et al.* (2014) provides evidence that the Federal Deposit Insurance Corporation (FDIC) actively encourages banks to provide emergency lending to affected firms and offers regulatory relief for such banks. As a result, credit flows more freely to impacted firms, with lending growth increasing by 0.1 percentage points relative to non-affected firms—equivalent to a 10% rise over the average lending growth. Similarly, Ivanov *et al.* (2022) find that for each 1% increase in hurricane-related damages per resident at the county level in US, credit commitments rise by 40 basis points. In the same line, Koetter *et al.* (2020) show that firms with headquarters in regions affected by the 2013 German floods increased their corporate borrowings by 16%.

There is, however, less consensus in the literature regarding debt maturity choices (Collier *et al.*, 2020; Huang *et al.*, 2019). On the one hand, 77% of surveyed SMEs affected by Hurricane Sandy in 2012 reported having resorted to additional debt financing. Among the most frequent financing needs include meeting short-term operating expenses (34%) as well as longer term needs such as capital investments (11%) and responding to changing customer demands (10%) (Collier *et al*., 2020). On the other hand, focusing on firms' self-reported climate risk exposure, Huang *et al.* (2018) find that a one SD increase in exposure leads to a -1.5 pp decrease in short-term debt and an +1.9 pp increase in long-term debt[6].

2.3.2. Cash-holdings

According to Opler *et al.* (1999), firms hold cash for two main reasons. First, excess cash allows firms to mitigate transaction costs faced when raising new funds, reducing the likelihood of

[6] Another potential issue is access to debt, namely if the banks are also exposed to affected firms (Berg & Shrader, 2012; Koetter *et al.*, 2020). For instance, Berg & Shrader (2012) study the credit applications of SMEs in the aftermath of a severe volcano eruption in Ecuador in 2006 and find that just after the eruption there is a drop in demand (1 month) followed by a significant increase 3 months after – which is interpreted as entrepreneurs needing some time to adjust after the eruption before asking for new credits. Approval rates, however, seem to decrease, suggesting that access to credit was negatively influenced by this event, although less so for existing bank customers.

having to sell assets to make payments (transaction cost motive). Second, firms can use liquid assets to finance their activities and investments whenever other funding sources are not available (precautionary motive). On the other hand, excess cash can be a sign of agency costs, as managers tend to have a greater preference for cash given that it reduces firm risk (quiet life hypothesis) and increases discretionary use (empire building and private benefits for managers) (Jensen & Meckling, 1976; Bates *et al.*, 2009).

The existing empirical literature unanimously associates physical climate risks to increased cash holdings (Huang *et al.*, 2018; Javadi *et al.*, 2023). Namely, Huang *et al.* (2018) document a 9.1 pp increase in the ratio of cash holdings to lagged assets as a result of a one SD increase in climate risk exposure. Similarly, a change from the bottom to the top quartile of drought trend[7] is seen to increase firms' cash holdings by 0.61% (Javadi *et al.*, 2023). Lastly, there is evidence that a one SD increase in the temperature trend leads to an increase in cash holdings, especially among financially constrained firms (Gounopoulos & Zhang, 2024).

2.3.3. Investment in tangible assets

In the aftermath of extreme weather events, managers of firms exposed to physical climate risks face crucial investment decisions under uncertainty (Fine & Freund, 1990), requiring them to determine whether to expand or delay investments based on prevailing conditions. We frame this decision under three alternative conceptual frameworks: the risk shifting perspective, the real options approach, and reference-dependent risk preferences theory.

According to the traditional risk-shifting perspective, firms experiencing financial distress due to extreme weather may pursue riskier investments (Black & Scholes, 1973), as the potential upside disproportionately benefits shareholders, leading managers to shift from safer to riskier assets in response to uncertainty (Jensen & Meckling, 1976). However, such traditional view does not fully capture the heterogeneity of investment responses across different physical risk conditions. In contrast, the real options approach suggests that some firms may have the option to delay investment decisions, and this option is valuable when (i) investments are irreversible

[7] Javadi *et al.* (2023) compute the drought trend as "the yearly average of time coefficient (times −1000) from an augmented AR(1) model using country-level monthly frequency historical Palmer Drought Severity Index (PDSI) data extending back to 1900 from a point of time." (p.294).

and (ii) uncertainty is high (McDonald & Siegel, 1986; Cooper & Priestley, 2011). Specifically in the context of hotels exposed to severe weather disruptions, we argue that, for firms that are not directly damaged (i.e., they do not depend on new CAPEX to operate as usual), the value of waiting can be non-trivial given that (i) hotel investments are location-specific, and hence difficult to reverse and (ii) post-disaster demand recovery as well as the reconstruction of landscape and natural capital is uncertain, and hence waiting for more information is valuable. On the other hand, managerial decision-making under climate-related shocks can also be framed from a behavioural perspective, drawing on reference-dependent risk preferences theory (Kőszegi & Rabin, 2007). According to this theory, managers evaluate outcomes relative to a reference point – such as pre-disaster performance – and exhibit different risk attitudes depending on whether they perceive themselves to be in a domain of gains or losses. When extreme weather events, like wildfires, push firms into a perceived loss domain (e.g., demand drops significantly due to direct damage placing the hotel's performance below what it used to be or its previously forecasted performance), managers may become more risk-seeking in an effort to recover. Conversely, firms that remain in the gain domain may exhibit increased risk aversion, opting to preserve value amid uncertainty (Barberis, 2013). This implies that firms facing physical climate risks may exhibit heterogeneous investment behaviours, not solely based on objective damage, but on how the shock alters their perceived position relative to prior expectations.

The only empirical paper studying the effects of acute physical risk on investment decisions regarding tangible fixed assets is by Rao *et al.* (2022)[8] – who find that firms in industries that are sensitive to excess (deficit) rain-sensitive increase (decrease) CAPEX by approximately +3.4% (-3.2%) when exposed to excess (deficit) rainfall. The authors link their results to the salience theory of choice under risk (Bordalo *et al.*, 2012), according to which managers may overweight the most salient features of outcomes when assessing different options (e.g., investment vs divestment) and/or may undervalue non-salient but relevant information, potentially leading to systematic biases in risk-taking. In our view, the key aspect of decision-making after extreme weather events (e.g., excess/deficit rainfall, large wildfires) is not the

[8] Most empirical papers studying the effects of natural disasters on investment decisions focus on earthquakes (Hosono *et al.*, 2016; Wang *et al.*, 2022), falling outside the scope of this review.

potential for salience-induced biases, but rather the change in risk appetite linked to (i) a shift in the business fundamentals relative to the pre-disaster reference points (Kőszegi & Rabin, 2007) and/or (ii) the option to wait before making irreversible investments (McDonald & Siegel, 1986).

2.4. Wildfires, economic activity and the tourism sector

According to Thomas *et al.* (2017), wildfire losses can be classified as direct – such as damage to hotel infrastructure, forests, and agriculture – and indirect, encompassing business closures, workforce dislocation, and disruption of supply chains and public infrastructure. Indirect effects also include losses of ecosystem services (e.g., parks, wildlife), which are harder to quantify but may have significant economic consequences. These losses can severely affect local economies, especially when amenities are central to tourism and recreation.

At the regional level, empirical evidence suggests that wildfires can reduce regional GDP and employment, particularly in sectors like tourism. Meier *et al.* (2023), examining Southern Europe (2011–2018), find wildfire-affected regions experienced GDP declines of 0.11–0.18% during fire years, with a rebound the following year – highlighting the short-term nature of these effects. Impacts vary by sector: tourism-related sectors (e.g., retail, accommodation, restaurants) suffer losses, while financial and business services may see gains. In the US, studies on the 2008 Trinity County wildfires (Moseley *et al.*, 2012; Davis *et al.*, 2014) report declines in private-sector jobs – especially in hospitality and recreation – offset by increases in public-sector employment due to fire-related forestry services[9]. Business owners emphasized the seasonality of the damage, noting losses concentrated during the peak summer months, which are critical for profitability. Wang *et al.* (2020) estimate the 2018 California wildfires cost about 1.5% of the state's GDP, with 59% of losses stemming from indirect supply chain disruptions, underlining the broader economic ripple effects. Similarly, Wang & Lewis (2024) show that

[9] We note that Nielsen-Pincus *et al.* (2013) find evidence suggesting that post-fire employment increases at counties more specialized in recreation activities located in non-metropolitan areas. One possible reason for such contradicting results may lie in the fact that the authors do not differentiate between sectors of activity. As documented by Davis *et al.* (2014) the increase in employment in the natural resources sector seems to be several times larger than the drop in tourism related employment.

the economic value of timberland is more severely impacted by changes to risk perceptions than by direct property damages.

Despite regional studies showing negative impacts on tourism, the literature on firm-level impacts is characterized by mixed effects. On one hand, tourism may decline due to damaged infrastructure, risk perception, or destination de-marketing. On the other hand, some regions may attract visitors' post-disaster due to media attention, humanitarian presence, or 'dark tourism' (Foley & Lennon, 1996). Overall, evidence leans toward negative impacts. Kim & Jakus (2019) find that Utah's national park visitation declined by 0.5–1.5% during fire years[10]. Otrachshenko & Nunes (2022) show that in Portugal (2000–2016), a 1% increase in burned area reduced domestic tourist arrivals by 3.5% and international arrivals by 1.1% in the year of the fire and the year after[11]. Rossello *et al.* (2020) estimate that wildfires reduce tourist arrivals by 3% per $100 million in damages, ranking second only to volcanic eruptions in tourism-related losses. Other studies highlight the role of safety concerns and cancellations: Thapa *et al.* (2013) note fire and smoke risks as major reasons for trip cancellations, particularly among more cautious tourist profiles. Butry *et al.* (2001), studying the 1998 wildfires in Florida, find that tourism sales dropped significantly in affected counties in the month following the fires[12]. Firm-level evidence is limited[13] but instructive. Gellman *et al.* (2022) analyse daily reservations at six US campgrounds (2008–2017), finding that nearby active fires reduce occupancy by 6.4 percentage points and significantly increase cancellations. These effects highlight how wildfire proximity and smoke conditions directly affect business operations.

In sum, the literature confirms that wildfires, exacerbated by climate change, pose meaningful risks to regional development – particularly in tourism-dependent areas. While the regional-

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[10] Similarly, Hesseln *et al.* (2003) find that the number of visitors to national parks in New Mexico significantly decreased as a function of the share of burned area. For instance, the average number of visits by hikers (bikers) declines from 1.9 (2.1) visits per year of sites with no burned area to 0.5 (0.5) visits for sites with 85% burned area.

[11] Regarding the profile of visitors across Portuguese regions, in 2016, domestic tourists accounted for 58.1% of stays in hotels located in the Centre Region, whereby the rest of the regions in Portugal were less reliant on domestic visitors (26.3%).

[12] Mercer *et al.* (2000) study the same wildfire event as Butry *et al.* (2001) and arrive at similar results.

[13] Adjacent to the topic of tourist expenditures, we note that Hunt *et al.* (2005) study the impact of wildfire nearby fishing sites on the pricing of fishing packages. The authors find that the share of burned area within a 3 km radius of the lake did not affect the prices of the operators in that region.

level impacts are better documented, evidence at the firm level remains scarce. Recent research on ecosystem services and firm activity (e.g., Pereira *et al.*, 2021) [14] also points to a growing interest in micro-level effects, suggesting an important gap this paper aims to address.

