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# Public Attention and Environmental Action: Evidence from Fires in the Amazon*

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August 11, 2022

**Abstract**

International agreements to reduce anthropogenic environmental disasters rely on public pressure driving local action. We study whether focused media and increased public outcry can drive local environmental action, reducing environmental damage. Although an annual affair, forest fires in the Brazilian Amazon received unprecedented public scrutiny in August 2019. Comparing active fires in Brazil versus those in Peru and Bolivia in a difference-in-differences design, we find that increased public attention reduced fires by 22% avoiding 24.8 million $MtCO_2$ in emissions. Our results highlight the power of public attention to compel local action on pressing environmental issues.

*JEL*: Q51, Q54, L82, F55

*Keywords*: Forest Fires, Media Attention, Carbon Emission, Amazon, Climate Change.

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# 1 Introduction

Environmental disasters can occasionally capture international public attention, especially if these are of global importance and national governments are unable or unwilling to curtail damages. While public awareness and mass media coverage are key to making governments responsive and accountable to society (Besley and Burgess, 2002; Besley and Prat, 2006; Snyder Jr and Strömberg, 2010), it is unclear whether efforts to raise public awareness about pressing environmental challenges have any local abatement effects. Indeed, the relevance of international environmental agreements is contingent at least partially on national and international attention compelling local conservation.

Empirically investigating the effects of public attention on conservation has been challenging. Public attention often builds either around the media coverage of idiosyncratic one-off events (e.g., a nuclear power plant disaster) or slowly and continuously around repeated phenomena (e.g., air pollution, water pollution). In both cases, it is rare to have a suitable comparison group to estimate the counterfactual conservation had the issue remained out of the public eye. When environmental events are unique, unobservables are likely underlying them. When events are repeated phenomena, the issue of selection in media coverage and global dissemination of information makes it unlikely to have such a comparison group.

In this paper, we use a quasi-experiment in public attention on forest fires in the Brazilian Amazon, one of the most biodiverse and carbon-rich tropical forests in the world. Fires in tropical forests are a pressing concern around the world, resulting in particulate emissions that harm human health (Jayachandran, 2009; Sheldon and Sankaran, 2017; Tan-Soo and Pattanayak, 2019; Barlow et al., 2020; Rocha and Sant'Anna, 2022) and contribute to global warming (Cochrane, 2003; Aragão et al., 2018; Araujo et al., 2020; Balboni et al., 2021a).

Seasonal forest fires occur every year in the Brazilian, Bolivian, and Peruvian Amazon biome burning thousands of square kilometers of land without receiving much media attention. In 2019, however, there was a surge in international attention on forest fires *in Brazil* in the second half of August. The sudden rise of public attention had three features that make it an ideal episode to evaluate the effect of public attention on local conservation. First, the phenomenon receiving attention – seasonal forest fires – is an annual affair allowing us to study them over time. Second, while the fires were usual, the surge in media coverage and public attention was unusually high. We show that searches for fires in the Brazilian Amazon increased manyfold during the second half of August 2019 as did stories in leading newspapers around the world. Finally, although these seasonal fires affected the Brazilian, Peruvian, and Bolivian Amazon roughly equivalently and at similar levels to previous years, the attention was uniquely focused on the Brazilian Amazon. Indeed, we show that the searches and articles were focused on the Brazilian Amazon or the Brazilian President.

We first show that trends in bi-weekly fires per square kilometer in Brazil, Peru, and Bolivia largely followed each other in the previous years and the first half of 2019. Second, we show that through much of this "pre-treatment period", international public attention on fires in the Brazilian, Peruvian, and Bolivian Amazon were largely similar and two orders of magnitude smaller than the attention peak on the Brazilian Amazon in the second half of August 2019. We then estimate the effect of international attention on fires in Brazil by employing a difference-in-differences strategy comparing fires in Brazil against fires in Peru and Bolivia before and after the spike in international attention.[1]

We estimate that the attention surge in 2019 reduced subsequent forest fires in the Brazilian Amazon by 22% in that year. A back-of-the-envelope calculation suggests the fires averted account for 3.8% of the reductions in emissions needed for Brazil to meet its commitments to the Paris Agreement. Our results are robust to using fire count or fire intensity measures, a Poisson model, a synthetic control method, and a triple-differences strategy where we further exploit seasonal differences in fires within each country.

We discuss potential mechanisms underlying our results. In response to the public pressure, the Brazilian government dispatched fire brigades to affected areas. We show that this action, although effective, cannot fully account for the reduction in fires. Our results suggest that other actions, including those from civil society, also contributed to controlling the fires in Brazil. We show that public awareness was particularly effective in reducing fires in forested areas, more so than in reducing field burning on agricultural land. We also show that these effects were not driven by the potential displacement of fire activity across national borders.

Our paper relates to a growing literature on the economic effects of media and public awareness. Prior work has shown that media coverage influences citizens' opinions about policy issues (DellaVigna and Kaplan, 2007; Gerber et al., 2009; Enikolopov et al., 2011; Chiang and Knight, 2011; Shapiro, 2016), affecting even individual environmental behavior. For example, Jacobsen (2011) shows that the documentary *An Inconvenient Truth* influenced people to buy carbon offsets. Beattie (2021) shows that the media's climate change coverage makes people choose more environmentally friendly driving options. Our findings show that mass media coverage and public awareness can pressure civil society and governments – even those hostile to conservation – to act on large and pressing environmental emergencies.

The remainder of this article is organized as follows. In Section 2 we discuss data on

[1] We use Bolivia and Peru over other neighboring countries (e.g., Venezuela, Colombia, Suriname, Guyana, and French Guiana) because the fire seasonality in other neighbors is substantially different than those in Brazil, Bolivia, and Peru (Marcus and Sant'Anna, 2021).

public attention and fires. In Section 3 we provide background on our natural experiment and describe our empirical setting and research design and in Section 4.1 we present our results. In Section 5 we offer concluding remarks.

## 2 Data

In this section, we describe the various data sources used in our analysis. The two main variables we examine are changes in public attention (measured by the number of Google searches and newspaper articles) and satellite-based measures of active fires.

**Public attention.** We measure global attention to specific issues using data on Google searches (see, e.g., Preis et al., 2013; Sheshadri and Singh, 2019).[2] This data captures the relative size of searches for specific terms normalized by the peak of searches in the period. We consider searches in the whole world in English, Portuguese, and Spanish. To complement our results on Google search terms, we also report trends in newspaper articles mentioning forest fires in Brazil appearing in leading English daily newspapers: The New York Times and The Guardian.

**Active fires.** We obtain remote sensing data on the count of pixel-days of active fires at 1km resolution from Fire Information for Resource Management System (FIRMS).[3] Using the standard MODIS Fire and Thermal Anomalies product, this data provides global coverage every 1-2 days, which we aggregate to a panel of pixel-weekly data between June and November for 2016 to 2019. Weeks are set starting on the first Monday of June of each year. Each pixel-week is flagged with a fire occurrence if it contains an active fire in that week. Under good conditions, FIRMS can identify fires as small as 100 $m^2$.

