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Using e-petition data to quantify public concerns during the COVID-19 pandemic: a case study of England

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ABSTRACT

The COVID-19 pandemic has had a profound impact on society and many governments and politicians were required to make quick decisions to protect public health. In reaching these decisions they needed to weigh advice from experts in many fields and then “sell” these decisions. However little was known at the time about the desires and aspirations of their electorates. Here we identify one such source of public opinion, signatures to various COVID-19 related Parliamentary e-petitions. Whilst there were over 1,500 such e-petitions, we identify 27 common and meaningful topics and show how the strength of these topics varies between individual parliamentary constituencies. Using a measure of support for each topic in the constituencies we identify five constituency groupings. There are two Conservative voting groups, “Middle England” and “Equity of Support”, the former are located largely in southern England whilst the latter are in the midlands and northern England. The groups that show strong support in Labour voting constituencies are ones around education and funding issues. This article shows how a targeted range of e-petitions can be grouped into topics and the popularity of topics established, and thereby function as a useful way of augmenting democracy and democratic institutions.

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1. Introduction

A new SARS-like coronavirus began to emerge in eastern China towards the end of 2019. At this stage of what was to become the COVID-19 pandemic, little was known about its characteristics, particularly how lethal it was and its capacity to spread (Reis et al. 2022). However, it soon became clear that this new virus and any potential variants were to become a challenge for all countries (Platto et al. 2021). Decisive and novel actions were required by governments to respond to this unprecedented and immediate threat (Lazarus et al. 2020) and that both listening to and influencing public opinion were essential to tackle the pandemic (L. Wright et al. 2022). One source of such opinions was various social media platforms (Gao, Hua, and Luo 2021; Chipidza et al. 2022; Dorostkar and Najarsadeghi 2022), and in this study, we use one such platform, parliamentary e-

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petitions, to provide a case study of COVID-19 public opinion in an established democracy, the United Kingdom (UK).

The first case of COVID-19 was reported in the UK on 29 January 2020 at a hotel in York (Weaver 2021). Over two years later, by the time of the Prime Minister's statement on *living with Covid*, on 24 February 2022, when most of the legislation regarding the pandemic lapsed (Prime Minister's Office 2022), 18.9 million cases and over 160,000 deaths within 28 days of a positive test result had been reported in the UK (UK Health Security Agency 2022).

Behind these numbers, there are many and various stories of sorrow and sacrifice, which have left an enduring mark on society and its collective experience (Zhou and Kan 2021). No aspects of life were left untouched. Initial attempts were made to put the National Health Service (NHS) into a state of readiness (Horton 2020; Willan et al. 2020), and throughout the pandemic and its various waves (Hunter 2020; Wise 2022) the NHS was tested to the extreme as demand soared (Alderwick 2022; Coyle 2022). The wider health and social care community was required to adapt, in regards to general practice health provision (Trethewey, Beck, and Symonds 2020; Pilbeam et al. 2022) and to fulfil an increase in demand for its services to care for the vulnerable in light of personnel challenges (Burton et al. 2020; Hinsliff-Smith et al. 2020; Nyashanu, Pfende, and Ekpenyong 2022). Routine family life was disrupted, with life events such as births (Riley et al. 2021; Sanders and Blaylock 2021), marriages (Probert and Pywell 2021), housing (Nanda et al. 2021), employment (Mayhew and Anand 2020), worship (Bryson, Andres, and Davies 2020), and bereavement (Torrens-Burton et al. 2022) all impacted. Aspects of work were transformed overnight, with homeworking becoming the norm for many (Deole, Deter, and Huang 2021), state support for some (Brewer and Tasseva 2021), and redundancy for others (Houston 2020). Education was disrupted (Ahlburg 2020), with schools and universities moving to online models of delivery (Bayrakdar and Guveli 2020) and examinations cancelled or severely disrupted (Kippin and Cairney 2022). Transportation came with new restrictions and requirements, both for domestic (Vickerman 2021; Harrington and Hadjiconstantinou 2022) and international journeys (Seyfi, Michael Hall, and Shabani 2020).

The unprecedented, in modern times, nature of the pandemic left politicians with little guidance on what appropriate measures were available and which were acceptable to the public in order to combat the disease – events were immediate and decisions largely reactive. The UK was not alone in this, with many nations needing to assess what was a proportionate and effective response to the pandemic (Shafi and Mallinson 2022). There is utility in reflecting on these decisions and measuring them against public opinion and expectations. To provide such a perspective on the pandemic, this paper seeks to quantify the themes and concerns of the British public by making an objective assessment of UK Parliamentary e-petition data.