3. Empirical context: the 2017 Wildfires in Portugal

Portugal is considered a high-risk country for wildfires (Alogoskoufis *et al.*, 2021; Meier *et al.*, 2023), with wildfires identified as the country's most significant climate-related physical risk (BdP, 2023, 2024). Between 1980 and 2020, Portugal recorded the highest average annual share of burned area in Europe over the entire period (1.24%, 4 times the share of the second most affected country, Spain) and suffered the largest share of yearly burned area in 32 of the 40 years in this period (including 9 of the 10 highest shares of burned area per country[15]). Panel A of **Figure 1** shows the geographical distribution of the wildfire susceptibility score[16] in Portugal – the measure used by the Institute for Nature Conservation and Forests (ICNF) to monitor wildfire risk. A visual inspection of the map indicates that a significant portion of the territory had a high or very high wildfire risk in 2016, just before the major wildfires we examine in this paper.

[Figure 1 near here]

Nonetheless, the fallout of the wildfire season in 2017 stands out as an extreme anomaly, marked by unprecedented impacts: a total area burned of 539,921 hectares (JRC, 2018) – the largest yearly burned area per country in Europe ever recorded (EEA, 2021) and representing around 5.9% of total land area in Portugal, alongside estimated physical damages amounting to

[14] Given the finance scope of this paper, we avoid entering the highly technical strand in the ecology literature that studies the impact of wildfires on the provision of ecosystem services (Cutter *et al.*, 2003; Palaiologou *et al.*, 2019; Pausas & Keeley, 2019; Pereira *et al.*, 2021; Pozo-Antonio *et al.*, 2020; Vukomanovic & Steelman, 2019)

[15] The 10 years with the highest shares of burned area in Europe per country between 1980 and 2020: (#1) 2017 Portugal (5.9%), (#2) 2003 Portugal (4.6%), (#3) 2004 Portugal (3.7%), (#4) 1991 Portugal (2.0%), (#5) 1995 Portugal (1.8%), (#6) 2016 Portugal (1.8%), (#7) 2000 Portugal (1.7%), (#8) 1998 Portugal (1.7%), (#9) 2007 Greece (1.7%), (#10) 2013 Portugal (1.7%).

[16] The wildfire susceptibility score can take on values between 0 (no risk) and 5 (very high risk). The computation of this metric accounts for several widely used inputs in wildfire analysis: "elevation, slope, land cover, average annual rainfall, average number of days with minimum temperature ≥20◦C, and past burn scar mapping (which was transformed into simple probability)" (Verde & Zêzere, 2010: p.486).

1 billion euros[17] and over 100 fatalities (Aon, 2018). The wildfires were concentrated in two periods: June to August, which accounted for 41.0% of the total burned area (221,318 hectares) and October[18], contributing to 53.5% (289,124 hectares). Also, as shown in panel B of **Figure 1**, which depicts the geographical distribution of the fires, the Centre Region, covering 30.6% of Portugal's total area, was disproportionately affected, with 78.7% of the total burned area (424,960 hectares). Within this region, 14.9% of the total area was burned and 17 municipalities experienced wildfires that consumed more than 50% of their total area[19].

Regarding the economic impacts of the 2017 wildfires, we note the following:

– *Physical damages to firms' infrastructures*. 587 firms submitted applications for government support[20], resulting in a total approved amount of 115 million euros; of these, 140 industrial firms were analysed in detail by Viegas *et al.* (2019), who concluded that almost half of the firms experienced complete destruction. Additionally, aggregate insurance data collected by the Portuguese Association of Insurance Companies (APS) indicate that, by July 2018, insurance companies had paid 127.5 million euros to firms affected by the 2017 wildfires and recorded additional provisions of 73.2 million euros[21]. Furthermore, local news reports indicate that the wildfires had a significant impact on the activity of hotels and local businesses due to their impact on

[17] Despite the unprecedented scale of the burned area in the 2017 wildfires, the estimated damages are lower than the costs of previous wildfires in the country. According to data from the international disaster database EM-DAT, curated by the Centre for Research on the Epidemiology of Disasters, the wildfires of 2003 and 2005 in Portugal led to estimated damages of 1.73 and 1.65 billion euros, respectively. Plus, two other wildfires have had greater losses since 2000 in Europe: Spain in 2005 (2.1 billion euros) and Greece in 2007 (1.75 billion euros).

[18] The Drought Index and the Fire Weather Index suggest that the 14-17 October 2017 wildfires in PT were strongly induced by extreme climate conditions. According to the 'climate change attribution' literature (Abatzoglou & Williams, 2016), such features suggest that the 2017 wildfires can be attributed to human-induced climate change.

[19] The three municipalities with the highest share of burned area in 2017 were Oliveira do Hospital (98%), Pedrógão Grande (76%) and Santa Comba Dão (75%).

[20] Three government programs were put in place to support the recovery of productive firms: REPOR (promoted by the Regional Coordination and Development Commission, CCDR), the CENTRO-53-2017-47 (organized by the CCDR Centre Region, under the Portugal 2020 framework, designed to support SMEs affected by the June 2017 wildfires) and MAFDR-PDR2020-6.2.2 (set up by the Ministry of Agriculture, Forests and Rural Development, under the 2020 Rural Development Plan).

[21] If we consider the Aon (2018) estimate of 1 billion euros of damages from the 2017 wildfires, the insured losses represent approximately 12.8% (or 20.1%, with provisions), which is in line with the estimate of 10% of historical insured losses from extreme weather events in Portugal, according to an ECB and EIOPA staff paper (Benalal *et al.*, 2023).

the surrounding nature[22] (NdC, 2018), and that such impacts seem to have endured well into 2018 (Publico, 2018);

- *Roads and motorways*. Several roads were closed due to tree falls and the proximity of the fire, but not for long; the monthly statistics on road traffic per highway section do not show significant change, even in the highway sections most affected by each fire (IMT, 2025). For instance, the A13 highway, which crosses the Centre Region, and which was temporarily closed both in the June and October fires, showed a 10% and 14% increase in monthly traffic, relative to the previous year; in addition, Portugal is characterized by a high road and motorway network density (OECD, 2013);
- *Air quality*. According to the Portuguese Environment Agency (APA), the quality of air in 2017 was not materially different from 2016, despite the large wildfires (APA, 2017). More precisely, daily air quality data retrieved from 9 weather stations located in the Centre Region of Portugal, show that the PM_{10} (i.e., number of particles with diameter below 10 µm) was significantly above (twice) the yearly average only on 3 days of the largest fires (i.e., October 15th till 17th) – according to Augusto *et al.* (2020) a potential reason for the short-term presence of particles in the air may be attributed to the strong winds that affected Portugal in this period, due to the Ophelia tropical storm;
- *National Parks (NP) and Special Regime Forests (SRF).* A total of 12 NPs and 88 SRFs were affected, with a total burned area of 112,6 thousand ha of NPs/SRFs, representing 14,0% of the total area of the affected NPs/SRFs and 9,1% of total area of all NPs/SRFs in Portugal; the most affected NPs/SRFs were all located in the Centre Region: National Forest of Leiria (86% burned, 9,500 hectares), NP/*SRFs* of Serra da Estrela (26%, 30,900 hectares), SRFs of Pedrogão Grande and Pampilhosa da Serra (75.6%, 6,700 hectares) and Serra da Gardunha (52,4%, 5,500 hectares).

[22] For instance, the local newspaper *Notícias de Coimbra* (NdC, 2018) refers that: "(…) nearly all operators in the region affected by the massive wildfire of last October (…) believe it will take several years to regain the growth momentum they were experiencing in a sector rooted in nature tourism. Now, they must reinvent themselves in the face of a charred landscape." Another account of the relevance of the destruction of the nature surrounding the hotels is given by a report by *New in Town* on a rural hotel called *Chão do Rio* (NIT, 2022): "The fire caused significant damage, and we were forced to close for seven months. We had to rebuild the reception area and two houses, but we managed to restore them within six months. Half of our property, which used to be a stone pine forest, had disappeared. When we reopened, there were no traces of the trees left." Lastly, a report by Tourism Centre describes the complete destruction of the agrotourism hotel *Casa Grande de Loureiro*, which was fully rebuild only in 2022 (TCP, 2022).

These observations carry significant implications for our research design. First, the timing of the wildfires, with a substantial portion occurring in October, suggests that their economic impacts may only become evident in 2018. Second, the concentration of the burned area within the Centre Region supports focussing exclusively on firms operating in this region. Third, while a considerable number of firms were directly affected, it is plausible that others experienced indirect effects – an aspect that forms a central part of our research design. Fourth, in this context, however, indirect effects are unlikely to stem from road closures or deteriorated air quality, which could for instance impact on labour productivity or supply chains, leading us to exclude these channels from our analysis. Fifth, The Centre Region of Portugal is characterized by a diverse landscape and touristic offer that includes coastal cities (including the surfing village of Nazaré), historical villages, and iconic religious sites such as the Fatima Sanctuary (TCP, 2025). Lastly, the extensive forest area burned may have served as an active channel for indirect effects on certain industries, particularly forestry services and tourism. As discussed in the data section, due to the lack of publicly available information on forest ownership in Portugal, we have chosen to focus solely on the impacts of the 2017 wildfires on the tourism sector.

4. Data and Methodology

4.1. Data sources

This study draws on multiple data sources to ensure a comprehensive analysis of the impacts of wildfires on the tourism sector in the Centre Region of Portugal. Data on hotel establishments were obtained from Turismo de Portugal’s National Registry of Tourism Enterprises (RNET), providing establishment-level details on the location, tax identification of the operating entity, and information on hotels that cancelled their registration (the latter obtained via a data protocol with Turismo de Portugal). Information on firm-level government support was gathered from website of the Coordination and Development Commission of the Centre Region (CCDR-C). Wildfire-related data were sourced from the Institute for Nature Conservation and Forests (ICNF), including detailed records of burned areas per year, wildfire susceptibility scores, and areas under the Rede Natura 2000 conservation network. Geographic and land-use information was derived from the Portuguese Directorate-General for Territory (DGT), specifically the Official Administrative Map of Portugal (CAOP) and the Land Use and Land Cover Map (COS). Finally, financial data for firms operating in the tourism sector were extracted from the SABI database. The period of analysis spans from 2014 to 2019, encompassing a pre- and post-fire period.

4.2. Identification of affected hotels

4.2.1. Directly affected hotels

We label a hotel establishment as *directly affected* if its address overlaps with the official 2017 wildfire perimeter maps, i.e., the distance to the nearest wildfire is 0 meters – as shown in Panel A of **Figure 2.** The underlying rationale is that hotels that experience fire damages to their property are likely to experience loss of revenues and potentially increased costs (e.g., uninsured recovery costs, higher insurance premiums).

[Figure 2 near here]

Moreover, not all directly affected hotels are impacted in the same way: while some may experience minor damages to outside equipment and infrastructures (e.g., swimming pools or garden), others may have suffered substantial damages to the main buildings. While we do not have access to data on the types of physical damages or the precise extent of destruction, we use the information on the government subsidies attributed to each hotel as part of the 2017 wildfire relief package ($2017\ WF\ Subsidies_i$) and the amount of tangible fixed assets recorded by the hotel in the year prior to the fire ($Fixed\ assets_{i,2016}$) to build the following proxy for the *extent of damages*[23]:

$$Extent\ of\ damages_i = \frac{2017\ WF\ Subsidies_i}{Fixed\ assets_{i,2016}} \tag{1}$$

[23] Alternatively, we test a measure which considers the change in fixed assets, and the baseline results hold.