For robustness checks, we also work with a measure of fire intensity (brightness per km$^2$) from FIRMS and burned area. Data on area burned are from MODIS Burned Area Monthly Global available at the 1km spatial resolution (similar to data on fires) but only at the monthly temporal resolution.

**Other data sources.** Country borders and the limits of the Brazilian Amazon biome are available from the Brazilian Institute of Geography and Statistics (IBGE)[4]. The limits of the Peruvian and Bolivian Amazon biome are available from the Amazon Geo-Referenced Socio-Environmental Information Network (RAISG)[5]. Data on land cover is from the Map-

[2]Data available at: trends.google.com/trends.
[3]Available at www.earthdata.nasa.gov/firms. Accessed through Gorelick et al. (2017).
[4]Available at www.ibge.gov.br/en/home-eng.html
[5]Available at www.amazoniasocioambiental.org/en

biomas project[6]. Weekly precipitation data is obtained from ERA5 produced by the European Centre for Medium-Range Weather Forecasts.

To investigate possible mechanisms through which the government may act on a fire crisis, we gather data on fire brigades at the municipal level for the year 2019 from the Registry of Fire Incidents from the Environmental Agency (ROI/IBAMA). These are the records of the organ inside the Ministry of the Environment responsible for the policy of preventing and fighting forest fires throughout the national territory. This data set does not paint a complete picture of fire brigades, since we do not have access to data on military operations, which happens outside the scope of the Ministry of the Environment.

# 3 Background and Research Design

In this section, we describe the study context and provide details on the natural experiment and the research design.

## 3.1 A Natural Experiment in Public Attention

Forest fires are an annual phenomenon in much of the Amazon in the second half of each calendar year. Although these seasonal forest fires occur every year in the Brazilian, Bolivian, and Peruvian Amazon biome (Figure 1a), there was a dramatic surge in public attention on forest fires in Brazil in the second half of August 2019. Using data on Google searches in the whole world, we see that searches on fires in the Amazon increased sharply in August 2019 in English, Portuguese, and Spanish (Figure 1b). At the same time, articles on fires in the Amazon in leading newspapers such as the Guardian and the New York Times also increased many fold (Appendix Figure A1). This unusual, unprecedented increase in attention provides the basis for our empirical analysis.

Three features make this episode ideal to study the effect of public attention on environmental outcomes. First, the surge in attention was unprecedented but around a routine annual affair. Appendix Figure A2 plots the accumulated number of fire outbreaks for the Brazilian Amazon for different years as evidence that 2019 was an average year of fire activity. It shows there were higher cumulative fires as of August 2019 than in August 2018 but similar to those in 2017, and is similar to the trajectories of the 2000's.[7]

[6] Available at: www.mapbiomas.org

[7] It also shows that cumulative fires in 2020 were similar to 2019 but accompanied with no surge in public attention (potentially because of COVID-19).

Second, even though fires were as much an issue in the Bolivian and Peruvian Amazon as they were in the Brazilian Amazon, only the Brazilian Amazon received this unusually high attention. Data show that the Google searches were specific to Brazil – a pattern evident either using the country's name (Figure 1c) or using the respective President's name (Figure 1d) in the search. Third, the outcome of interest can be tracked using the same data source (satellite imagery) before and after the surge in attention.

**What caused the increase in public attention?** Although we exploit the surge in public attention in 2019, we cannot definitively point to a single factor that led the world to pay such close attention to fires in the Brazilian Amazon in 2019 as opposed to previous years or neighboring countries. Although the fire season arrived earlier in 2019 than it did in 2016-2018 (Caetano, 2021), the peak in 2019 was similar to that in 2018 and lower than that in 2017 (Figure 2a). Moreover, the accumulated number of fire outbreaks in August 2019 is about average for the same month in the last two decades (Figure A2). For our empirical design, this suggests that fire intensity was unlikely to be a major driver of international attention. A more likely reason is that the newly elected Brazilian President Jair Bolsonaro had previously attracted international scorn for an anti-environmental agenda, prompting greater scrutiny of environmental incidents in Brazil (Escobar, 2019). Indeed, most newspaper articles included a mention of his anti-environmental stance.

**International versus Domestic Public Attention.** An important caveat is that we are not definitively able to distinguish between *international* public attention as opposed to *domestic* visibility. Indeed, it is possible that domestic outcry also played a role in pressuring the government out of concerns about local air pollution. However, several pieces of evidence suggest that this was unlikely to be the dominant factor. For example, air pollution levels in São Paulo, the largest city in Brazil, were similar (if anything lower) in 2019 to the same period in previous years (Figure A3).

A unique episode, however, may have contributed to igniting the media coverage. On August 19, suspended particulates from the fires in the Amazon, brought by a cold front, reached São Paulo creating a black sky during the day. Such "black sky days" are a recurrent phenomenon in cities closer to the Amazon, but it was a one-off event in São Paulo. This may have caught the public attention to the Amazon fires, as the population of the largest city in South America could see the smoke of the Amazon fires clearly for the first time. This was covered in all national and some international news. As we show in Appendix B, despite what sparked the surge in public attention, evidence from Google searches suggests strongly that the focus of both national and international attention was on the Amazon fires and not on São Paulo's "black sky day" (Figure A4). Nonetheless, we can't disentangle the relative roles of national versus international public attention since the two likely catalyze each other.

## 3.2 Research Design

To estimate the effect of public attention on fires in the Brazilian Amazon, we employ a difference-in-differences strategy using fires in the Bolivian and Peruvian Amazon as a control group for the fires in the Brazilian Amazon (Armenteras et al., 2017). As shown in Figure 1c-d, the international attention on forest fires was entirely focused on Brazil with very little interest in the similar magnitude of fires taking place in Peru and Bolivia.

We estimate the differential Amazon fires in Brazil relative to Bolivia and Peru over 2019 as captured by $\gamma_t$ from the equation below:

$$fire_{i,r,w} = \alpha_i + \delta_w + \sum_{t=Jun3}^{Nov5} \gamma_t BrAm_i 1\{w = t\} + \eta_r X_{i,w} + \varepsilon_{i,r,w} \tag{1}$$

where $fire_{i,r,w}$ is the number of fires in pixel $i$ in country $r$ in week $w$, $BrAm_i$ is a dummy for the Brazilian Amazon region, $\alpha_i$ are pixels and $\delta_w$ are week fixed effects (weeks starting in the date indicated) – pixel fixed effects control for time-invariant factors that are specific to each pixel such as geography and regulatory context. $X_{i,w}$ is a vector of pixel-week controls (contemporary precipitation and average fire outbreaks between 2016–2018). We allow $\eta_r$ to differ across countries $r$. $\varepsilon_{i,r,w}$ is the idiosyncratic error, which we cluster at 25km $\times$ 25km grids to account for serial and spatial correlation. Because we have over 120 million pixels, for computational reasons, we estimate equation 1 using a random sample of 50% of total pixels.

