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Temperature highs, climate change salience, and Eco-anxiety: early evidence from the 2022 United Kingdom heatwave

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ABSTRACT

Extreme weather episodes may increase the salience of climate change and worsen people's well-being. Empirically studying these effects is however challenging, given limited data availability around difficult-to-predict such events. Addressing this issue, I use Google Trends information to assess how climate change salience and people's wellness were affected by an unprecedented mid-July 2022 heatwave in the United Kingdom, when temperatures exceeded 40C for the first time in the country's history. I document a significant rise in the search-intensity for 'climate change', as well as for 'worry' as a marker of psychological distress at the time of the heatwave. In contrast, I show that similar patterns did not emerge in 2019, when comparably high temperatures were recorded, but when the 40C-threshold was not exceeded. Taken together, my results suggest that the effects of the 2022 heatwave are partially driven by a climate anxiety mechanism, wherein extreme weather episodes constitute negative signals for climate change progression. I conclude by discussing several limitations of my study that future work may tackle.

KEYWORDS

Climate change; Mental Health; climate anxiety; Google Trends; UK heatwave

JEL CLASSIFICATION

I1; I3; I10; I12; I31

I. Introduction

Climate change may worsen people's mental-health (Hayes et al. 2018). For instance, soaring temperatures (Carleton 2017) or droughts (Luong et al. 2021) are associated with worse markers of well-being, among which higher rates of depression or suicide.[1] And, as explained by Mullins and White (2019), the economic burden of mental illness is large – both directly, given the spending required to manage mental-disorders (Roehrig 2016) and indirectly, through distress-driven lower productivity (Trautmann, Rehm, and Wittchen 2016).[2] Understanding how climate change impacts wellness can therefore help us formulate policies which mitigate undesirable healthcare and economic consequences of environmental degradation.

Relevant for my study, recent work (Clayton 2020; Wullenkord et al. 2021) hypothesizes that, besides any physiological channels via which extreme weather may impact wellness,[3] such events increase the salience of climate change and affect well-being by exacerbating anxieties among those affected – as depicted in Figure 1.

Concretely, extreme weather episodes constitute signals, which agents use to update their beliefs on the trajectory of climate change, leading them to increasingly conclude that the situation is becoming more dire (Reyes et al. 2021).

Clayton et al. (2017) describe climate anxiety [CA][4] as a '*chronic fear of environmental doom*' (p. 68).[5]

From an economics perspective, studying CA contributes to a literature tackling economic distress more broadly, which highlights that one's expectations of the macroeconomic environment alters one's beliefs and decisions (Fetzer et al. 2021; Kuchler and Zafar 2019). In this scholarship, how people form expectations when salient events occur (Gallagher 2014) remains an open question. CA is

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[1]For a review, see Cianconi et al. (2020).

[2]More broadly, the economics literature on mental health has expanded substantially in recent years, with numerous studies focusing on mental health indicators as their primary outcome variables – see e.g. Golberstein et al. (2019), Golin (2022), Altindag et al. (2022), as well as Braghieri et al. (2022) and the references therein.

[3]For example, periods of high-heat may lead to physical distress, which directly worsens well-being (Burke et al. 2018).

[4]Also referred to as 'Eco-anxiety' (Coffey et al. 2021).

[5]See also Schwartz et al. (2022).

Supplemental data for this article can be accessed online at https://doi.org/10.1080/13504851.2023.2257026