A potential limitation of our study is the lack of insurance data. Hotels with insurance coverage for natural disasters may experience less severe cash-flow impacts compared to uninsured hotels, as they can use the insurance claim payouts to repair or replace damaged equipment and infrastructure – enabling them to resume operations quicker than their uninsured counterparts. We argue that this issue may be dampened in our empirical setting for various reasons. First, the insurance protection gap in Portugal is among the highest in the EU. A joint paper by ECB and EIOPA staff (Benalal *et al.*, 2023) shows that, between 1980 and 2021, the share of insured losses from extreme climate-related events in Portugal was below 10%. Second, given the evidence that climate-related insurance is purchased mainly by larger firms (Linnerooth-Bayer et *al.*, 2019), we partially control for the likelihood of a hotel being insured by including hotel size in the matching process and in all regressions. Lastly, a substantial part of the analysis will focus on the top line of the income statement (operating revenues), which is not directly influenced by insurance payouts.

4.2.2. Indirectly affected hotels

To identify hotels that may suffer an indirect impact of the wildfires, we use a distance-based approach[24]. Namely, in our baseline identification strategy we consider as *indirectly affected* all hotels located within a 1 km radius of the nearest 2017 wildfire perimeter that were not directly affected[25]. A visual representation of this procedure is provided in Panel B of **Figure 2**. The rationale is that the proximity to the fire increases the likelihood of damages to the natural ecosystems located nearby the hotel, as well as potential safety concerns.

[24] An alternative approach could be, for instance, to consider hotels that saw their workers, customers or suppliers directly affected by the disaster. For instance, Carvalho *et al.* (2021) explore a proprietary data consisting of customer-supplier relationships to shed light on how the shock from the Great East Japan earthquake in 2011 propagated and amplified across supply chains.

[25] There is no consensus in the literature regarding the radius within which wildfires may be expected to affect businesses. For instance, Jung & Kim (2017) find evidence that 1 km is an appropriate distance to measure the benefits of greenbelt proximity on the renting market in Seoul. Additionally, several studies on the effects of wildfires in the housing market tend to establish the 0-1 km threshold to remove spillover effects (An *et al.*, 2024; Biswas *et al.*, 2023). On the other hand, Hunt *et al.* (2005: p.104) argue that "Extensive tests with tourism clients and anecdotal information provided by tourism operators suggested that 3 km related to the maximum extent that disturbance should have an impact on the tourism arena.". On the other hand, in a *Nature Sustainability* paper by Modaresi Rad *et al.* (2023) the authors estimate the secondary effects of wildfires by analysing "human, road and powerline exposure to fires for 0.5 km, 1 km, 2.5 km and 5 km buffer zones around the perimeters of fires in each year" (p.8). Bearing these results in mind, we perform robustness checks on the identification of indirectly affected hotels, by re-running the PSM and regressions for hotels with a 0.5 km and 2 km radius.

One important distinction between indirect and direct effects is related to the ability the firm has to restore the pre-fire earnings potential. Namely, while the decision to restore the directly damaged assets depends exclusively on the affected firms and its availability of financial resources, the restoration of the damaged landscape and infrastructure, as well as repairing the perception of the firms' location as a safe tourism destination, is a collective endeavour, led by public spending, and is likely to take longer.

The approach to identify indirect effects faces some limitations. Effectively, the best way to convincingly document the existence of indirect effects of wildfires would be to have access to a log of booking cancelations, with the respective justification, explicitly pinpointing the wildfire risk as the reason for the cancelation. This data, however, is not accessible. Moreover, as discussed in section 3, the evidence we have of the 2017 event, suggests that road closures and air quality were not a material channel for indirect effects. Hence, to shed on what may drive the indirect cash-flow effects of wildfires we look at two potential channels: *landscape destruction* and *damages to nearby tourist attractions*.

To test the *landscape destruction* channel, we go beyond the baseline identification (dummy) and compute, for hotels that were not directly affected, the share of burned area in the 1km radius of each hotel. Effectively, for the landscape destruction channel to be feasible, we expect indirectly affected hotels with higher shares of destruction in their surrounding area to suffer a more severe cash-flow shock. As for the *tourist attractions* channel, we identify the indirectly affected hotels for which a share of the burned area within the 1km radius belongs to the Rede Natura 2000 (RN 2000), a European ecological network of protected areas that, among other things, fosters eco-tourism. Intuitively, for this channel to be active, the wildfires effects would need to be relatively stronger for hotels with damaged tourist attractions.

4.3. Sample construction, descriptive statistics and matching

Table 1 provides a summary of the process followed to build our baseline sample of hotels. We begin with the list of 4,079 hotels founded before 2017 and with a valid license coming into 2017, ensuring that the hotels in our sample were active when the 2017 wildfires erupted. Next, we cumulatively apply the following six filters. First, we focus exclusively on hotels located in the Centre Region. This follows the observation that the wildfires affected mostly the Centre

Region (78.7% of the total burned area). Second, the year 2017 was marked by the visit of Pope Francis to the Fátima Sanctuary, located in the municipality of Ourém. Hence, to mitigate the effect of this factor, we remove from the sample all hotels located in the municipality of Ourém. Third, we observe that the sample is comprised of some hotels that are operated by individuals and government entities. To ensure that we have access to financial data, we restrict our sample to hotels managed by firms. Fourth, we obtain data on the primary code of activity of each firm and identify several cases where the primary activity is not accommodation. This is potentially problematic because some of these firms may be operating in sectors which are not as sensitive to the local conditions as hotels. As a case in point, we find a large firm in our sample primarily dedicated to manufacturing. Hence, to ensure a level-playing field, we remove all hotels ran by firms that do not have accommodation as the primary sector of activity. Fifth, we find that some hotels in our sample are operated by firms that have multiple establishments. Given the lack of establishment-level financial data, we are forced to exclude these hotels from our sample. Finally, we only keep hotels that are operated by firms for which we have financial data for 2016. After implementing the abovementioned filters, we obtain a total of 364 hotels.

[Table 1 near here]

Table 2 shows the descriptive statistics of the pre-matched sample. A total of 130 hotels were either directly (33) or indirectly affected (97) by the 2017 wildfires (36.1% of the total sample). As expected, the pre-2017 wildfire susceptibility score was higher for directly and indirectly affected hotels (3.4 and 3.0) than for non-affected hotels (2.5). The mean distance to the nearest wildfires was significantly shorter for all hotels in 2017 than in in the pre-fire period (2014-16) and the percentage of burned area was larger – especially for the affected hotels. Only a small share of hotels in the sample was affected by pre-2017 fires. In terms of firm-level characteristics, overall, the hotels in the sample are small, have a high ratio of tangible assets and are quite leveraged. A closer inspection of the lower panel of **Table 2** allows us to spot several meaningful differences between the three sub-groups of hotels: for instance, on average, the affected hotels seem to be smaller and younger than the non-affected. Such differences between affected and non-affected hotels may cast doubts on the ability to use the non-affected hotels as adequate counterfactuals. Hence, to robustly implement a differences-in-differences approach, we take further steps to ensure the quality of the controls.

[Table 2 near here]

For each group of affected hotels (directly and indirectly), we conduct 'Propensity Score Matching' (PSM) using the Nearest Neighbour Matching procedure without replacement. Note that (i) the pool of potential control group firms only includes unaffected hotels (i.e., located further than 1km from nearest wildfire in 2017), (ii) due to the relatively small sample size, we allow controls to be drawn from the same pool for directly and indirectly affected hotels, and (iii) we identify 4 and 2 controls per treated hotel, respectively. The propensity score (p) is defined as "the conditional probability of assignment to a particular treatment given a vector of observed covariates" (Rosenbaum & Rubin, 1983: p.41) for each hotel i:

$$p(\mathrm{X}_i) = \Pr(\,\Omega_i = 1 \mid \mathrm{X}_\mathrm{i}) \tag{2}$$

wherein Ω_i is a dummy that takes the value 1 if the firm is classified as 'affected' and 0 otherwise; and X_i is the set of matching variables which we expect to cumulatively bear some impact on the treatment (affected dummy) and outcome variables (cashflows), namely: the *wildfire susceptibility score*, the forest and water ratio within a 1 km radius, size, and tangibility. Moreover, we force exact matching on the hotel type, i.e. whether the hotel fits into the rural hotel establishment classification (RTE).

The results of the matching process are displayed in **Table 3**. As shown, the matched sample substantially reduces the pre-matching differences across all variables, enhancing confidence in the robustness of our methodology. Furthermore, **Figure 3** illustrates the evolution of the mean operating revenues for the matched sample of directly affected hotels (Panel A) and indirectly affected hotels (Panel B). In both cases, the graphs provide evidence supporting the validity of the 'parallel trends' assumption.

[Table 3 near here]

[Figure 3 near here]

In **Table 4**, we provide descriptive statistics for the matched sample of hotels. Panel A presents statistics for directly and non-affected hotels, while Panel B focuses on indirectly and non-affected hotels. Besides confirming that hotels in our sample are small, relatively young, and unprofitable, we can observe that the key cashflow measures (operating revenues, operating costs, and cashflow) exhibit a balanced distribution. Furthermore, the hotels in our sample record high levels of tangibility and leverage – which is aligned with the industry practice (Serrasqueiro & Nunes, 2014). Interestingly, we do not find evidence of cancellations of the registration of affected hotels during the sample period, and hence we focus our analysis on the impact of the wildfires on the intensive margin.

[Table 4 near here]

4.4. Measuring the impact of wildfires on cashflows and financial decisions

To assess the impact of wildfires on the cashflows and financial decisions of affected hotels, we estimate the following differences-in-differences (DiD) model, with two-way clustered standard errors (year and hotel) to mitigate the presence of heteroskedasticity and autocorrelation:

$$Y_{i,t} = \beta_0 + \beta_1 Aff_i + \beta_{2t}(Aff_i \times Year)_{i,t} + FC_{i,t} + Year_t + M_i + \varepsilon_{i,t} \quad (3)$$

wherein Y_i represents the cashflow metrics (operating revenues, operating costs, COGS, staff expenses, external supplies, cash-flow), all of which are log-transformed, as well as the proxies for financial decisions (bank debt, trade credit, capital expenditures, and cash holdings); the definition of each variable is provided in **Table 5**; β_0 denotes the model constant, while Aff_i is a dummy variable equal to 1 if the hotel is labelled as affected by the 2017 wildfires. For the directly affected regressions, this is defined as having a distance-to-nearest fire of 0 meters, whereas for the indirectly affected regressions, the hotel is located within 1 km but is not directly affected. The term $FC_{i,t}$ includes the firm-level control variables: size (natural log of total assets), age (natural log of hotel age), profitability (net income to total assets) tangibility (tangible fixed assets to total assets), cash (cash and cash equivalents to total assets), and leverage (total liabilities to total assets). We check the correlations between variables and do not find evidence supporting potential multicollinearity or overfitting. The baseline specification also incorporates year and regional fixed effects, with the latter defined at the municipality level. To reinforce the reliability of our baseline findings, several alternative model specifications are explored, which are detailed in **Section 6**.

[Table 5 near here]

5. Results

5.1. Do wildfires impact the cashflows of directly affected hotels?

Panel A of **Table 6** shows the baseline results for the directly affected hotels, using the directly affected *dummy* (1 if the shortest distance to the 2017 is 0 meters) as the main independent variable. Overall, the results suggest that directly affected hotels suffered a significant drop in operating revenues *vis-à-vis* the pre-treatment period (2017: -20.5%, 2018: -30.0%, 2019: -18.5%)[26] but were able to adjust their businesses by lowering operating costs, particularly staff expenses and external supplies. Despite this adjustment, we find a significant drop of 6.8% and 9.2% in cashflow for directly affected hotels in 2017 and 2018, which is consistent with the drop in revenues visible in **Figure 3** (Panel A). In general, the control variables exhibit the expected signs: size, age and profitability bear positively on revenues and cashflows, whereas higher tangibility is consistently linked to worse performance.