Under the assumption that forest fires in the Brazilian Amazon, absent media and public attention, would have followed a similar trend as the fires in Bolivia and Peru, $\gamma_t$ estimates the average treatment effect of public attention on fires over the remaining of the 2019 fire season. Figure 2a shows that the number of fire outbreaks per unit area from 2016-2018 followed similar trends within the year in Brazil and Peru and Bolivia. Figure 2b shows that the number of fire outbreaks in 2019 across Brazil, Peru, and Bolivia followed a common trend until mid-August.

We also estimate the average effect of public pressure on fires in the Brazilian Amazon between September and mid-November, captured by $\gamma$, in the following equation:

$$fire_{i,r,w} = \alpha_i + \delta_w + \gamma BrAm_i 1\{w \geq Aug18\} + X_{i,r,w}\eta_r + \varepsilon_{i,r,w} \tag{2}$$

following a similar notation as in equation 1.

As a robustness check, we estimate a triple-differences strategy where we compare Brazil with its neighbors before and after August in 2019 versus 2016-2018. We estimate the following equation:

$$fire_{i,r,w,2019} - fire_{i,r,w,2016-2018} = \alpha_i + \delta_w + \gamma BrAm_i 1\left\{w \geq Aug18\right\} + X_{i,r,w}\eta_r + \varepsilon_{i,r,w} \quad (3)$$

where $AvgFire_{i,r,w,2016-2018}$ is the average fire outbreak in pixel $i$ in fire week $w$ between 2016 and 2018. The coefficient $\gamma$ in this equation captures the triple-difference estimate.

# 4 Results

## 4.1 Main Results

Figure 3a shows the differential number of fire outbreaks per km$^2$ in the Brazilian Amazon every two weeks relative to the Peruvian and Bolivian Amazon – as captured by $\hat{\gamma}_t$ from equation (1). We observe no differential fires in Brazil before the spike in public attention, supporting the common trends assumption that underlies a causal interpretation of difference-in-differences estimates. We estimate that the surge in public attention reduced fires in the second half of September 2019 by 60% (0.013 days of fire per km$^2$) relative the average fires during the same period in the Peruvian and Bolivian Amazon. While the effect is most prominent in September, it persists through early November as the fire season comes to an end in the region. We estimate that public awareness reduced fires by 40% (0.003 days of fire per km$^2$) in the Brazilian Amazon from October to early November relative to its neighbors in the same period.

Figure 3b shows the results of the difference-in-differences estimation using fire intensity (brightness per km$^2$) as the dependent variable. This measure of fire activity produces remarkably similar effects to those using fire counts data – a 60% reduction in the second half of September and a 37% reduction in October and early November. We also obtain similar results if we use monthly area burned as the dependent variable (Appendix Figure A5a) or estimate the model with week specific coefficients (Appendix Figure A5b).

Table 1 columns 1-4 show the results for the average effect of public pressure on fires, as described in equation 2. Our estimates are robust to controlling for precipitation and average fires from 2016-2018 at the pixel level. In our preferred specification (column 4), we observe that fires decline by 0.004 days of fire per km$^2$ after the spike in international attention until the end of the 2019 fire season. Altogether, our estimates indicate that international attention resulted in 187,215 fewer pixels-days of active fires than would have occurred in the absence of the same attention. This corresponds to a reduction of 22% of the total pixel-days of fires in the Brazilian Amazon relative to the counterfactual scenario where public attention is absent.

The result of the triple-difference specification (accounting for additional within-year differences in fire activity), described in equation 3, is shown in Table 1 column 5. The effect is slightly larger than the difference-in-differences estimate in column 4 – fires decline by 0.005 days of fire per $km^2$ (as opposed to 0.004 days of fire per $km^2$) after the spike in international attention.

To further explore the structure of our count data on fire activity we estimate a Poisson model as in (Balboni et al., 2021a). The Poisson model is estimated with a substantially smaller sample because a Poisson model with unit fixed effects limits the sample to units with variation in the dependent variable (Correia et al., 2019). Thus, the Poisson model is capturing an intensive margin of the use of fire (pixels with multiple occurrences of fires over the season) rather than an extensive margin. Table 1 column 6 consequently shows that the Poisson model recovers noisier and smaller effects, as it estimates a 6% reduction in the intensive margin of fire activity.

In all specifications we cluster standard errors at $625km^2$ grids. To minimize additional concerns over spatial correlation, we implement the Synthetic Control method by averaging weekly fire at the country level (i.e., Brazilian Amazon, Bolivian Amazon, and Peruvian Amazon). Figure A5c shows the results of the synthetic control using Bolivia and Peru as donor pool. The synthetic control method estimates an average reduction of 0.0037 days of fire per $km^2$ in the period, similar to the effect size 0.0040 days of fire per $km^2$ estimated using the conventional difference-in-differences method.

## 4.2 Were fires displaced across national borders?

One potential concern could be that at least part of the reduction in fires in Brazil was driven by the displacement of illegal fires across the border. We find no evidence to support this concern. First, the map of fire intensity shows that the main locations of active fires in August 2019 were not close to the border (Figure A6). If anything, we can observe an increase in fires in Brazil near the border around Rio Branco and at the Chico Mendes Extractive Reserve in the state of Acre.

Second, we compare occurrences of fires around the Brazilian border with Bolivia and Peru using a border regression discontinuity design as in Burgess et al. (2018). Figure A7 shows the average number of fire outbreaks within 27km from the border in August and September.[8] We see that the reduction of fires between August and September on the Brazilian side of the border was not followed by an equivalent increase in fires in the neighboring countries close to the border. The regression discontinuity estimates show no discontinuous fire outbreaks at the border neither before or after the surge in public attention.

### 4.3 Where was public attention most effective?

To quantify the impact of public attention on the amount of carbon released by the fires, we investigate whether the public pressure was more effective to prevent fires in areas with denser forest cover than in other areas, such as pastureland. We assess this issue by estimating heterogeneous effects of the public pressure on fires in areas with greater forest cover, as captured by $\gamma_2$ in the following equation:

$$\begin{aligned} fire_{i,r,w} &= \alpha_i + \delta_w + \gamma_1 BrAm_i 1\{w \geq Aug18\} \\ &+ \gamma_2 BrAm_i 1\{w \geq Aug18\} \times Forest_i + X_{i,r,w}\eta_r + \epsilon_{i,r,w} \end{aligned} \tag{4}$$

where $Forest_i$ is the share of forest cover in each pixel in 2015 or an index equal to one for pixels with forest cover above a certain threshold.

We present results in Table 2 columns 1-4. We find that public attention was about three times more effective to reduce fires in forested pixels than in non-forest pixels. For example, we estimate in column 2 that while attention reduced the number of fire outbreaks by 0.0016 days of fire per km$^2$ in pixels with less than 50% of forest cover, it reduced additional 0.0029 days of fires in pixels with more than 50% of forest cover. This suggests that agents refrained from setting fires on or near forested areas more so than in non-forested areas. This is consistent with Balboni et al. (2021b) who show that agents act strategically when setting fires, internalizing the risk of government punishment.