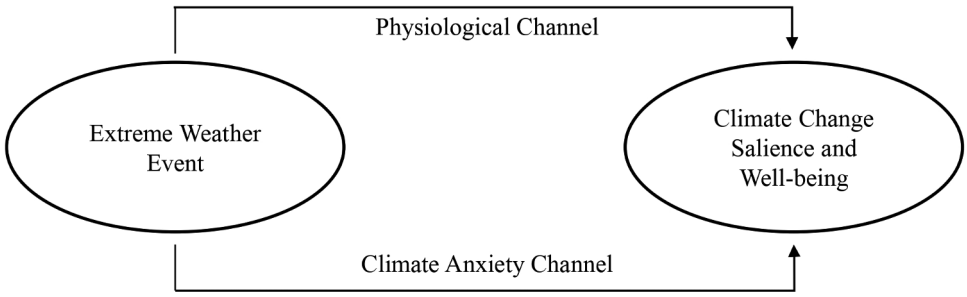

Figure 1. The effects of extreme weather events - mechanism decomposition. *Note*: Assessing whether a climate anxiety mechanism partially exacerbates the impact of extreme weather on climate change salience and well-being is empirically challenging for two reasons. First, because of limited data availability around such difficult-to-predict events, quantifying the aggregate causal effects of extreme weather is often unfeasible. Second, even if such an aggregate impact is estimated, it is difficult to ascertain whether climate anxiety plays a role.

then a pertinent example of the ways in which major events shape one's views, especially as extreme episodes become more commonplace (IPCC 2021).

However, investigating the effects of extreme weather is challenging given limited data-availability and difficulties associated with planning research around tough-to-predict events (Goldmann and Galea 2014).

I contribute to the literature by analysing the effects of an unprecedented mid-July 2022 UK heatwave ['the heatwave'], when temperatures exceeded 40C for the first time in the country's history. Declared a national emergency on 15 July,[6] the heatwave provides an ideal setting for studying CA, as it constitutes a salient, contextually-novel signal that the environment is changing in likely unfavourable ways, in a country that is ill-equipped to withstand soaring temperatures.[7]

To circumvent data-limitations, I rely on Google Trends information (Choi and Varian 2012), an increasingly prevalent approach in empirical studies,[8] which is especially useful when the data of interest are either not available in other forms (e.g. surveys), or available at reduced frequencies (Caperna et al. 2022).

My findings suggest that the heatwave affected climate change salience and well-being, partially via a CA mechanism. Relative to 2019 - a year in which the UK experienced another period of high temperatures, but when these did not exceed the 40C threshold – the 2022 heatwave is associated with increased search-intensity for 'climate change', and for anxiety markers, specifically 'worry'. However, the search-intensity for markers of physiological distress such as 'heatstroke' increased by comparable magnitudes in both years, suggesting that climate anxiety arising from 40C being passed partially explains the 2022 heatwave's effects, over and above the physiological channel.

Besides corroborating the CA hypothesis, a contribution of this note is extending the Google Trends methodology to studying the effects of changing environmental conditions.

II. The 2022 record-breaking United Kingdom heatwave

I explain why the heatwave allows me to study CA.

The UK experienced an unprecedented heatwave mid-July 2022, with a temperature reading of 40.3C measured on 19 July. The Met Office issued its first-ever 'red' extreme-heat warning on 15 July - Figure 2. According to the Office for National Statistics, just under 1,700 excess deaths were recorded in the heatwave week ending 22 July.[9]

Besides limited data-availability, a methodological challenge for assessing the effects of extreme weather lies in separating CA from the physiological consequences of distressing environmental

[6] https://bbc.in/3R2xJXl.
[7] https://bit.ly/3c1a7Uf.
[8] e.g., Götz and Knetsch (2019), Daniel et al. (2020).
[9] https://bit.ly/3SFJvsc. See also Dickie (2022).