[Table 6 near here]

As for Panel B, the results indicate that hotels with direct damages recorded lower revenues and cashflows only in 2018 (-42.9% and -14.0%, respectively) – consistent with the baseline regression on cashflows (column 6). Furthermore, by exploring the extent of damages (government subsidy amount to total assets), and we find that the hotels with the highest damages also suffered a negative impact on performance only in 2018. In sum, these results suggest that the impact of wildfires on directly affected hotels was severe but short-lived – potentially due to the extensive government measures put in place in the aftermath of the fires to support the directly affected hotels.

[26] Given the ln-linear nature of our model, the main coefficients of interest should be transformed to be reported as percentage changes in the dependent variable. For instance, the coefficient of Directly affected x 2017 (-0.230), reported in Panel A of Table 6, must be transformed in the following way: $(e^{-0.230}-1) = -0.205 = -20.5\%$.

Finally, we perform a back-of-the-envelope analysis (Munch & Schaur, 2018) to estimate the impact of peak accumulated loss of revenues faced by directly affected hotels in the sample period. To do so, we take the interaction term coefficients of the baseline regression (1) and apply it to the pre-fire turnover of the directly affected hotels (6.2 million euros). This yields a peak accumulated loss of turnover of 11.1 million euros in the 2017-19 period – which represents 18.5% of the pre-fire turnover of hotels located in the municipalities where the directly affected hotels are located and represents more than 50% of the turnover for the four most exposed[27] municipalities. The results are presented in **Table I**, in the Appendix.

5.2. Do wildfires impact the cashflows of indirectly affected hotels? If so, via which channels?

Table 7 documents the wildfire cashflow shocks for indirectly affected hotels. Panel A shows that the dummy representing the indirectly affected hotels (i.e. 1 if the shortest distance to the 2017 fire is lower than 1 km, but not directly affected) bears a negative effect on revenues in 2018 (-7.4%) and a positive effect in 2019 (+6.3%), signalling that indirectly affected hotels seem to have suffered a short-run break in sales, followed by a recovery that virtually offset the loss of revenues observed in 2018 – which is consistent with the pattern observed in Panel A of **Figure 3** and with our back-of-the-envelope estimates (obtained via the previously described method), according to which the accumulated turnover losses of indirectly affected hotels peak in the 2017-18 period. While the overall estimated loss of turnover (6.8 million euros) represents only a small fraction of the local hotel market (3.1%), we find significant heterogeneity in the cross-section: for almost a fifth of the municipalities (9 in 51) the peak losses represent more than 10% of the turnover of the local hotel market.

Interestingly, in terms of cashflow effects, we do not observe a similar recovery in 2019, given the increase in operating costs – due to the rise in COGS and external supplies –, resulting in a decline of 4.9% and 6.2% in the cashflows of 2017 and 2018. One explanation for this pattern could be an increase in the insurance premiums – but due to lack of data we cannot test this narrative.

[27] In this context, exposure is measured as the pre-fire weight of the turnover of directly affected hotels in the total hotel turnover of the municipality where the affected hotel operates.

[Table 7 near here]

In Panel B, we provide evidence on the landscape destruction channel using two proxies. First, in columns (7) to (9), we employ the share of burned area in the 1 km radius of each hotel as the proxy for damages to the surrounding landscape. The findings in terms of cashflow impact are consistent with the baseline results: in fact, hotels in areas that were more affected by the 2017 fires tend to record higher operating revenues (even though in 2018 that difference was reduced) but also operate with (much) higher costs; these joint effects result in a loss of cashflow for hotels operating in more affected areas, despite not being directly affected by the fires. Moving to columns (10) to (12), we split the sub-sample of indirectly affected hotels between low and high burned radius, using the median value of burned area in the 1 km radius (23.6%) as the threshold. The findings for the impact of wildfires on the cashflow of indirectly affected hotels are in line with the previous, although at a greater magnitude (2017: -18.0% and 2018: -13.4%). A fundamental contribution of this analysis is to document that the magnitude of the burned area matters: effectively, the impact of the share of burned area is only observed for highly burned areas (>23.6% of burned area).

Finally, in Panel C we test the tourist attractions channel using two alternative measures: a dummy of 1 if the hotel is located within a 1 km radius of a burned area belonging to 'Rede Natura 2000' (RN2000 damaged within 1km radius) and a gravitational-based measure, which adjusts the share of RN2000 area damaged within 1 km by the distance to the nearest burned area belonging to RN2000:

$$Proximity\ damaged\ RN2000\ _i = \frac{Share\ of\ damaged\ RN2000\ in\ 1km\ radius_i}{Distance\ to\ nearest\ damaged\ RN2000_i} \quad (4)$$

In general, we find weak results for this channel. We do not rule out the possibility of measurement errors, that could be potentially mitigated using more precise information on the tourist infrastructures that were damaged. However, to the best of our knowledge, this information is not readily available.

5.3. Do wildfires impact the financial decisions taken by the affected hotels?

Table 8 presents our findings regarding the impact of some of the main financial decisions taken by hotels: How much bank debt to take on? Which type of bank debt: short- and long-term? How much cash to hold? How much trade credit to negotiate with customers and suppliers? How much to (re)invest in real assets? The analysis is performed using the baseline specification.

Regarding Panel A, we observe that directly affected hotels changed their debt profiles in the 2017-19 period. Specifically, in the years of the fire and post-fire (2017 and 2018), directly affected hotels increase long-term bank debt (3.5 pp and 3.2 pp), only to significantly reduce it again in 2019 (-2.0 pp; mean: 35.5%). The increase in debt is aligned with extant empirical literature on post-disaster corporate borrowing (Cortés *et al.*, 2014; Koetter *et al.*, 2020; Ivanov *et al.*, 2022). Following Diamond (1991), this may indicate that firms faced higher liquidation risk in the aftermath of the wildfires, using long-term debt to fend off potential future short-term liquidity concerns. Another potential explanation is that hotels used these as bridge loans, given that part of the government subsidies were only paid in 2019 (Observador, 2019).[28] In terms of trade credit, hotels reduced accounts receivables in 2018 (-0.5 pp; mean: 1.3%), and significantly increased accounts payables in 2019 (+0.3 pp; mean: 3.3%), which could reflect an effort of directly affected hotels to actively manage the working capital in the aftermath of the wildfire cashflow shock.

Lastly, in the presence of additional sources of finance (i.e., increased bank debt and higher working capital), did the directly affected hotels (i) invest in tangible fixed assets, (ii) withhold investment and conserve cash (e.g., waiting for the full payment of the government subsidy), or (iii) pursue both strategies? The answer is provided in columns (6) and (7) which suggest that hotels opted for a mix of both policies: on one hand, they reinvested in tangible fixed assets (+12.3 pp; mean: 35.4%) and, on the other hand, increased the cash holdings by 1.5 pp (mean: 10.2%).

[28] For the 26 hotel firms that received government support, the process took on average 211 days, of which 157 days to submit the application and 54 days for the government to approve it. On top of this period, one must add the financial liquidation of the subsidies, which follow a staggered method, wherein payments are typically made as the firm makes the investments, either against invoices (advances) or payment receipts (reimbursements).

[Table 8 near here]

With respect to the indirectly affected hotels, Panel B shows that these hotels opted to slightly increase short-term bank debt and also focussed on managing working capital conditions. Such behaviour seems consistent with the proposition that firms affected by natural disasters may use short-term debt to bridge short-run liquidity needs (Ivanov *et al.*, 2022). The lack of additional sources of funds contributed to a decrease in both tangible assets (-4.2 pp; mean: 59.1%) and cash holdings in 2017 (-1.1 pp; mean: 11.1%). We note that the sum of both losses corresponds roughly to the loss of cashflow reported in 2017 (Table 7, Panel A), suggesting the presence of a direct link between the cashflow shock and the decrease in tangible assets' investment for indirectly affected hotels.

The divergent investment responses of directly and indirectly affected hotels present an interesting contrast, which can be interpreted through two complementary lenses. Real-options theory suggests that indirectly affected hotels can delay capital expenditure while assessing the pace of demand and environmental recovery, whereas directly affected hotels, facing immediate operational losses, cannot benefit from such strategic waiting (McDonald & Siegel, 1986; Cooper & Priestley, 2011). Behavioural theory offers a complementary explanation: under reference-dependent preferences (Kőszegi and Rabin, 2007), directly affected hotels interpret their situation as a loss and thus exhibit greater risk-seeking through investment, while indirectly affected hotels perceive a relative gain and respond with heightened risk aversion, reducing investment.

6. Robustness checks and additional analyses

6.1. Exclude hotels affected by wildfires before 2017

One potential concern is that our baseline results may be materially impacted by the presence of hotels exposed to wildfires in the period between 2014 and 2016. Effectively, after the matching process, the sample used to test the impact of the 2017 wildfires on directly affected hotels (n=165) includes a total of 32 hotels affected by fires in the pre-2017 period (2 directly and 30 indirectly); whereas the sample used to examine the impact on indirectly affected hotels (n=281) includes 53 hotels previously affected (3 directly and 50 indirectly). As a robustness check, we exclude hotels affected (directly or indirectly) by wildfires in the 2014-16 period and re-run the matching process. In Panel A of **Table 9a** we present the results for the directly affected hotels. Overall, we can observe that the sign and statistical significance of the coefficients on cashflow remain similar to the baseline results. However, as expected, the magnitude of the effects is slightly larger. For instance, the estimated drop in cashflows in 2018 is -12.9% (baseline: -9.2%). Additionally, we observe a more pronounced increase in tangible fixed assets in 2018 of +14.6 pp (baseline: +12.3 pp), and this increase is statistically significant already in 2017 and prolongs into 2019, which contrasts with the baseline findings (only 2018). These results are intuitive in the sense that we are removing previously affected hotels (mostly) from the control group, which are likely to have made significant investments in tangible assets in the post-fire period – in other words, the presence of previously affected hotels in the control sample reduces the estimated effect of the 2017 wildfires on the investment policy of affected hotels. Nonetheless, given the relatively small size of the sample, we chose to keep our decision to not exclude these hotels from the baseline analyses.

[Table 9 near here]

As for Panel B, the decision to exclude pre-2017 affected hotels leads to a significant drop in the number of indirectly affected hotels in 2017, from 97 to 71. We observe small changes to our baseline results. For instance, the impact of indirect exposure to the 2017 wildfires still bears a short-term impact on cashflow in 2017 and the magnitude of the 2018 interaction term coefficient is similar to the baseline (-5.8% vs baseline: -6.2%), but its statistical significance is less powerful (from 5% to 20%). The remaining results are similar – e.g., the estimated impact on the investment in tangible fixed assets in 2017 is -4.3% (baseline: -4.2%).