### 4.4 How did government actions curtail fires?

Forest fires in the Amazon are an annual phenomenon, but a marked increase in international attention resulted in nearly 22% fewer pixel-days of active fire in 2019. Two main actions were taken by the federal government after the outcry: (i) fire control actions by recruiting and dispatching fire brigades to specific areas – some under the military "Green Brazil Operation"; and (ii) a 60-day ban on the use of agriculture fires inside the Legal Amazon. As the timeline

[8] We follow (Calonico et al., 2014) to obtain the optimal bandwidth.

of events shows (see Appendix C), both actions were initiated after the marked increase in public attention.

Although we cannot test for the extent to which each civil or government action in the aftermath of international outcry affected subsequent fires, we assess whether the fire brigades dispatched or recruited to control the forest can fully explain the effects we estimate. We use government records to identify the municipalities that received external fire brigades or that received funds to recruit firefighters (from the Ministerial Ordinance # 3020/2019). We regress equation 4 using as interaction term a dummy for the municipalities that received fire brigades instead of the $Forest_i$ variable.

The coefficients in Table 2 column 5 show a differential reduction of fires in areas that received fire brigades. However, we also see that the public outcry reduced fires in areas that did not receive federal assistance with fire brigades. Our estimates imply that fire brigades only partially contributed to reducing fires following the international outcry, suggesting that actions mediated by civil society and local governments also contributed to fire control.

It is worth noting that the "Green Brazil Operation" launched in 2019 was a military operation that included additional fire brigades over and above those sent by non-military agencies, such as IBAMA. Unfortunately, data from the military operations are not available and therefore excluded from our analysis. As such, our result is an existence result in that we show that increased public attention reduced fires in the Brazilian Amazon through a combination of various actions from the government and civil society. However, disentangling the relative magnitude of each government action in reducing fires is beyond the scope of this paper.

**Why did international public attention work?** As we discussed in Section 3, one limitation of the paper is that it is difficult to empirically disentangle why the increase in international attention led to domestic action. We include a timeline of key events in the Appendix C. Economic and reputational reasons might have encouraged the government to curtail the fires. For example, after the news of the fire reached the press, France threatened to block the Mercosur-European Union trade agreement, and foreign investors representing $16.2 trillion in assets signed a letter calling on firms to protect the world's rainforest. As shown in Hsiao (2021), when domestic action faces resistance from the government, trade policy offers an intervention strategy for the international community.

## 4.5 Quantifying the effects in $CO_2$

The Amazon remains one of the major strands of tropical forests in the world and preserving its integrity is crucial to meeting targets under the Paris Agreement and the United Nations

Sustainable Development Goals. We perform a back-of-the-envelope calculation to quantify the avoided forest fires in terms of avoided $CO_2$ emissions.

To do so, we use Global Fire Emissions Database (GFED) which has compiled and revised data on fire count and emissions 2003-2015 (Randerson et al., 2012; Giglio et al., 2013; Van Der Werf et al., 2017).[9] This data is not available for 2019, so we predict emissions based on GFED data in two steps. First, we run a linear regression of fire counts on emissions between 2003 and 2015.[10] Second, we predict emissions between September and mid-November 2019 using these estimates and the fire count in this period.

We predict that the total emissions in the Brazilian Amazon between September and November 2019 was 112 million tons of $CO_2$. Thus, we calculate the reduction of 22% of fire days caused by public attention (Table 2 column 2) helped prevent the release of 24.81 million tons of $CO_2$ to the atmosphere.

We benchmark this number with the difference between Brazil's current emissions (De Azevedo et al., 2018) and the Brazilian goal of emission reductions under the Paris Agreement. Our back-of-the-envelope calculations suggest that the effect of public pressure corresponds to 3.86% of $CO_2$ emissions that Brazil should have cut down in 2018 to reach the Paris Agreement goal.

# 5 Conclusion

The Amazon remains one of the major strands of tropical forests in the world and preserving its integrity is crucial to meeting targets under the Paris Agreement and the United Nations Sustainable Development Goals. In this paper, we examine the effect of a dramatic spike in public attention on the Brazilian Amazon on fires. By exploiting the unusual attention on a seasonal affair, we estimate the effects of public attention on local environmental outcomes.

We show that the surge in media and public attention to the Brazilian Amazon fires in August 2019 reduced the number of fires in Brazil by 22% (187,215 avoided pixel-days of active fire) relative to those in the Bolivian and Peruvian Amazon in the same period. We estimate that public attention was at least twice more effective in areas with denser forest cover. Back-of-the-envelope calculations reveal that the fires averted in 2019 in the wake of public awareness account for 3.8% of the reductions in emissions needed for Brazil to meet its commitments to the Paris Agreement. Our findings imply that even under administrations

[9] Data available at http://www.globalfiredata.org/

[10] The predictive power of using fire counts to predict emissions is high in our setting – the R-squared of the regression is 0.746, larger than some regressions presented in GFED's regional estimates.

openly hostile to conservation, public attention can lead to positive responses to urgent environmental catastrophes.

More work is needed to understand what captures media and public attention to a specific issue. Although fire activity remains very high in Brazil since the 2019 episode, the marked attention that led to a decline in forest fires in 2019 has been largely absent. That fires resume strongly in the subsequent seasons suggests the effects of public awareness are short-lived, and that attention needs to remain high to keep local governments under pressure to act. It remains an open question whether the effects of continued public attention persist or fade over time. Future work should also shed light on whether international outcry can lead the government to act on issues other than environmental disasters.