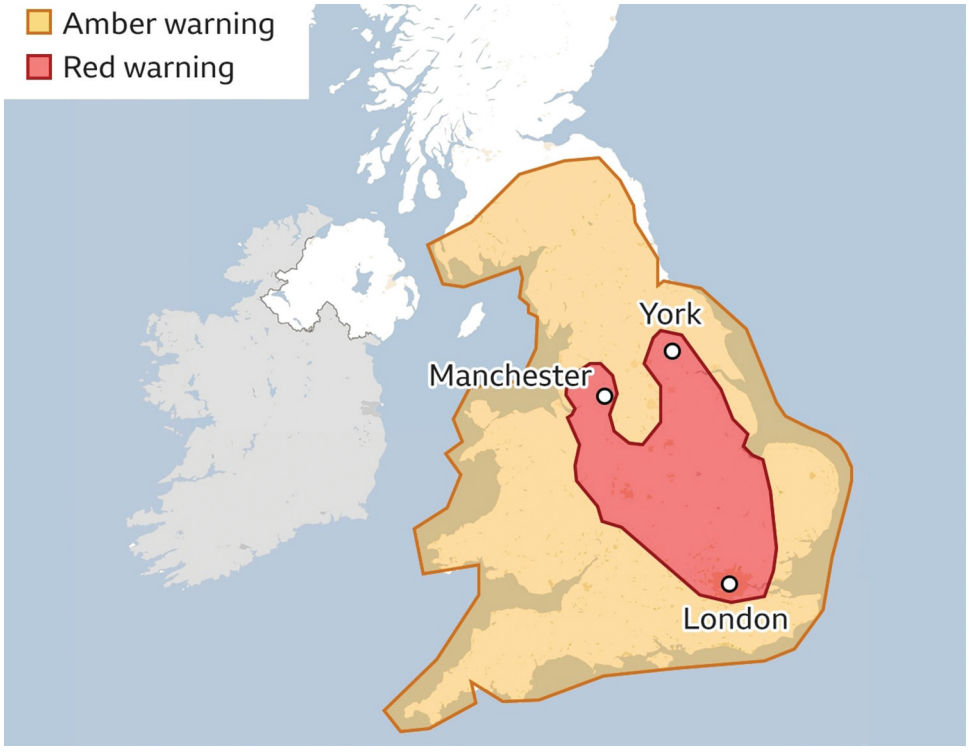

Figure 2. Extreme-heat warning, 15 July 2022. *Note*: The Met Office issued a red heat warning, cautioning that dangerous weather conditions are expected: https://bbc.in/3ABLlDA.

conditions (Figure 1). For instance, if one were to find that heatwaves exacerbate depression, one could not tell whether this results from people internalizing unusually-high temperatures as a worrisome signal (the CA channel), rather than from the physical distress caused by high-heat (the physiological channel).[10]

The heatwave then presents an opportunity to empirically-corroborate CA specifically, for two reasons. First, temperatures soaring above 40C for the first time constitutes a novel and easy-to-understand signal for intensifying global warming, particularly pertinent since the climate change discourse depicts *temperature thresholds* being passed as indicators of climate change progression (IPCC 2021). The record temperatures also made for easy headlines,[11] exacerbating the signal's public salience.

Second, to quantify the heatwave's effects, I compare the Google-search intensity for certain indicators of distress recorded in the summer of 2022 with that measured in 2019. Conveniently, July 2019 was also characterized by unusually high temperatures, with a high of 38.6C recorded on the 25th. In fact, the 2019 heatwave period roughly coincided with the 2022 one, with the highest temperatures recorded mid-to-late July.

However, despite both heatwaves potentially having physiological effects, the 40C threshold was *not* exceeded in 2019, and hence a similarly pertinent signal fuelling CA did not materialize.

Therefore, documenting strong climate change salience and wellness changes mid-July 2022 *relative* to 2019 constitutes evidence for CA exacerbating the effects of extreme weather, addressing the difficulty of separating the aforementioned channels.

III. Methodology and results

To assess the effects of extreme weather, one requires data gathered both after *and before* an episode. Unfortunately, pre-event information is generally not available since extreme weather is difficult-to-predict (Sillmann et al. 2017).

[10]Nori-Sarma et al. (2022).
[11]https://bbc.in/3c7Nttq; https://cnn.it/3Th6vhU.