6.2. Radius used to find indirectly affected hotels

Another legitimate question is whether our results are sensitive to the radius used to define indirectly affected hotels. Indeed, while the 1 km radius is used in several works in the literature (e.g., Jung & Kim, 2017; Biswas *et al.*, 2023; An *et al.*, 2024), some authors argue that these effects may be also seen in other radii. For instance, Hunt *et al.* (2005: p.104) argue that "extensive tests with tourism clients and anecdotal information provided by tourism operators suggested that 3 km related to the maximum extent that disturbance should have an impact on the tourism arena.”. On the other hand, Modaresi Rad *et al.* (2023) estimate the secondary effects of wildfires by analysing “human, road and powerline exposure to fires for 0.5 km, 1 km, 2.5 km and 5 km buffer zones around the perimeters of fires in each year” (p.8). Bearing these results in mind, we perform robustness checks on the identification of indirectly affected hotels, by re-running the PSM and regressions for hotels in the 0.5 km and 2 km radius.

The results are presented in Panel C of **Table 9a**. When shortening the threshold radius to 0.5 km around the hotel (columns 7 to 9), we observe that the baseline results remain generally unchanged – in fact, as expected, we observe a small increase in statistical significance in the main coefficients of the three regressions. On the contrary, when expanding the radius of the indirectly affected to 2 km, all the interaction terms lose statistical significance, suggesting that the indirect effects of wildfires on hotels are bound by the proximity to the fire perimeter.

6.3. Exclude municipalities adjacent to Ourém

It is possible that our strategy to mitigate the effects of the Pope Francis visit to Fátima, i.e., the exclusion of hotels located in the municipality of Ourém, may not be sufficient to circumvent the effects of the visit. More precisely, it is possible that tourists may have had to book their stays in hotels located in municipalities adjacent to Ourém, for instance due to the lack of capacity in hotels located closer to the Fátima Sanctuary. This rationale led us to question whether our baseline results would hold if we took a more restrictive approach and removed from the sample (affected and pool of potential controls) the hotels located in the municipalities adjacent to Ourém, namely Leiria, Batalha, Alcanena, Torres Novas and Tomar. Panel D of **Table 9b** presents the findings of the robustness check. We can observe that, in general, the baseline results remain substantially the same.

6.4. Non-affected hotels located outside the Centre Region

An additional concern with our baseline design is that the control sample, which is drawn from the same region as the affected hotels, located further than 1km from the nearest 2017 wildfires, may not consist of “true” non-treated hotels, given the possibility of regional spillovers. Alternatively, the control hotels could be drawn from other regions in Portugal. We recall, from the discussion presented in the Methodology section, that such choice can open way to other issues, such as the presence of significant differences in the evolution and type of tourism across regions. Bearing in mind these issues, we re-run the baseline regressions for directly and indirectly affected hotels imposing the criteria that the sub-sample of controls (non-affected hotels) is comprised exclusively of hotels located outside the Centre Region. The results, which are presented in Panel E of **Table 9b**, generally align with the key baseline results, indicating the presence of a short-term cash-flow effects and heterogeneous investment decisions between directly and indirectly affected hotels.

6.5. Spillover effects to hotels with high wildfire risk located outside the Centre Region

While our baseline design relies on distance-based measures of exposure (directly affected hotels are located in the fire perimeter and indirectly affected hotels within 1km), this approach does not capture the possibility that, rather than wildfire damage, wildfire risk itself may shape hotel outcomes, even in areas not immediately touched by the 2017 wildfires. To provide preliminary evidence on this matter, we focus on hotels situated outside the Centre Region and located more than 3 km from the nearest fire, and investigate whether outcomes differ according to their wildfire susceptibility score. Using the same propensity score matching procedure as in the baseline specification, we contrast the performance of hotels located in high risk areas (average parish with a wildfire susceptibility score of 4 or more) with low-risk hotels (average score of 2 or more).

The results, presented in Panel F of **Table 9b**, reveal an interesting pattern. We find no evidence of short-term effects on cash flows, which suggests that customers did not immediately adjust their behavior toward high-risk locations situated far from the burned areas. However, hotels with high wildfire risk appear to face tighter credit conditions, as indicated by reduced access to debt financing, and display lower levels of investment in tangible assets. These results suggest that wildfire risk may influence financing constraints and investment decisions independently of direct fire exposure, pointing to a channel that is more forward-looking in nature. While these findings are not central to our main identification strategy, they provide suggestive evidence that the economic consequences of wildfire risk may extend beyond the directly affected areas and thus warrant further investigation.

7. Conclusions and Policy implications

The increasing frequency and severity of natural disasters, driven by climate change, pose substantial challenges to businesses operating in high-risk areas (Abatzoglou & Williams, 2016; IPCC, 2021). This paper contributes to the growing literature on the economic and financial impact of natural disasters by analyzing the effects of the 2017 wildfires in Portugal. Using a diff-in-diff approach with propensity score matching and proximity-based measures, we disentangle the direct and indirect effects of the wildfires on hotel cashflows and financial decisions.

Our results show that directly affected hotels experienced persistent revenue losses after the wildfires, partially mitigated by reductions in operating costs such as staff expenses and external supplies. Nonetheless, these adjustments were insufficient to prevent a significant decline in cashflows in 2018. For indirectly affected hotels, short-term cashflow disruptions arose from reduced revenues and higher costs. Regarding the financial decisions, directly affected hotels responded by increasing long-term debt and a mix of investment in tangible assets and cash hoarding, while indirectly affected hotels did not actively manage their capital sources and apparently passed on the cashflow shock to their investment and cash holding policies. Such divergence can be interpreted under two complementary theories: real options (McDonald & Siegel, 1986; Cooper & Priestley, 2011) and reference-dependent risk preferences (Kőszegi & Rabin, 2007).

The magnitude of the indirect effects of wildfires on tourism – transmitted via landscape destruction – may seem striking. However, they are aligned with estimates put forward by Wang *et al.* (2022), suggesting that the indirect economic losses of wildfires can be more relevant than the direct ones – especially for some economic sectors. While these authors shed light on the indirect losses by mapping the supply chain effects, this paper documents a novel channel in the finance literature related to the loss of ecosystem services, i.e., the loss of benefits that humans obtain from nature (Pereira *et al.*, 2021). This channel may also be material for any economic activity that indirectly relies on ecosystem services that are sensitive to wildfires. For instance, industries that rely on nearby water sources may be indirectly impacted by the contamination induced by the ashes produced by large wildfires. Similarly, some outdoor activities are likely to be affected by wildfires, particularly in extreme smoke days (Addoum *et al.*, 2023; Kong *et al.*, 2023).

The findings in this study offer several policy implications. First, our evidence indicates that indirectly affected businesses – specifically hotels – face significant challenges that may be overlooked. Given the clear and sizeable effects on firms, policymakers could consider extending financial relief to indirectly affected firms, as their cashflow disruptions and increased costs may have substantial ripple effects on local economies. Following the methodology of our paper, we argue that any public support to indirectly affected firms would require a deep understanding of the specific context and channels via which the event is claimed to impact businesses (e.g., case-by-case analysis of claims with qualitative narratives). Second, this paper contributes to the broader discussion on climate-related physical risks for businesses and creditors. In a context where insurers may reduce coverage for high-risk areas and governments may face fiscal constraints (FT, 2024; Guardian, 2024), firms could benefit from proactively strengthening their financial resilience. Such efforts include diversifying revenue streams, enhancing liquidity, and managing capital structures to ensure there is room to tap into 'emergency' debt. Regulators and investors should incorporate physical risks into their frameworks, ensuring businesses are prepared for an increase in climate-driven shocks. Finally, our results underscore the importance of investments in wildfire risk mitigation and resilience. Given the indirect economic impact through damaged landscape and tourist attractions, public investment must include the restoration and protection of key infrastructure.

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Figures

Panel A. Wildfire susceptibility score 2016 | Panel B. Burned areas 2017

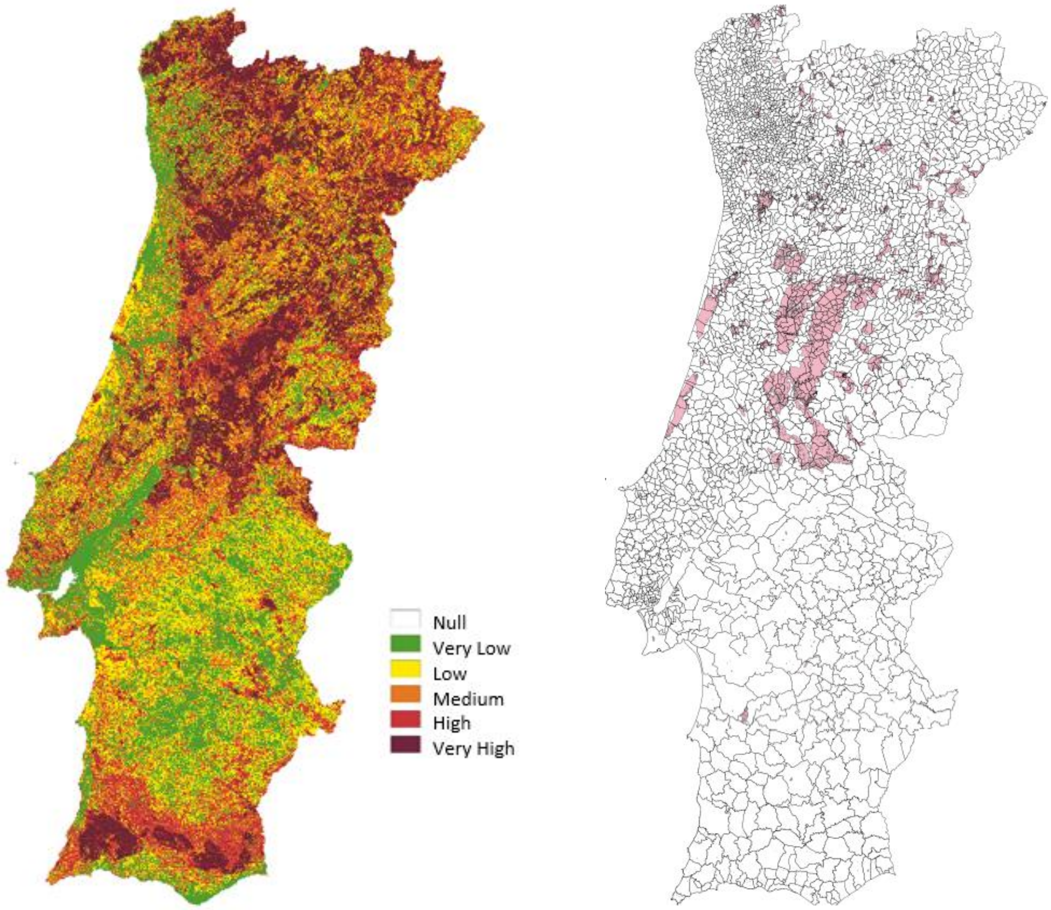


Figure 1. Wildfire susceptibility score (2016) and burned areas (2017) in Portugal.

Notes: Both maps were sourced with information from ICNF and mapped using QGIS software. *Wildfire susceptibility score* is used by ICNF to monitor wildfire risk; can take on values between 0 (no risk) and 5 (very high risk).