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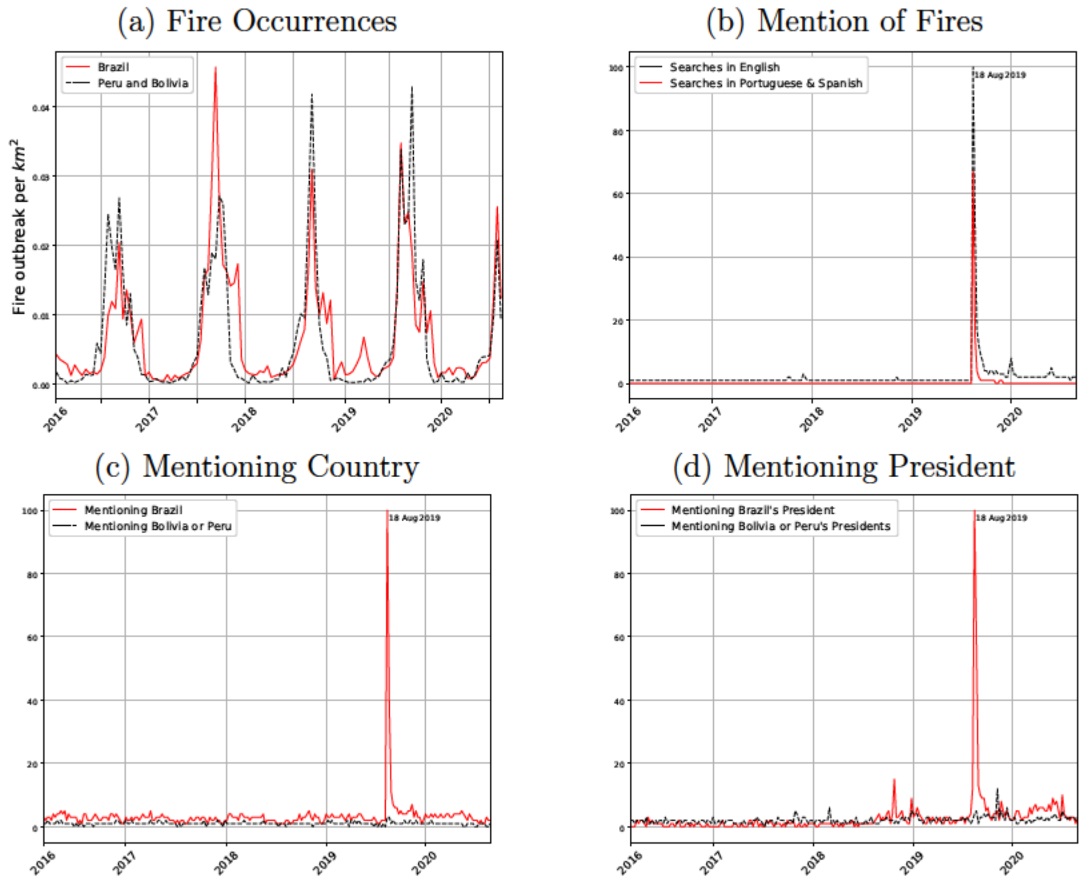
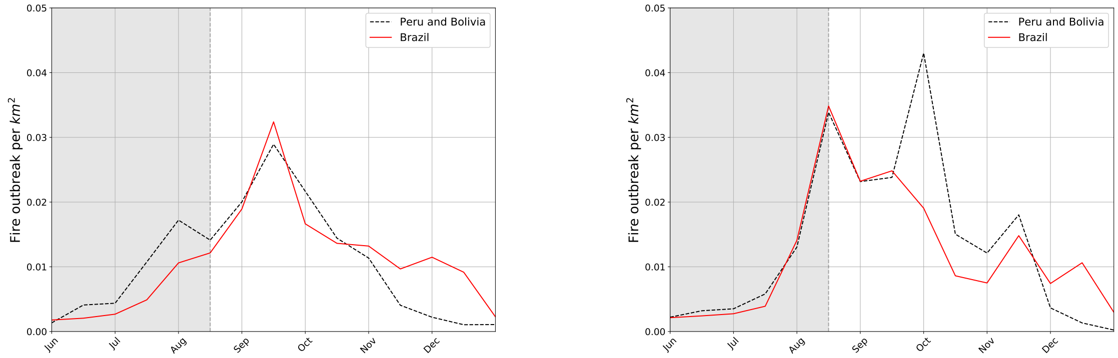
Figure 1: Fire Occurrences and Google Searches on Fires in Brazil




This figure shows that searches on fires in Brazil increase in August 2019 but fire patterns are similar to previous years. Figure (a) shows the number of days of active fire in each $1\text{km}^2$ pixel in the Amazon biome in Brazil and Bolivia and Peru every two weeks from January 2016 through October 2020. Figure (b) shows Google searches about Amazon fire in English and in Portuguese or Spanish since 2016. Figure (c) depicts searches mentioning "Rainforest Brazil" and "Rainforest Bolivia" or "Rainforest Peru". Figure (d) shows searches on Amazon and the name of each country's president.

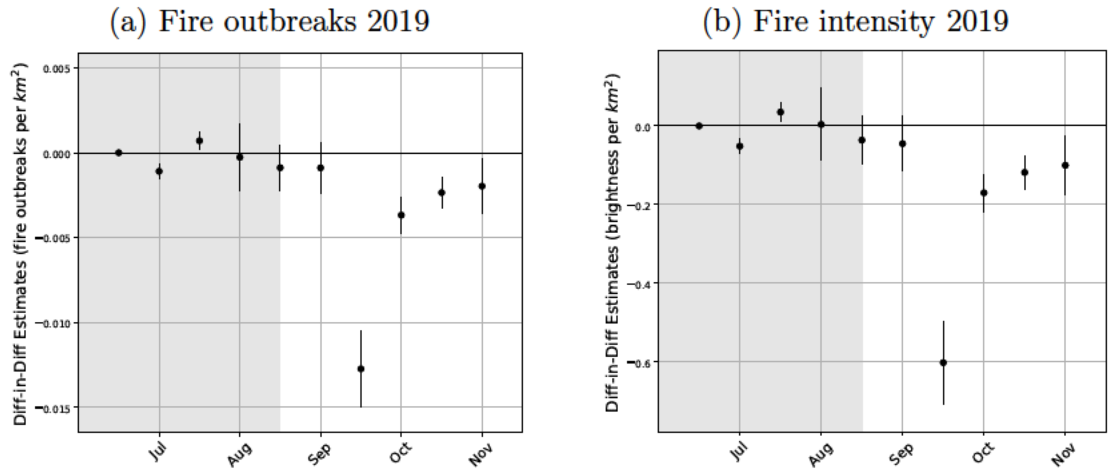
Figure 2: Fire Occurrences over the season in the Brazilian, Peruvian, and Bolivian Amazon

(a) Average Fire Occurrences 2016–2018 | (b) Fire Occurrences 2019




This figure shows fire outbreaks per km$^2$ in the Brazilian, Peruvian, and Bolivian Amazon. Figures (a) and (b) show the average number of fire outbreaks per km$^2$ for two-weeks intervals between 2016 and 2018, and in 2019, respectively.

Figure 3: Dynamic Difference-in-Differences Results




Figures (a) and (b) show difference-in-differences estimates of fire outbreaks and fire intensity per $km^2$ in the Brazilian Amazon relative to fires in the Bolivian and Peruvian Amazon as captured $\gamma_t$ in eq. (1), respectively. Each point indicates the point estimate for every two week period. Vertical bars present 95% confidence intervals. Shaded area marks the period before the rise of international attention. Standard errors clustered at $625km^2$ grids. Number of observations (clusters): 63,879,421 (9,309).

Table 1: Difference-in-Differences Results and Robustness

| | Dep. var.: fire outbreaks per $1km^2$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Brazil × Sep-Nov ($\beta$) | -.0031*** | -.0034*** | -.0037*** | -.0040*** | -.0050*** | -.0589 |
| | (.0005) | (.0005) | (.0004) | (.0005) | (.0004) | (.0573) |
| Precipitation | No | Yes | No | Yes | Yes | Yes |
| Avg fire 2016–2018 | No | No | Yes | Yes | Yes | Yes |
| Triple difference | No | No | No | No | No | Yes |
| Avg Fire Sep-Nov Bolivia & Peru | .0112 | .0112 | .0112 | .0112 | .0112 | .0994 |
| Avg Fire Sep-Nov Brazil 2016-2018 | .009 | .009 | .009 | .009 | .009 | .0557 |
| # Observations | 127,758,882 | 127,758,882 | 127,758,882 | 127,758,882 | 127,758,882 | 11,156,725 |
| # Clusters | 9,309 | 9,309 | 9,309 | 9,309 | 9,309 | 5,072 |

This table presents the results of our main difference-in-differences approach (columns 1-4) and additional robustness. The table shows the coefficient of the interaction term of a pixel belonging to the Brazilian Amazon with a dummy indicating the period after the week of the rise in international attention (coefficient $\gamma$ from expression (2)). All specifications include pixel fixed-effect and week fixed-effect. Units of observation are $1km^2$ pixels in a week period. From columns (1) to (4) we vary the controls included. The results are robust to including precipitation at the pixel-week unit and the average fire count of each pixel in the equivalent week of the years 2016-2018. Column (4) presents our preferred estimates. Column (5) shows the estimates of a triple-difference estimate as represented in equation 3. Column (6) shows the estimates of the Poisson specification. Number of observations (and clusters) from the main specifications: 127,758,882 (9,309). Number of observations (and clusters) from the Poisson specifications: 11,156,725 (5,072). Standard errors clustered at $625km^2$ grids in parentheses. Significance levels: *10%, **5%, ***1%.