Petitioning as a public act refers to the act of submitting a formal request or appeal to a government or other public body, usually in the form of a written document called a petition and has a long tradition (Dodd 2007; Fraser 1961). This petitioning can be done individually or as part of a group and is typically done to address a specific issue or to request a specific action (Almbjär 2019). Petitioning as a public act can also be seen as a means of holding the government accountable or a way for citizens to make their opinions heard on certain issues, and for government to respond to citizens' demands

or concerns (Carpenter 2023). The act of petitioning the UK Parliament was revitalized during the mid-2000s by the establishment of a series of e-petitioning platforms (Leston-Bandeira 2019). Such platforms offer several advantages over traditional petitions to the government. Firstly, there is the convenience and cost-effectiveness; e-petitions make it easier for citizens to participate in the democratic process by allowing them to submit petitions online, which can save time and effort compared to traditional paper petitions. Secondly, there is increased participation, with e-petitions having the potential to increase citizen participation in the democratic process by making it more accessible to people who may not have the resources or ability to participate in traditional petitioning methods. Thirdly, the UK parliament's e-petitioning platform makes available the signatory data for each e-petition, thereby making the process and outcome more transparent. Finally, there is the opportunity to amplify the voices of marginalized or under-represented communities, as it can be easier for them to access and participate in the petitioning process through digital means.

In this study, use is made of published e-petitions that make reference to the COVID-19 pandemic. The strength of support for the sentiment that each e-petition gains is measured through the number of signatures. Using these data we provide insight into the different concerns of citizens during the COVID-19 pandemic that are not easily captured by other means. Additionally, whilst the strength of topics can be identified on a national scale via bespoke surveys, the platform also makes available signature counts by Parliamentary constituencies, and this geographic detail allows these impacts to be studied at a local scale. This provides insight into the agreement or divergence of concern for different groups of the electorate. How these impacts are reflected in individual parliamentary constituencies, and the grouping of constituencies derived from these differences in support is also illustrated here. At the end of this process, we evaluate the correspondence and association of topics with the 18 roles for e-petitions that Cristina Leston-Bandeira (2019) identifies. This evaluation helps us assess the usefulness of such data as a tool for fulfilling these roles and enhancing the democratic process. The roles are grouped into four types. The first type of roles revolves around Linkages that reinforce a direct relationship between citizens and parliament. The second type of roles covers activities that bring people together to advocate for a particular outcome or to share information about an issue and are called Campaigning roles. The third type of roles are concerned with Scrutiny, forming judgments on the operation of parliament, and providing challenges. Finally, the Policy roles are those that attempt to influence or effect actual change to legislation in pursuit of a goal or objective.

The remainder of the paper is structured as follows. Section 2 provides a literature review of public concerns during the pandemic, political engagement, and the wider use of e-petition data to assess public sentiment. Section 3 outlines the data and methods of the study. Section 4 presents results and Section 5 offers discussion and conclusions.

2. Literature review

In this review, we will be primarily concerned with literature covering the governance and legislative concerns in the UK, debate around the effectiveness of e-petitions, and changes in governance during the pandemic. More international studies are available that deal with similar issues in other countries, more broadly (Toshkov, Carroll, and

Yesilkagit 2021; Shafi and Mallinson 2022) and specifically Sweden and Greece (Zahariadis et al. 2021), the United States of America (Kapucu and Moynihan 2021), and China (Cai, Jiang, and Tang 2022).

2.1. Public concerns during the COVID-19 Pandemic

The concerns of the public during the pandemic have been multi-faceted. During the first phase of the pandemic, these centred on the practicalities of lockdowns and how households could pivot towards, and provision for, something that was beyond almost everyone's experience (Eggers and Harding 2022). The second phase concerned the ability of the NHS to treat expected waves of infection, by having both the necessary personnel and the equipment available (Sayburn 2020). Given the speedy implementation of much new legislation, the understanding and enforcement of the regulations also became a concern (Sheldon 2021). An on-going concern was the availability and requirements around the testing and tracing of cases, both for community health reasons but also for work and travel (Hao-Yuan, Cohen, and Hsien-Ho 2021). As vaccines were developed and became available, their prioritization and perceived coercion around deployment became a concern (Stead et al. 2021). The ongoing concern is how practicable is it to "live with covid" (Gurdasani and Ziauddeen 2022)?

2.2. COVID-19 and governance

During these unrepresented times, many looked to their local and national politicians for guidance and assistance, resulting in a range of legislation enacted to control and regulate everyday behaviour not seen since the Second World War (Cairney 2021). This task, and the communication of requirements, was complicated to some extent due to the UK containing devolved authorities in Scotland, Wales, and Northern Ireland, each with their own legislative oversight of issues around health, education, and economic development (MacKinnon 2015). This organization of governance meant that some of these regulations were enacted through the United Kingdom Parliament in Westminster, London, whilst others were enacted through the bodies of the three devolved authorities (Cameron-Blake et al. 2020), leading to some divergence and confusion in the public mind (Cushion et al. 2020).