Panel A. Directly affected hotels | Panel B. Indirectly affected hotels

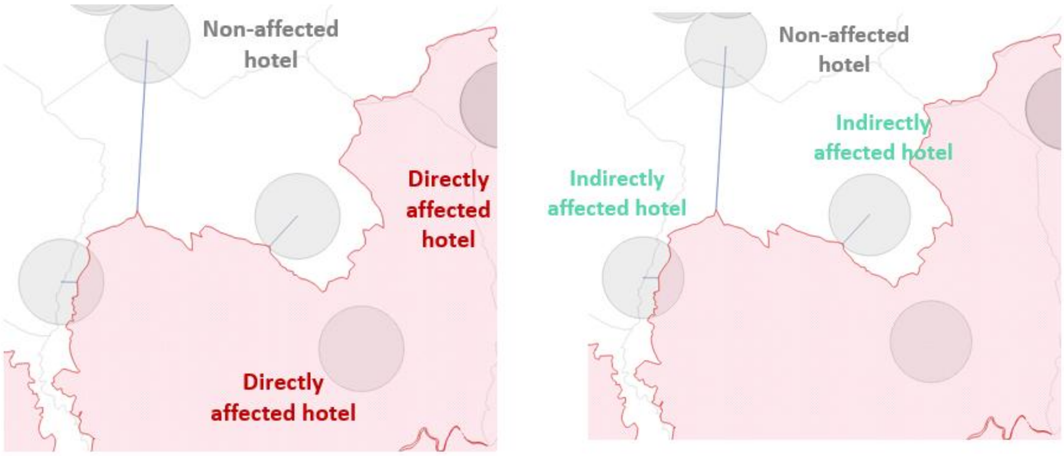
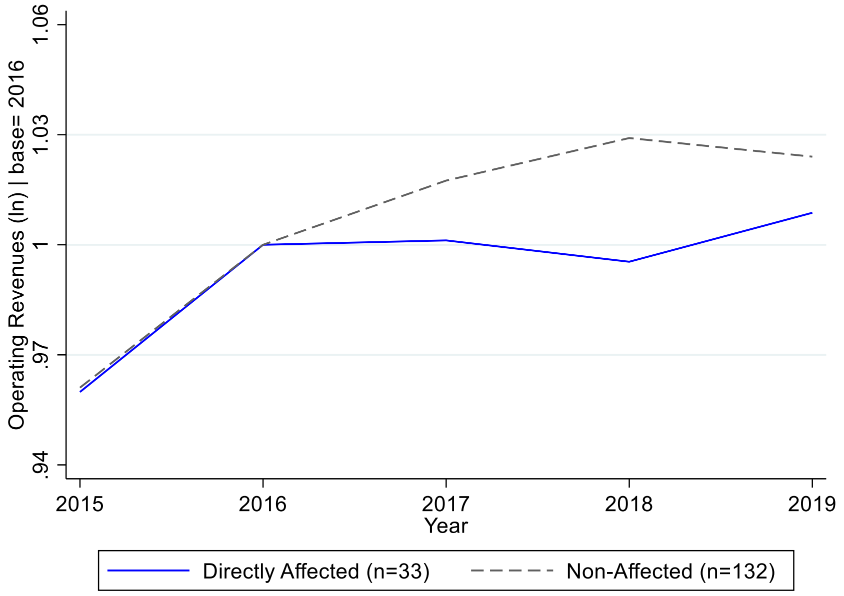


Figure 2. Example of directly and indirectly affected hotels.

Notes: The figures illustrate a snapshot of the 2017 wildfire front at the municipality of *Castanheira de Pêra*. The grey circles represent the radius of 1km around each hotel perimeter. The blue lines represent the distance between each hotel and the nearest fire front. The red shade is the fire front/burned area.

Panel A. Directly affected hotels



Panel B. Indirectly affected hotels

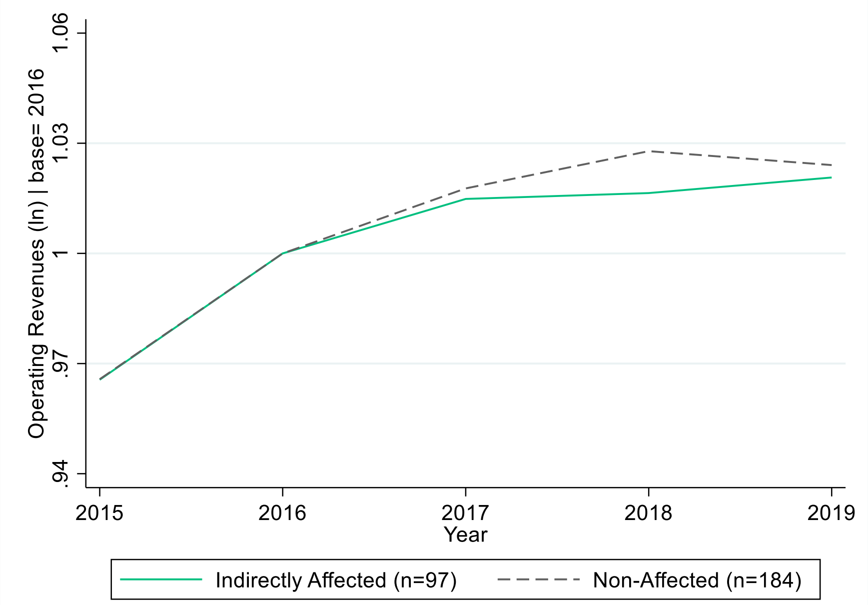


Figure 3. The evolution of operating revenues in directly and indirectly affected hotels.

Notes: The figures present the evolution of the mean operating revenues (ln) per group of hotels: directly and indirectly affected, and respective controls.

Tables

Table 1. Sample construction

Criterion		Nbr. of hotels
Base	Hotels founded before 2017 and with active license entering 2017	4,079
Criteria 1	Hotels located in Centre Region (NUTS II of 2013)	1,092
Criteria 2	Hotels located outside of *Ourém* municipality (Pope visit to Fátima Sanctuary)	1,032
Criteria 3	Hotels operated by non-financial firms	804
Criteria 4	Hotels operated by firms with accommodation as the primary code of activity	689
Criteria 5	Hotels operated by firms with only one establishment	485
Criteria 6	Information on Turnover of 2016 is available	364
	Nbr. of hotels in baseline sample	364

Notes: This table reports the number of hotels that results from the cumulative application of each filter.

Table 2. Overview of the unmatched sample

	All hotels	Directly affected	Indirectly affected	Non-Affected
Nbr. Hotels	364	33	97	234
Wildfire exposure				
Wildfire susceptibility score (pre-2017)	2.7	3.4	3.0	2.5
% of hotels above median of WSS	50.0	81.8	64.9	38.9
% of forest & water in 1 km radius	46.1	67.6	48.9	41.9
Mean distance to nearest WF (km) (2017)	8.7 (2.9)	4.4 (0.0)	4.7 (0.5)	9.3 (4.4)
% of burned area WF in 1km radius (2017)	0.5 (12.1)	0.3 (87.9)	0.8 (15.5)	0.5 (0.0)
Nbr. of hotels directly affected pre-2017	4	1	3	0
Nbr. of hotels indirectly affected pre-2017	64	9	24	31
Firm level features (2016, mean values)				
Operating revenues (k€)	379.4	189.3	308.6	435.6
Cashflow (k€)	82.7	48.6	66.3	94.3
Size (k€)	1,257.0	788.6	1,115.2	1,366.5
Age (years)	13.4	9.3	11.0	14.9
Tangibility (%)	69.8	76.4	70.5	68.5
Cash (%)	9.4	7.4	7.6	10.5
Leverage (%)	68.8	74.1	69.9	67.6

Notes: The values outside of the brackets represent the statistics for the years before 2017 (2014-16); the values in brackets represent the 2017 values. *Wildfire susceptibility score* (WSS) is used by ICNF to monitor wildfire risk; can take on values between 0 (no risk) and 5 (very high risk). *Operating revenues* and *Cashflow* (i.e., EBITDA) are divided by total assets, *Size* is the natural log of total assets, *Age* is the natural log of age, *Tangibility* is tangible fixed assets divided by total assets, *Cash* is cash & cash equivalents divided by total assets, and *Leverage* is total liabilities divided by total assets.

Table 3. Matching quality between affected and non-affected hotels

	Pre-PSM			Post-PSM	
	Directly affected	Non-affected	Diff.	Non-affected	Diff.
	(1)	(2)	(3) = (1) – (2)	(4)	(5) = (1) – (4)
Panel A. Directly affected					
Nbr. hotels	33	234		132	
Wildfire exposure					
Wildfire susceptibility score	3.4	2.5	0.9***	2.9	0.5***
% of forest & water (1 km)	67.7	41.9	25.8***	49.1	18.6***
Financial profile					
Operating revenues (ratio)	47.7	58.8	-11.1	40.9	6.8
EBITDA (ratio)	5.0	7.0	-2.0	4.1	0.9
Size (ln)	12.6	13.0	-0.4	12.8	-0.2
Age (ln)	1.7	2.2	-0.5**	1.8	0.1
Tangibility	76.5	68.5	8.0	74.7	1.8
Cash	7.4	10.5	-3.1	7.7	-0.3
Leverage	74.1	67.6	6.5	71.0	3.1
	Pre-PSM			Post-PSM	
	Indirectly affected	Non-affected	Diff.	Non-affected	Diff.
	(6)	(7)	(8) = (6) – (7)	(9)	(10) = (6) – (9)
Panel B. Indirectly affected					
Nbr. hotels	97	234		184	
Wildfire exposure					
Wildfire susceptibility score	3.0	2.5	0.5***	2.7	0.3**
% of forest & water (1 km)	48.9	41.9	7.0***	45.1	3.8
Financial profile					
Operating revenues (ratio)	50.6	58.8	-8.2	49.3	1.3
EBITDA (ratio)	5.5	7.0	-1.5	5.7	0.2
Size (ln)	12.8	13.0	-0.2	13.0	-0.2
Age (ln)	2.0	2.2	-0.2	2.0	0.0
Tangibility	70.5	68.5	2.0	70.2	0.3
Cash	7.6	10.5	-2.9*	9.8	2.2
Leverage	69.9	67.6	2.2	68.1	1.7

Notes: Panels A and B analyse the matching quality of directly and indirectly affected hotels, respectively. The columns (3), (5), (8) and (10) report the mean test comparison between the affected and non-affected hotels. Hotels are classified as non-affected if the shortest distance to the 2017 wildfires was longer than 1 km. ***, ** and * represent the statistical significance at the 1%, 5% and 10% levels, respectively.

Table 4. Descriptive statistics of the matched sample

	Obs.	Mean	SD	P5	Median	P95
Panel A. Directly and non-affected						
Operating revenues (ln)	765	11.1	1.9	8.5	11.1	13.8
Operating costs (ln)	765	11.1	1.5	8.8	11.0	13.6
Cashflow (ln)	765	0.0	1.0	-1.1	0.1	0.8
Wildfire susceptibility score	765	3.0	0.8	1.7	3.0	4.2
Size (ln)	765	12.7	1.3	10.5	12.6	15.2
Age (ln)	765	2.0	1.0	0.0	1.8	3.6
ROA (%)	765	-3.0	23.6	-18.9	-0.2	14.2
Tangibility (%)	765	74.9	25.0	11.4	85.0	97.7
Cash (%)	765	8.2	12.3	0.1	2.8	34.0
Leverage (%)	765	77.2	65.7	13.0	67.9	157.5
Panel B. Indirectly and non-affected						
Operating revenues (ln)	1,301	11.6	2.0	8.8	11.6	14.5
Operating costs (ln)	1,301	11.5	1.7	8.8	11.4	14.2
Cashflow (ln)	1,301	0.1	0.8	-0.7	0.2	0.7
Wildfire susceptibility score	1,301	2.8	0.9	1.5	2.8	4.2
Size (ln)	1,301	13.0	1.5	10.7	12.8	15.7
Age (ln)	1,301	2.1	1.0	0.7	2.1	3.7
ROA (%)	1,301	-1.6	22.1	-16.5	0.1	16.2
Tangibility (%)	1,301	70.5	27.9	8.3	81.9	97.4
Cash (%)	1,301	9.2	14.1	0.1	2.9	41.4
Leverage (%)	1,301	82.1	111.7	12.6	64.3	158.5

Notes: The description of each variable is provided in **Table I** (in the Appendix). The number of observations represent the firm-year observations for the sample period (2015-2019). Namely, Panel A includes 165 hotels (33 directly affected and 132 non-affected matched) which are present, on average, 4.6 years in the sample period (765/165); Panel B is comprised of 281 hotels (97 indirectly affected and 184 non-affected matched) also with an average of 4.6 years in the sample period (1,301/281).