Table 2: Heterogeneous Effects

| | Dep. var.: fire outbreaks per 1km$^2$ | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Brazilian Amazon × Sep-Nov ($\gamma_1$) | -.0044*** | -.0016*** | -.0015** | -.0015** | -.0031*** |
| | (.0006) | (.0006) | (.0006) | (.0006) | (.0005) |
| Brazilian Amazon × Sep-Nov ($\gamma_2$) | .0004 | | | | |
| × Forest Cover | (.0003) | | | | |
| Brazilian Amazon × Sep-Nov ($\gamma_2$) | | -.0029*** | | | |
| × Forest Cover > 50% | | (.0003) | | | |
| Brazilian Amazon × Sep-Nov ($\gamma_2$) | | | -.0034*** | | |
| × Forest Cover > 75% | | | (.0003) | | |
| Brazilian Amazon × Sep-Nov ($\gamma_2$) | | | | -.0036*** | |
| × Forest Cover > 90% | | | | (.0003) | |
| Brazilian Amazon × Sep-Nov ($\gamma_2$) | | | | | -.0050*** |
| × Brigades Sent or Budgeted | | | | | (.0006) |
| Precipitation | Yes | Yes | Yes | Yes | Yes |
| Avg fire 2016–2018 | Yes | Yes | Yes | Yes | Yes |
| Avg Fire Sep-Nov Bolivia & Peru | .0112 | .0112 | .0112 | .0112 | .0112 |
| Avg Fire Sep-Nov Brazil 2016-2018 | .009 | .009 | .009 | .009 | .009 |
| # Observations | 127,758,882 | 127,758,882 | 127,758,882 | 127,758,882 | 127,758,882 |
| # Clusters | 9,309 | 9,309 | 9,309 | 9,309 | 9,309 |

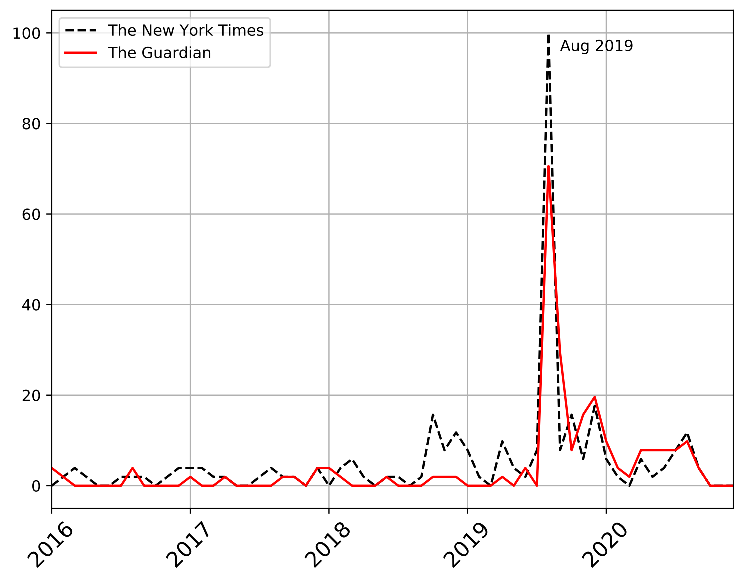
This table presents the results of the difference-in-differences approach with heterogeneous effects. Columns (1) to (4) show the coefficient of the interaction term of a pixel belonging to the Brazilian Amazon with the a dummy indicating periods after the bi-week of the rise in international attention interacted with a pixel's forest cover in 2015 (coefficient $\gamma_2$ from equation (4)). All specifications include pixel fixed-effect, week fixed-effect, and controls for precipitation and average fires from 2016-2018 at the pixel-week level. Units of observation are 1km$^2$ pixels in a week period. In column (1) the forest cover variable is the share of the forest cover in that pixel. From columns (2) to (4) we create dummy variables that equals to one when the forest cover of a pixel is above a threshold (50%. 75%, and 90% respectively). In these columns we see that the effect of the reduction on fires was stronger in areas with greater forest cover. In column (5) we consider the interaction term of a pixel belonging to the Brazilian Amazon with a dummy indicating the period after the bi-week of the fire ban with a dummy variable that indicates if a fire brigade or a special budget to combat fire was sent to the municipality that the pixel belongs, after the fire ban. We observe a stronger effect of fire reductions on municipalities that receive such help. Nonetheless, it does not explain all the reduction on fires. Standard errors clustered at 625km$^2$ grids in parentheses. Significance levels: *10%, **5%, ***1%.

# Appendix (for online publication)

- Section A presents additional figures and tables discussed in the paper.
- Section B discuss whether air pollution could have attracted domestic public attention.
- Sections C presents a detailed timeline of events.