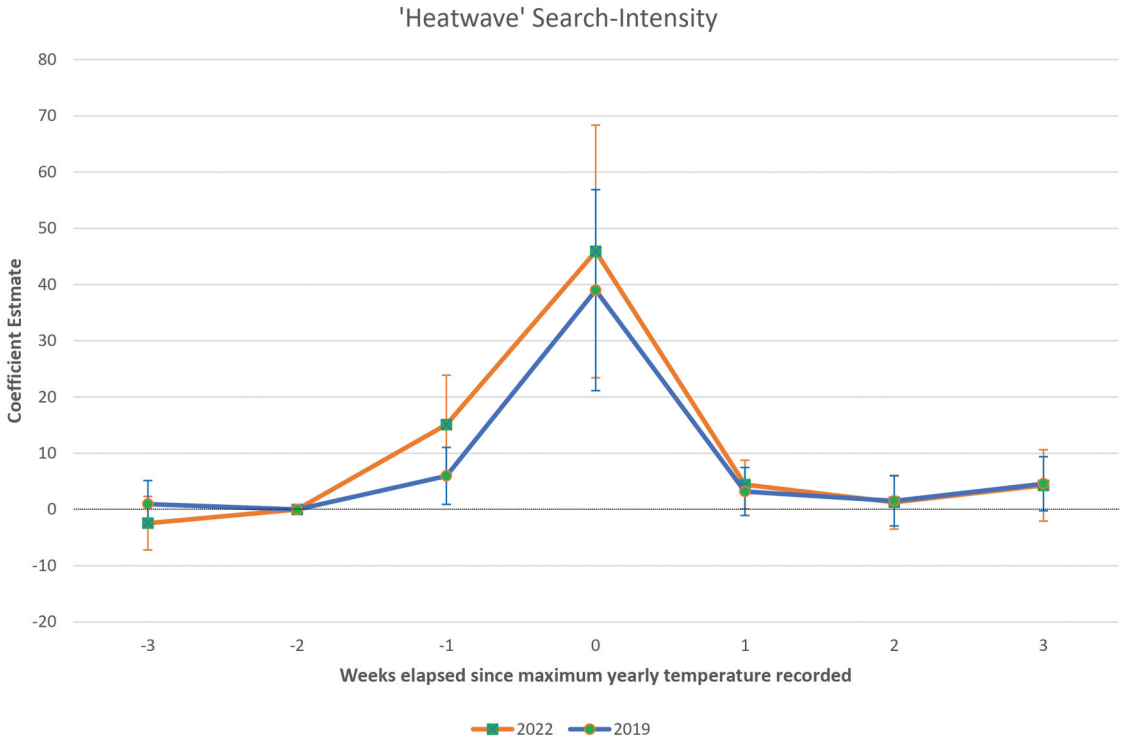

Figure 3. The heatwaves' salience. *Note*: I plot the coefficient estimates from specification 1 alongside 90% confidence intervals for 2022 and 2019 in orange and blue, respectively. The maximum temperature recorded in 2022 (2019) was 40.3C (38.6C) on 19 (25) July. See Appendix A for details on scaling.

I follow Brodeur et al. (2021) and Fetzer et al. (2021), who rely on Google Trends data to study how the COVID-19 pandemic and lockdowns affected well-being. Google Trends supplies daily or weekly search-intensity indexes for given geographical areas over user-specified periods. The index takes on values from 0 to 100, with 100 occurring on the day when most relevant-searches occurred. Thus, one can use these data to perform before-and-after comparisons around salient events. Moreover, since the data capture all Google searches, they are not susceptible to small-sample biases, or biases arising from the observer-expectation or interviewer effects (Brodeur et al. 2021).

I retrieve daily UK search-data for 18 June to 25 August, for both 2019 and 2022.[12] Since the search-index is scaled, I apply a correction to make the data comparable between the two years – detailed in Appendix A.