Table 5. Variables description.

Variable	Description	Source
Dependent variables		
Operating revenues	Natural log of total operating revenues plus 1.	Moody's Analytics BvD SABI
Operating costs	Including, namely, costs of goods sold, staff expenses and external supplies. Natural log of total operating costs plus 1.	Idem
COGS	Costs of goods sold. Natural log of COGS plus 1.	Idem
Staff expenses	Natural log of staff expenses plus 1.	Idem
External supplies	Costs related with utilities, rent, etc. Natural log of external supplies plus 1.	Idem
Cashflow	Difference between the natural log of Operating revenues and the natural log of Operating costs.	Idem
Δ Bank debt	Growth in bank debt. Difference between total bank debt (short and long term) in years t and t-1, divided by the lag of total assets x 100.	Idem
Δ Short-term bank debt	Growth in bank debt with maturity shorter than 1 year. Difference between short-term (current) bank debt in years t and t-1, divided by the lag of total assets x 100.	Idem
Δ Long-term bank debt	Growth in bank debt with maturity longer than 1 year. Difference between long-term (non-current) bank debt in years t and t-1, divided by the lag of total assets x 100.	Idem
Δ Accounts receivables	Growth in trade credit provided to customers. Difference between accounts receivables in years t and t-1, divided by the lag of total assets x 100.	Idem
Δ Accounts payables	Growth in trade credit from suppliers. Difference between accounts payables in years t and t-1, divided by the lag of total assets x 100.	Idem
CAPEX	Capital expenditures. Difference between tangible fixed assets in years t and t-1 plus depreciations and amortizations, divided by the lag of tangible fixed assets x 100 (Rao *et al.*, 2022).	Idem
Δ Cash	Growth in cash holdings. Difference between cash and cash equivalents in years t and t-1, divided by lag of total assets x 100.	Idem
Wildfire variables		
Wildfire susceptibility score	Score used by ICNF to monitor wildfire risk; can take on values between 0 (no risk) and 5 (very high risk). The computation of this metric accounts for several widely used inputs in wildfire analysis: "elevation, slope, land cover, average annual rainfall, average number of days with minimum temperature ≥20◦C, and past burn scar mapping (which was transformed into simple probability)" (Verde & Zêzere, 2010: p.486).	TP and ICNF
Directly affected	Dummy 1 if the hotel is located within the 2017 wildfire perimeter.	TP and ICNF
Direct damages	Dummy 1 if the hotel was awarded a government subsidy in the aftermath of the 2017 wildfires.	CCDR-C
Extent of damages	Ratio between the total amount of government subsidy approved in the aftermath of the 2017 wildfires and tangible fixed assets in 2016.	CCDR-C
Indirectly affected	Dummy 1 if the hotel is located within 1km of the 2017 wildfire perimeter and is not Directly affected.	TP and ICNF
Share of burned radius	Share of the 1km radius surrounding the hotel that was burned.	TP and ICNF
Low (High) burned radius	Dummy 1 if the Share of burned radius was below (above) the median of the sample of indirectly affected hotels.	TP and ICNF
RN2000 impacted (<1km)	Dummy 1 if the 1 km radius surrounding the hotel includes a RN2000 forest that was burned.	TP and ICNF

Variable	Description	Source
Proximity RN2000 impacted	The inverse of the distance to the nearest RN2000 area impacted, [i.e., 1/ (1+ Distance to nearest RN impacted)].	TP and ICNF
Firm-level controls		
Size	Natural log of total assets.	Moody's Analytics BvD SABI
Age	Natural log of the difference between year t and the year that the hotel was opened.	Idem
ROA	Ratio between net income and total assets.	Idem
Tangibility	Ratio between tangible fixed assets and total assets.	Idem
Cash	Ratio between cash and cash equivalents and total assets.	Idem
Leverage	Ratio between total liabilities and total assets.	Idem

Table 6. Impact of wildfires on cash-flows: directly affected hotels

	Operating revenues	Operating costs	COGS	Staff expenses	External supplies	Cashflow
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Baseline						
Directly affected	0.232	0.271	-0.779	0.371	0.350	-0.010
Directly affected x 2017	-0.230**	-0.177**	0.162	-0.110	-0.164**	-0.070*
Directly affected x 2018	-0.357**	-0.301***	-0.100	-0.334***	-0.236***	-0.097**
Directly affected x 2019	-0.204*	-0.273**	-0.004	-0.159*	-0.212**	0.025
Wildfire susceptibility score	-0.054	-0.072	-0.123	0.127	-0.044	0.034
Size	0.686***	0.672***	0.898***	0.694***	0.550***	0.014
Age	0.306**	0.266**	0.262	0.327**	0.283**	0.031
ROA	3.293**	1.653	3.530*	0.610	2.107	1.478***
Tangibility	-1.041**	-1.402***	-1.029	-0.892**	-1.465***	0.246
Cash	0.243	0.216	1.185	0.877	-0.343	-0.175
Leverage	0.409	0.309	-0.022	0.190	0.443	0.085
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	765	765	633	681	765	765
Adjusted R^2 *(within)*	0.488	0.488	0.394	0.428	0.440	0.126
	Operating revenues	Operating costs	Cashflow	Operating revenues	Operating costs	Cashflow
	(7)	(8)	(9)	(10)	(11)	(12)
Panel B. Direct damages						
Direct damages	0.313	0.307	0.027			
Direct damages x 2017	-0.021	-0.124	0.012			
Direct damages x 2018	-0.561***	-0.426***	-0.151**			
Direct damages x 2019	-0.331	-0.342*	-0.046			
High damages				0.113	0.108*	0.011
High damages x 2017				0.028	0.013	-0.006
High damages x 2018				-0.089***	-0.068**	-0.025*
High damages x 2019				-0.025	-0.039	0.005
Firm controls (lagged)	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	765	765	765	765	765	765
Adjusted R^2 *(within)*	0.488	0.487	0.125	0.493	0.492	0.125

Notes: The table presents the regression results for the baseline approach (*Panel A*), where we use the directly affected dummy (1 if shortest distance to the 2017 is 0 meters) as the main independent variable; in *Panel B*, we show the results of using government data to identify the hotels that received government aid (*Direct Damages*) and exhibited the highest damages (25^{th} percentile and above of the ratio of government subsidy amount to tangible fixed assets). The results are obtained using OLS regressions with two-way clustered standard errors (Hotel and Year) and time and regional (municipality) fixed effects. The sample covers the full period (2015-19), directly affected hotels (n=33) and matched hotels (n=132). The dependent variables are log transformed (natural log). Due to data quality concerns, the regressions on the breakdown of operating costs, (3), (4) and (5) are performed only for observations with positive values for the dependent variable. The firm-level controls are lagged 1 period: *size* (natural log of total assets), *age* (natural log of hotel age), *profitability* (ROA), *tangibility* (tangible fixed assets to total assets), *cash* (cash & cash equivalents to total assets), and *leverage* (total liabilities to total assets). All variables are winsorized at the 5% and 95% levels. Given the ln-linear nature of the baseline model, to interpret the main coefficients of interest (i.e., affected hotels) as percentage changes in the dependent variable, in the text we report the transformed results: $\Delta x = 1\ (affected) \Rightarrow \Delta\% y = (e^{\beta} - 1) \times 100$. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***.

Table 7a. Impact of wildfires on cash-flows: indirectly affected hotels

	Operating revenues	Operating costs	COGS	Staff expenses	External supplies	Cashflow
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Baseline						
Indirectly affected	0.187	0.104	0.057	0.182	0.080	0.070
Indirectly affected x 2017	-0.039	-0.001	0.033	0.041	0.002	-0.050**
Indirectly affected x 2018	-0.078**	-0.020	0.086*	-0.033	0.059*	-0.064**
Indirectly affected x 2019	0.065**	0.052**	0.177***	-0.050	0.055**	0.023
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,301	1,301	1,088	1,189	1,301	1,301
Adjusted R^2 *(within)*	0.617	0.603	0.462	0.498	0.567	0.124
	Operating revenues	Operating costs	Cashflow	Operating revenues	Operating costs	Cashflow
	(7)	(8)	(9)	(10)	(11)	(12)
Panel B. Landscape destruction						
Share of burned radius	1.054*	0.895*	0.173			
Share of burned radius x 2017	-0.255	0.028	-0.282***			
Share of burned radius x 2018	-0.382**	-0.175	-0.193***			
Share of burned radius x 2019	-0.192	-0.161	0.003			
Low burned radius				0.158	0.075	0.065
Low burned radius x 2017				-0.012	-0.012	-0.025
Low burned radius x 2018				-0.044	-0.048	-0.016
Low burned radius x 2019				0.017	0.012	0.006
High burned radius				0.407	0.295	0.144
High burned radius x 2017				-0.204**	-0.018	-0.199***
High burned radius x 2018				-0.274***	-0.156	-0.144***
High burned radius x 2019				-0.123	-0.090	-0.011
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,301	1,301	1,301	1,301	1,301	1,301
Adjusted R2 (within)	0.621	0.607	0.123	0.618	0.604	0.127

Notes: (cont.)

Table 7b. Impact of wildfires on cash-flows: indirectly affected hotels (cont.).