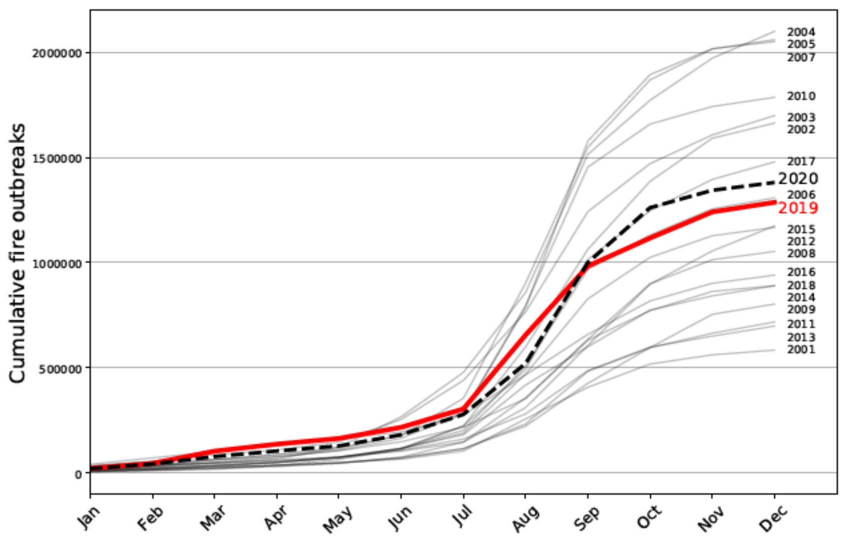
# A Appendix Figures and Tables

Figure A1: Hits on The New York Times and The Guardian Newspapers



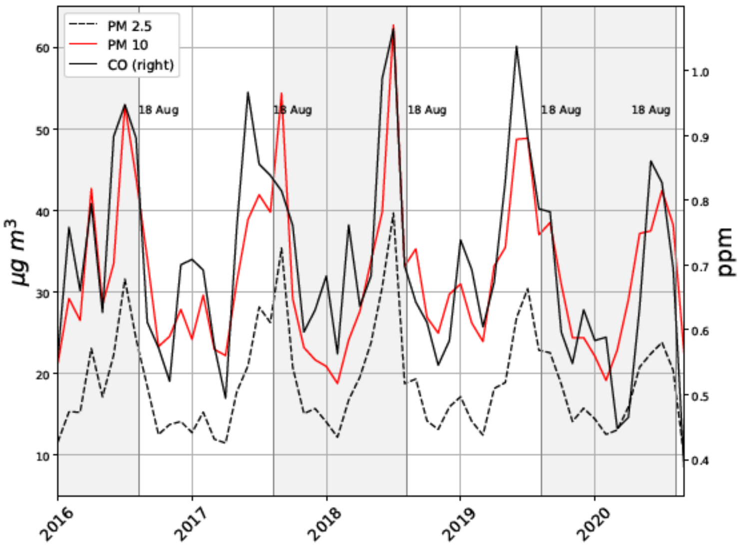

This figure presents the number of articles that mentioned the words "Amazon", "fires", and "Brazil" together, normalized by the maximum value (of August 2019). The data were built using The New York Times Developer Network (developer.nytimes.com) and The Guardian Open Platform (open-platform.theguardian.com)

Figure A2: Cumulative fires outbreaks in the Brazilian Amazon between 2001 and 2020




This figure shows the cumulative number of fires outbreaks in the Brazilian Amazon between 2001 and 2020. The red line marks 2019. The dashed line marks 2020.

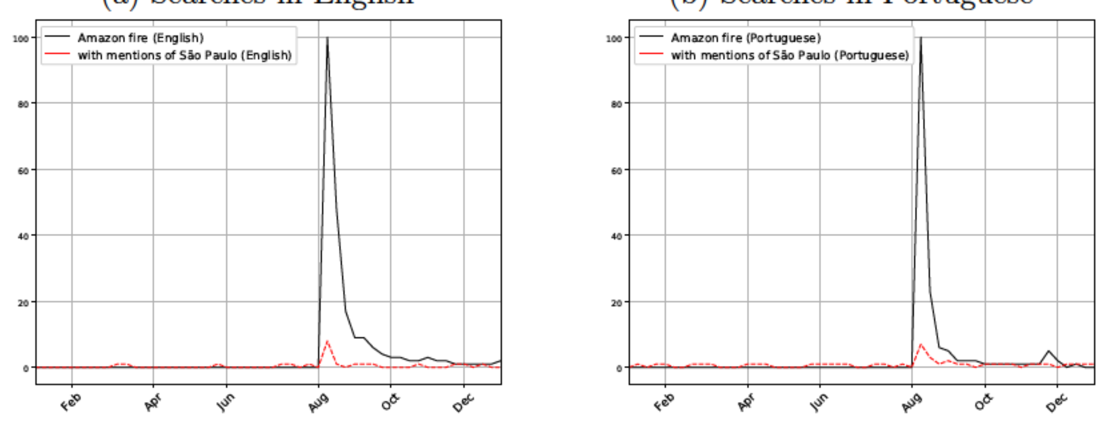
Figure A3: Pollution in São Paulo, Brazil followed similar trends in 2019 as in previous years




This figure presents different measurements of pollution for the city of São Paulo Brazil from 2016-2020. Data is from the Environmental Company of the State of São Paulo. We used data from the Marginal Pinheiros' station, aggregated by month. Data is available at https://cetesb.sp.gov.br/.

Figure A4: Searches on Amazon Fires in Brazil and Dark Sky Day in São Paulo

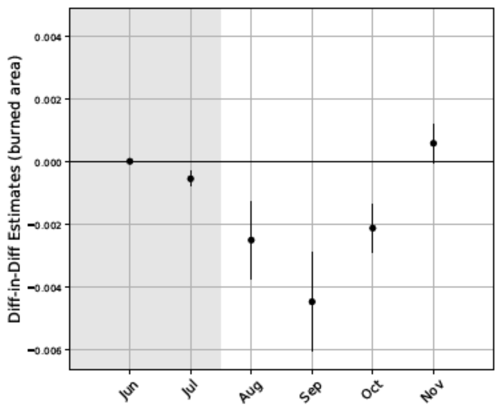
(a) Searches in English (b) Searches in Portuguese



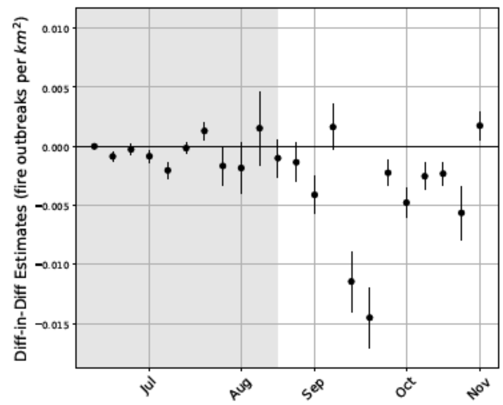

This figure shows searches on fires in Brazil compared with searches mentioning São Paulo. Figure (a) shows Google searches in English about Amazon fire compared with searches about Amazon fire and the dark sky day in São Paulo. For this we used the words "smoke", "fire", "sao paulo", or "amazon". Figrue (b) shows the same Google searches results in Portuguese. For this we used the words "fumaça", "fogo", "são paulo", or "amazônia".

Figure A5: Robustness Estimates

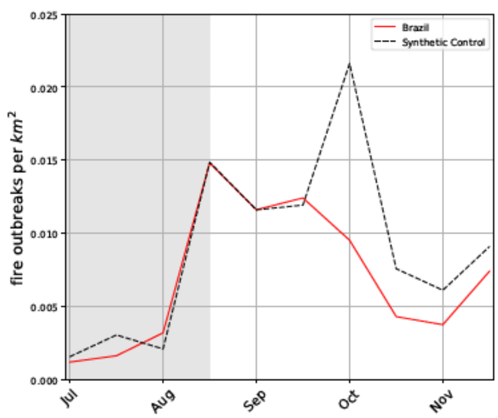
(a) Difference-in-Differences:
Burned area (monthly)




(b) Difference-in-Differences:
Fire outbreaks (weekly)



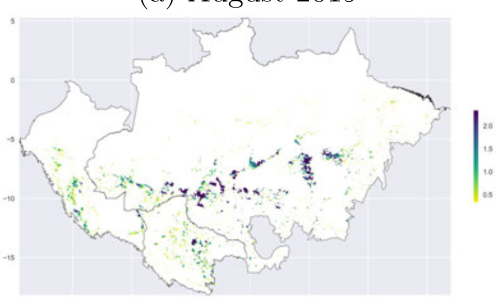

(c) Synthetic Control:
(bi-weekly)