The searches I focus on are those for 'heatwave', to verify the event's salience, and for different CA markers, including 'climate change', and the following wellness indicators: 'irritability', 'panic', 'sleep', 'stress' and 'worry'.[13] Additionally, I gather search-data for 'heatstroke' to capture high-heat distress. By showing that the search-intensity for this marker rose similarly in 2019 and 2022, while the number of climate change salience and anxiety-related searches increased significantly more in 2022, I provide evidence for CA partially exacerbating the impacts of extreme weather.

I begin by running the following using 2022 data:

$$Y_d = \sum_{\substack{w=-3 \\ w\neq -2}}^{w=3} \beta_w H_w + \alpha_d + \in_d \qquad (1)$$

Above, *Yd* gives the scaled Google Trends search-intensity for one of the aforementioned indicators on day *d*. *Hw* are dummy variables for the three weeks preceding, the week of, and the three weeks following 19 July – in total, I have 49 observations for each search-intensity outcome. α_d are weekday

[12]While I focus on aggregate UK search data in the main evaluation, additional analyses suggest that the effect is, perhaps unsurprisingly, chiefly driven by searches taking place in England. These results, alongside those retrieved when homing in on Wales, Northern Ireland or Scotland are available upon request.
[13]These are the 'anxiety'-related searches performed in Brodeur et al. (2021). See Figure 2 in their article. They relate to the mental-health markers assessed in the GHQ (Goldberg and Blackwell 1970). For completeness, I also use searches related to 'anxiety' itself as my outcome in Appendix D.