	Operating revenues	Operating costs	Cashflow	Operating revenues	Operating costs	Cashflow
	(13)	(14)	(15)	(16)	(17)	(18)
Panel C. Tourist attraction damages						
RN2000 damaged (<1km)	0.040	0.123	-0.052			
RN2000 damaged (<1km) x 2017	0.118*	0.052	0.100			
RN2000 damaged (<1km) x 2018	-0.102*	-0.156*	0.097			
RN2000 damaged (<1km) x 2019	0.187**	0.112***	0.189			
Proximity RN2000 damaged				0.130	0.066	0.162
Proximity RN2000 damaged x 2017				0.008	-0.013	0.052
Proximity RN2000 damaged x 2018				-0.764***	-0.659**	-0.128
Proximity RN2000 damaged x 2019				0.120	-0.111	-0.075
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,301	1,301	1,301	1,301	1,301	1,301
Adjusted R2 (within)	0.616	0.603	0.122	0.617	0.604	0.126

Notes: The table presents the regression results for the baseline approach (*Panel A*), where we use the indirectly affected dummy (1 if the shortest distance to the 2017 is lower than 1 km, but not directly affected); *Panel B* provides evidence on the landscape destruction channel, where we use the share of burned area in the 1km radius of each hotel as the proxy for damages to the surrounding landscape; and *Panel C* documents the affected tourist attractions channel, where two measures are used: a dummy 1 if the hotel is located within 1 km radius of a burned area belonging to 'Rede Natura 2000' and a gravitational-based measure, which adjusts the share of RN2000 area damaged within 1 km by the distance to the nearest burned area belonging to RN2000. The results are obtained using OLS regressions with two-way clustered standard errors (Hotel and Year) and time and regional (municipality) fixed effects. The sample covers the full period (2015-19), indirectly affected hotels (n=97) and matched hotels (n=184). The dependent variables are log transformed (natural log). Due to data quality concerns, the regressions on the breakdown of operating costs, (3), (4) and (5) are performed only for observations with positive values for the dependent variable under analysis. The firm-level controls are lagged 1 period: *size* (natural log of total assets), *age* (natural log of hotel age), *profitability* (ROA), *tangibility* (tangible fixed assets to total assets), *cash* (cash & cash equivalents to total assets), and *leverage* (total liabilities to total assets). All variables are winsorized at the 5% and 95% levels. Given the ln-linear nature of the baseline model, to interpret the main coefficients of interest (i.e., affected hotels) as percentage changes in the dependent variable, in the text we report the transformed results: $\Delta x = 1\ (affected) \Rightarrow \Delta\%y = \left(e^{\beta} - 1\right) \times 100$. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Table 8. Impact of wildfires on financial decisions: directly and indirectly affected hotels

	ΔBank debt	ΔShort-term bank debt	ΔLong-term bank debt	ΔAccounts receivables	ΔAccounts payables	CAPEX	ΔCash
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Directly affected							
Directly affected	2.901	0.338	1.227	0.348	-0.222	-4.254	1.173
Directly affected x 2017	3.944**	0.402	3.470***	-0.112	0.770***	8.231	-0.776
Directly affected x 2018	0.138	-0.871	3.225***	-0.546*	0.344*	12.325**	1.521**
Directly affected x 2019	-3.181*	-0.153	-1.980***	-0.199	0.719***	7.398	1.086**
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	765	765	765	765	765	761	765
Adjusted R^2 *(within)*	0.058	0.007	0.047	0.017	0.029	0.265	0.145
	ΔBank debt	ΔShort-term bank debt	ΔLong-term bank debt	ΔAccounts receivables	ΔAccounts payables	CAPEX	ΔCash
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Panel B. Indirectly affected							
Indirectly affected	2.016	-0.047	0.627	0.339	0.364	3.802	-0.214
Indirectly affected x 2017	-1.022	0.221**	-0.200	-0.560**	0.688**	-4.200*	-1.092**
Indirectly affected x 2018	-2.744	0.169	-2.223	-0.358	-0.089	-2.285	-0.181
Indirectly affected x 2019	-1.364	-0.337***	0.133	-0.242	-0.380	-0.739	-0.202
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,301	1,301	1,301	1,301	1,301	1,276	1,301
Adjusted R2 (within)	0.033	0.006	0.014	0.018	0.028	0.213	0.051

Notes: The table presents the regression results using the directly affected dummy (1 if the shortest distance to the 2017 is 0 meters) in *Panel A*, and the indirectly affected dummy (1 if the shortest distance to the 2017 is lower than 1 km, but not directly affected) in *Panel B*. The dependent variables are computed as the yearly change divided by lagged total assets and multiplied by 100, except CAPEX which is the change in tangible fixed assets plus amortizations, divided by lagged tangible fixed assets and multiplied by 100. Given the within format of the dependent variables (change), the results are obtained using OLS regressions with one-way clustered standard errors (Year) and time and regional (municipality) fixed effects. All variables are winsorized at the 5% and 95% levels. Given the delta-linear nature of this model, the main coefficients of interest (i.e., affected hotels) can be directly interpreted as percentage point changes in the growth rate of the dependent variable. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Table 9a. Robustness checks

	Cashflow	Δ Debt	ΔReceivables	ΔPayables	CAPEX	Δ Cash
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Exclude hotels affected by wildfires in 2014-16: directly affected						
Directly affected	-0.113	2.667	0.083	-0.502	-0.423	1.401
Directly affected x 2017	-0.114***	4.543***	0.043	0.976***	7.415*	-0.643**
Directly affected x 2018	-0.138***	3.018*	-0.509***	0.657**	14.622***	1.926***
Directly affected x 2019	0.041	-4.414**	0.111	1.089***	10.344**	-0.840*
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	646	646	646	646	639	646
Adjusted R2 (*within*)	0.135	0.057	0.019	0.031	0.286	0.141
	Cashflow	Δ Debt	ΔReceivables	ΔPayables	CAPEX	Δ Cash
	(7)	(8)	(9)	(10)	(11)	(12)
Panel B. Excluding hotels affected by wildfires in 2014-16: indirectly affected						
Indirectly affected	0.033	1.401	0.257*	0.126	4.357	0.510
Indirectly affected x 2017	-0.067*	-2.211	-0.471**	0.602*	-4.335**	-1.338***
Indirectly affected x 2018	-0.060	-2.571	-0.297*	0.289	-1.271	-0.085
Indirectly affected x 2019	0.034	-2.218	-0.254*	0.311	-0.663	-1.201**
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	985	985	985	985	965	985
Adjusted R2 (*within*)	0.123	0.024	0.027	0.030	0.196	0.040
	Cashflow	Δ Debt	CAPEX	Cashflow	Δ Debt	CAPEX
	(13)	(14)	(15)	(16)	(17)	(18)
Panel C. Alternative radius/thresholds for indirectly affected						
Indirectly affected (0.5km)	0.129*	1.795	-1.820			
Indirectly affected (0.5km) x 2017	-0.085**	-1.730	-5.279**			
Indirectly affected (0.5km) x 2018	-0.105***	-1.687	-2.057			
Indirectly affected (0.5km) x 2019	-0.015	0.125	1.277			
Indirectly affected (2 km)				0.012	3.217	7.002
Indirectly affected (2 km) x 2017				-0.012	-2.248	-2.758
Indirectly affected (2 km) 2018				-0.004	-2.842	-1.520
Indirectly affected (2 km) 2019				0.026	-1.163	-2.149
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,027	1,027	1,007	1,543	1,543	1,516
Adjusted R2 (*within*)	0.108	0.044	0.228	0.110	0.036	0.218

Notes: (cont.)

Table 9b. Robustness checks (cont.).

	Cashflow	Δ Debt	ΔReceivables	ΔPayables	CAPEX	Δ Cash
	(19)	(20)	(21)	(22)	(23)	(24)
Panel D. Exclude municipalities adjacent to Ourém						
Indirectly affected	0.063	2.208	0.335	0.299	1.576	-0.155
Indirectly affected x 2017	-0.045**	-0.853	-0.499**	0.596***	-2.736*	-1.520***
Indirectly affected x 2018	-0.057*	-2.626	-0.364*	-0.065	-1.439	-0.072
Indirectly affected x 2019	0.025	-1.704	-0.236	0.314*	0.914	0.555
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,227	1,227	1,227	1,227	1,207	1,227
Adjusted R2 (within)	0.119	0.031	0.019	0.024	0.216	0.053
	Cashflow	Δ Debt	CAPEX	Cashflow	Δ Debt	CAPEX
	(25)	(26)	(27)	(28)	(29)	(30)
Panel E. Non-affected hotels located outside the Center Region						
Directly affected	-0.094	0.046	-0.196**			
Directly affected x 2017	-0.028	0.025**	0.111**			
Directly affected x 2018	-0.037*	-0.003	0.134***			
Directly affected x 2019	-0.015	-0.029	0.035			
Indirectly affected				-0.067	0.009	-0.127**
Indirectly affected x 2017				-0.019**	-0.032	-0.088
Indirectly affected x 2018				-0.021*	-0.031	-0.005
Indirectly affected x 2019				-0.032**	-0.007	0.002
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and District FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	760	760	754	1,334	1,334	1,308
Adjusted R2 (within)	0.151	0.035	0.301	0.122	0.021	0.223
	Operating revenues	Operating costs	Cashflow	Δ Debt	CAPEX	Δ Cash
	(31)	(32)	(33)	(34)	(35)	(36)
Panel F. Spillover effects to hotels with high wildfire risk located outside the Center Region						
High wildfire risk	-0.462	-0.269	-0.047	0.045**	-0.034	0.018
High wildfire risk x 2017	0.062	0.057	-0.037	-0.037*	0.051	-0.057**
High wildfire risk x 2018	-0.000	0.049	-0.044	-0.042*	-0.149***	-0.061**
High wildfire risk x 2019	-0.056	-0.032	0.088	0.008	0.044	-0.042**
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year and District FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	411	411	411	411	407	411
Adjusted R2 (within)	0.655	0.679	0.153	0.073	0.261	0.066

Notes: Each panel presents a robustness check: in panels A and B we exclude hotels directly or indirectly affected in the 3-years before the 2017 wildfires (2014-16) and re-run the matching process; in panel C, we test alternative thresholds for indirectly affected hotels: 0.5 km and 2 km; in panel D, we remove all hotels located in the neighbour municipalities of Ourém (Fátima); in panel E, we select unaffected hotels located outside the Center Region; in panel F, we use hotels located in high wildfire risk located outside the Center Region as the treated units. The firm-level controls are lagged 1 period: *size* (natural log of total assets), *age* (natural log of hotel age), *profitability* (ROA), *tangibility* (tangible fixed assets to total assets), *cash* (cash & cash equivalents to total assets), and *leverage* (total liabilities to total assets). All variables are winsorized at the 5% and 95% levels. In columns (1), (7) and (13), the dependent variable is log-transformed, hence the coefficients need to the transformed: $\Delta x = 1\ (affected) \Rightarrow \Delta\%y = \left(e^{\beta} - 1\right) \times 100$; in the remaining columns, the coefficients can be interpreted as percentage point changes in the growth rate of the dependent variable. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Appendix

Table I. Back of the envelope analysis: aggregate effects

						Accumulated losses	
		2016	2017	2018	2019	2018-19	2017-19
Panel A. Directly affected							
Single establishment hotels (n=33)	Total revenues	6 245					
	Average revenues	189					
	Estimated effect		0.205	0.300	0.185		
	(1) Quantification		1 280	1 874	1 155	3 154	4 309
Multiple establishment hotels (n=26)	Total revenues	9 811					
	Average revenues	377					
	Estimated effect		0.205	0.300	0.185		
	(2) Quantification		2 011	2 943	1 815	4 954	6 769
Total hotels (n=59)	(3) = (1) + (2)		3 291	4 817	2 970	8 108	11 078*
All hotels in municipalities of directly affected hotels	(4) Total revenues	59 781					
Local impact of peak accumulated losses	$(3)_{2017\text{-}19}$ / (4)	18.5%					
Panel B. Indirectly affected							
Single establishment hotels (n=97)	Total revenues	29 929					
	Average revenues	309					
	Estimated effect		0.039	0.078	-0.065		
	(5) Quantification		1 167	2 334	-1 945	3 501	1 556
Multiple establishment hotels (n=46)	Total revenues	28 119					
	Average revenues	611					
	Estimated effect		0.039	0.078	-0.065		
	(6) Quantification		1 097	2 193	-1 828	3 290	1 462
Total hotels (n=143)	(7) = (5) + (6)		2 264	4 527	-3 773	6 791*	3 018
All hotels in municipalities of indirectly affected hotels	(8) Total revenues	217 290					
Local impact of peak accumulated losses	$(7)_{2018\text{-}19}$ / (8)	3.1%					

Notes: Values expressed as thousands of euros, unless stated otherwise. The estimated effect corresponds to the interaction term coefficients of regression (1) presented in **Table 6** (directly affected) and **Table 7a** (indirectly affected). Quantification is calculated as total revenues in 2016 multiplied by the estimated effect. Peak accumulated losses marked with *.

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