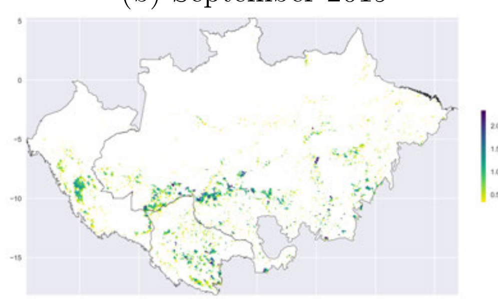

Figures in the top row show the difference-in-differences estimates of monthly burned area per km$^2$ (a) and of weekly fire outbreaks per km$^2$ (b) in the Brazilian Amazon relative to fires in the Bolivian and Peruvian Amazon as captured $\gamma_t$ in equation (1), respectively. Each point indicates the point estimate for every two week period. Vertical bars present 95% confidence intervals. Shaded area marks the period before the rise of international attention. Standard errors clustered at 625km$^2$ grids. (c) shows the synthetic control using Bolivia and Peru as donor pool.

Figure A6: Maps of Intensity of Fire Outbreaks

(a) August 2019



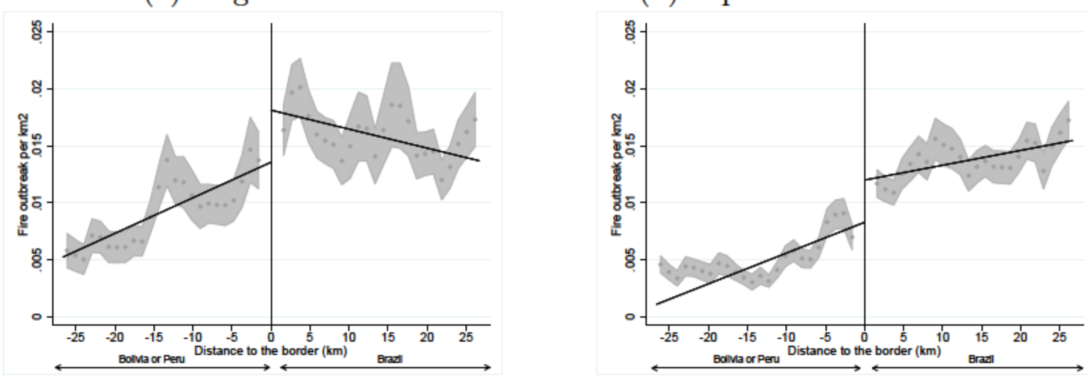
(b) September 2019



This figure shows maps of the intensity of fire outbreaks in August (a) and September 2019 (b).

Figure A7: Regression Discontinuity at the National Borders

(a) August 2019 (b) September-November 2019




This figure shows the regression discontinuity at the national borders. Figure (a) and (b) show average fire outbreaks in August 2019 and September-November 2019, respectively, within 27km from the Brazilian border with Bolivia and Peru. Each point shows the average number of fire outbreaks by 1km bins of distance to the border; positive distances represent pixels in Brazil and negative distances represent pixels in Bolivia or Peru. Black solid lines depict linear polynomials, whereas the shaded grey region depicts the 95% confidence interval.

# B Air Pollution and Domestic Public Attention

Figure A3 shows evidence that air pollution in major cities, for example, São Paulo was similar in August 2019 as it was in previous years. We take this as suggestive evidence that levels of air pollution in São Paulo were not driving domestic public attention and outcry towards forest fires. Although domestic public attention likely played some role in reducing forest fires, this evidence suggests that this effect was likely not driven by domestic air pollution concerns.

On August 19, São Paulo's sky became black during the day caused by suspended particles from the Amazon fires brought by a cold front. While this may have startled the local media, we show evidence that the focus of public attention remained in the Amazon fires, not in São Paulo's black sky. Figure A4 shows Google searches for "Amazon fires" (in English and in Portuguese) and searches for the combination of the words "São Paulo" and "fire", "smoke", or "Amazon". We can see that the focus of public attention was the Amazon fires, not São Paulo.

## C Timeline

**10/25/18** President-elect Bolsonaro pledges to quit Paris climate deal *(Reuters)*

**11/28/18** Brazil backs out of hosting the 2019 Climate Change Meeting *(New York Times)*

**12/10/18** Ricardo Salles is appointed as Minister of Environment, recommended by the Brazilian Rural Society. For him, the debate over Climate Change is "pointless" *(Guardian)*

**01/01/19** Jair Bolsonaro's inauguration *(Washington Post)*

**01/02/19** Brazil's Bolsonaro hands farming interests greater sway over Amazon lands *(Washington Post)*

**05/17/19** Minister of Environment says he will change rules for applications of the Amazon Fund, accusing NGO's of failing to account for the use of money. Norway responds: "Norway is satisfied with the robust governance structure of the Amazon Fund and the significant results that the entities supported by the Fund have achieved in the last 10 years" *(Reuters)*

**07/19/19** President Bolsonaro questions the satellite data on deforestation from the government's National Space Research Institute (INPE) after the data showed an increase in deforestation in May and June. "I am convinced the data is a lie. We are going to call the president of INPE here to talk about this." *(Guardian)*

**08/01/19** Deforestation in the Brazilian Amazon hits the cover of The Economist *(Economist)*

**08/02/19** The director of INPE is sacked *(Guardian)*

**08/16/2019** Amazon Fund is shut down *(Guardian)*

**08/19/2019** Suspended particulates from the Amazon reach São Paulo city *(Estadão)*

**08/21/19** Amazon fires in the New York Times and main media outlets *(New York Times)* *(Fox News)* *(CNN)*

**Aug/19** President of France, on Twitter, calls the fires an "international crisis". He calls members of G7 Summit to discuss it.
*(Twitter post. 08/22/19, 4:15 PM.*
*https://twitter.com/emmanuelmacron/status/1164617008962527232)*

**08/22/19** President Bolsonaro answers “The French president’s suggestion that Amazonian matters be discussed at the G7 without the involvement of countries of the region recalls the colonialist mindset that is unacceptable in the 21st century.” *(Twitter post)*

**08/23/19** President Macron says France would oppose an EU trade deal “in its current state” with the Mercosur bloc. *(BBC)*

**08/23/19** Government authorizes hiring fire brigades in the Amazon *(Agencia Brasil)*

**08/29/19** Brazil bans the use of fire in the Amazon for 60 days *(CNN)*

**08/29/19** Ibama delayed hiring of fire brigades *(O Globo)*

**09/18/19** 230 big investors representing $16.2 trillion call on firms to protect world’s rainforests *(Reuters)*

**06/23/20** In light of rising deforestation, 251 financial institutions representing over $17 trillion demand action over the dismantling of environmental policies and protection agencies *(Folha de São Paulo)*

**09/15/20** On the first 14 days of September 2020, the Amazon already has more fires than in all September 2019 *(Folha de São Paulo)*