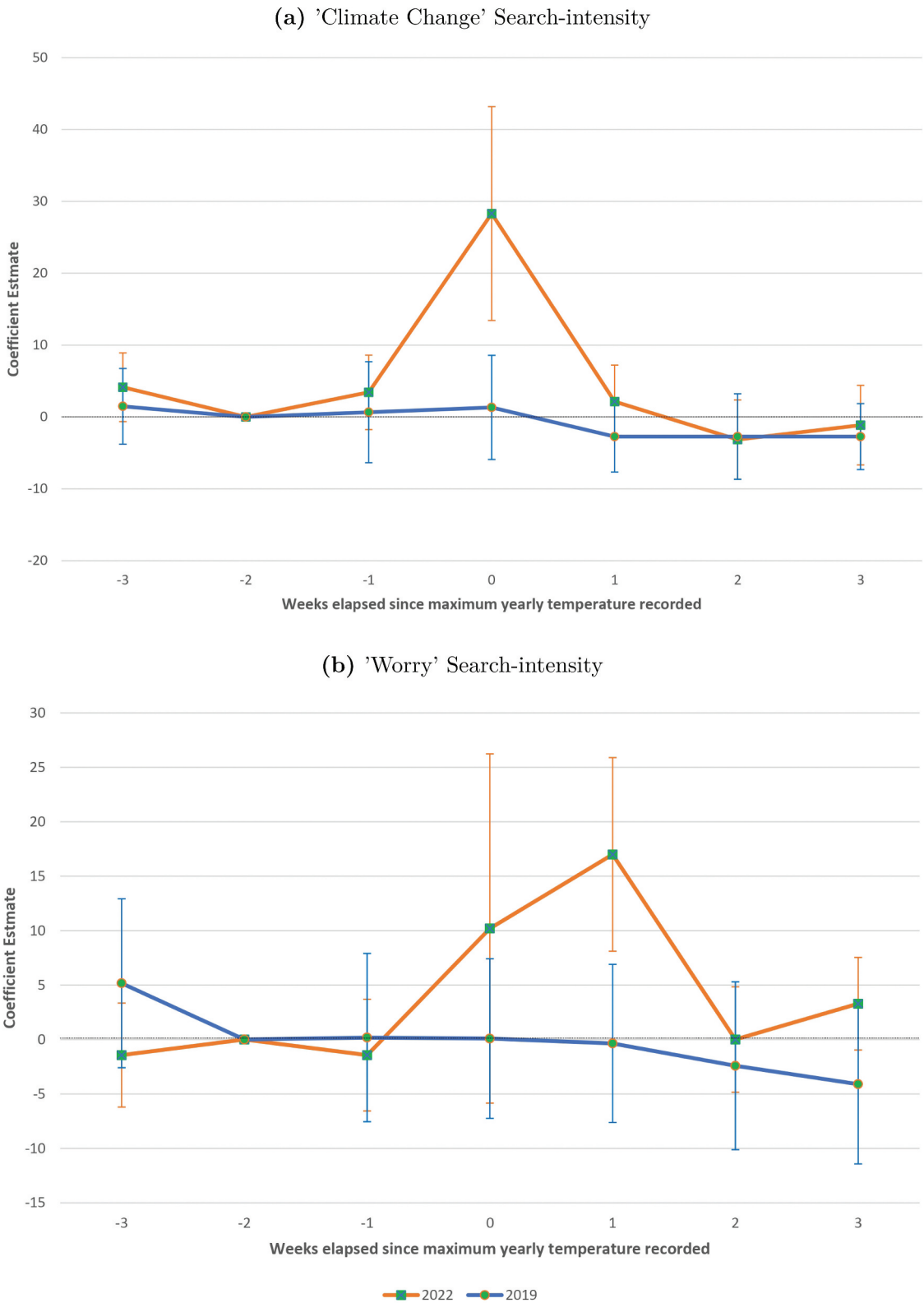

Figure 4. Temperature thresholds, climate change salience, and worries. *Note*: See Figure 3.

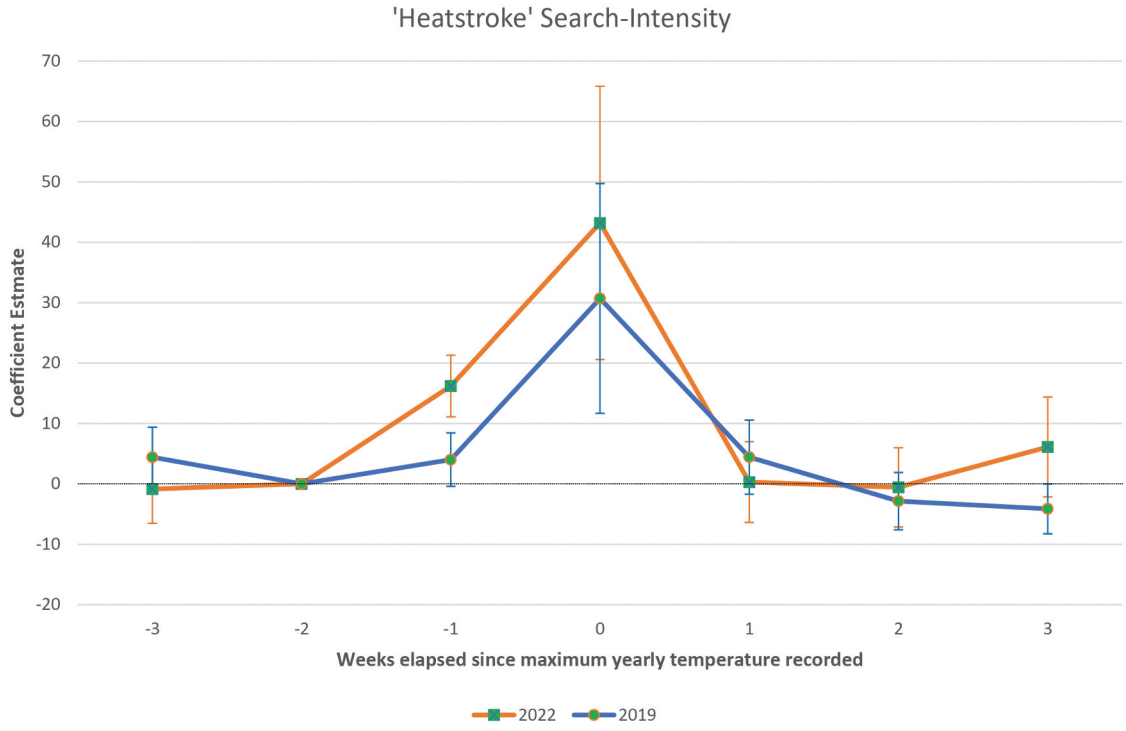

Figure 5. Physiological distress during the heatwaves. *Note*: See Figure 3.

(Monday to Sunday) fixed effects. Robust standard errors are clustered at the day-level. The coefficients of interest are β_0 and β_1 whose estimates measure the heatwave's short-term effects. β_2's and β_3's estimates assess persistence, although I note that Google Trends is best suited for short-term studies. In the long-run, other confounding shocks may occur, possibly introducing a bias.[14] Finally, H_{-2} is the reference period. Hence, the estimated coefficients should be interpreted relative to this omitted category.

I first show in Figure 3 that the 'heatwave' search-intensity increased, most notably in the week when 40C were recorded – as expected. Then, Figure 4 shows increased searches for 'climate change' and 'worry' in panels A, and B, respectively, suggesting that the heatwave had an effect on climate change salience and well-being – as hypothesized.[15] The corresponding numerical estimates are in Table D1, Panel A.

Of course, by themselves, these findings do not corroborate CA as a driver. As shown in Figure 5, the search-intensity for 'heatstroke' also jumped during the heatwave.[16] Then, in line with the difficulty highlighted in Figure 1, it is challenging to ascertain whether CA played a part, over and above the physiological effects caused by high-heat discomfort, in explaining the findings from Figure 4.

For this reason, I run specification 1 on 2019 data, shifting the time-series around the 25 July, when the 38.6C temperature high was recorded. The coefficient estimates are illustrated again in Figures 3, 4 and 5 alongside the ones pertaining to 2022, and in Table D1, Panel B.

The takeaway is that, while the search-intensities for 'heatwave' and 'heatstroke' followed similar patterns in the two years considered, suggesting that high-heat discomfort was present both in 2019 and 2022, the search-intensities for 'climate change' and 'worry' increase by a notably higher margin in 2022 *relative* to 2019. This result – my note's main contribution – provides new evidence for CA partially explaining the effects

[14]See Appendix B.
[15]I do not retrieve significant estimates when analysing the search-intensity for 'irritability', 'stress' or 'panic'. While I do find some evidence for 'sleep', the results are noisy. See Appendix D.
[16]Similar patterns are documented when using search intensities relating to less severe discomfort-related indicators such as 'cooling' or 'fans'. Results available upon request.

of extreme weather on climate change salience and wellness. After all, temperatures surpassing 40C in the UK – the 'new threshold' signal – only occurred in 2022.

IV. Conclusion and limitations

Leveraging the July 2022 record-breaking UK heatwave, I bring evidence for CA exacerbating the effects of extreme weather on climate change salience and well-being.

My study, however, has limitations. First, as with all Google Trends analyses, I am unable to conduct heterogeneity tests across demographic characteristics to see who was affected most. Second, I cannot ascertain the extent to which my results show CA worsening at the extensive margin, with people previously unconcerned with the environment starting to worry, rather than at the intensive margin, with those already climate-conscious displaying more interest. Third, given the observational nature of the study, causality is difficult to establish. In particular, one should question whether other, non-climate related relevant events may have occurred at the time, partially explaining the documented patterns.[17] Finally, while the 2019 heatwave was used as a comparison to rule out the physiological channel, it is worth noting that 2019 and 2022 differed significantly in terms of their socio-cultural and political landscapes, potentially affecting how people respond to extreme events more broadly.[18]

Therefore, despite the key data-availability advantage of Google Trends methods, more traditional survey-based methods may be used in future work to address these limitations.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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[17]This point is discussed in-depth in Appendix B.

[18]Addressing this point, and corroborating the idea that the record-breaking temperatures of the 2022 heatwave do play a role, I replicate my analysis in Appendix C using 2021 as the comparison year instead. The results are qualitatively robust.

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