During the early stages of the pandemic, there were few opportunities for constituents to influence the decision-making of their politicians, with a range of in-person activities prohibited, e.g. face-to-face consultation surgeries were cancelled, street demonstrations were made illegal and elections were postponed. Much of this lobbying moved online, through email, social media and latterly video meetings (Lake 2021; Leston-Bandeira and Prior 2021), and the nature and volume of MP's staff workload changed (Salisbury 2021). One avenue of collective influence that was largely unaffected by the pandemic was e-petitions.

2.3. The utility and effectiveness of e-petitioning as a tool for policy influence

The UK Westminster Parliament has operated an e-petition platform since 2015, following on from previous platforms hosted by the Prime Minister's office (2006–2010) and

the Government (2011–2015). UK residents or citizens are able to suggest the topic and text of an e-petition to the UK Parliament's petitions committee. Prior to publication, each e-petition needs the support of five other named individuals and undergoes some checks, for example, that the subject matter is pertinent to the work of the parliament and that it does not duplicate an existing or recent e-petition (UK Parliament 2022). When an e-petition is published, it can be signed by any UK resident or citizen by providing their name, email address, postcode, and affirming their eligibility to sign. The actual signing is done by clicking on an emailed link. There is no requirement to register with the website to participate. When an e-petition receives more than 10,000 signatures, it is guaranteed a response from the appropriate government department, and those that receive more than 100,000 are considered for a debate in Parliament. Each e-petition stays live for 6 months or until the end of the current Parliament. Every Parliament accounts for its own e-petitions and the details of all e-petitions and their current or eventual support is published on the committee's dedicated web site (UK Parliament 2019). These data can be downloaded for research purposes as .csv or JSON files. There were 11k valid e-petitions for the 2015–2017 Parliament, 8k for the 2017–2019, and so far 9k e-petitions for the current Parliament. A large proportion of e-petitions are rejected before publication, for example in the current Parliament around three quarters of submitted e-petitions are rejected (the details of rejected e-petitions are made available, along with the reason for the rejection).

The evidence on the effectiveness of e-petitions in influencing politicians and government policy is limited (Bochel 2016). Because the e-petition platform publishes the support for each e-petition within every Parliamentary constituency, Members of Parliament (MPs) are aware of the local support for e-petitions in their constituency. In their study, Blumenau (2021) found that an MP was likely to advocate for the subject matter of an e-petition that demonstrated significant support amongst their constituencies, but this was mediated by factors such as party policy or the electoral competition. Also, Cristina Leston-Bandeira (2017) argues that e-petitions have a role in raising awareness of issues among national politicians and the media, and can be a good vehicle for demonstrating discontent or protest. An e-petition that gains large-scale support is likely to gain coverage in both the mainstream media and social media, with crossovers evident (Asher, Leston-Bandeira, and Spaiser 2019). Subsequently, Cristina Leston-Bandeira (2019) proposed a framework around which to consider the role and effectiveness of e-petition platforms, identifying roles that fall into four types; linkage, campaigning, scrutiny, and policy.

The Petitions Committee also has the authority to launch its own enquires and the subject matter of these can be influenced by the support associated with a group of e-petitions, as reported in Matthews (2022) around the issue of online abuse experienced by disabled people. Whilst there is evidence of positive engagement and outcomes, there are sometimes negative aspects to e-petitions. Matthews (2021) reports evidence of skewness in the significance associated with e-petitions, with immediate issues given priority over important issues and amplification of already loud voices in the political sphere. They also warn of an intensification of misunderstanding about the work of government and parliament that can lead to frustrations, both on the part of signatories and e-petition initiators (Wright 2015). Girvin (2018) also highlights that the UK Parliament's e-petition system does not necessarily encourage debate and nuance, and suggests that mechanisms within other countries' e-petition platforms should be considered for the UK to

help address some of these concerns. Beyond e-petitions themselves, there is some debate on the effectiveness of forms of e-participation (commonly termed “slacktivism” or “clickivism” (Christensen 2011) and how this form of activism may displace or galvanize other forms of support (Skoric 2012; Heley, Yarker, and Jones 2022).

The data associated with e-petitions have been used in various studies to gauge political involvement and typify aspects of political engagement. The growth in support for e-petitions over their lifetime is examined by Yasseri, Hale, and Margetts (2017), and how this characteristic changes as the e-petition platform is adapted by showing trending e-petitions is studied by Hale et al. (2018). Looking to identify what factors may influence this rise in e-petition signatures, S.D. Clark and Lomax (2020) replicated a study by Hagen et al. (2016) into these influences, covering such aspects as initial support, linguistic style, and topic. There have also been studies that use the sentiment and support for e-petitions that follow particular themes to monitor public attitudes, such as the shape of the UK’s energy sector (Kolosok, Vasylieva, and Lyeonov 2021) and the promotion of animal welfare initiatives (Chaney, Jones, and Fevre 2021). Many studies have reported various attempts to use the political sentiment captured by signatures to the generality of e-petitions in order to categorize each Parliamentary constituency (Clark, Lomax, and Morris 2017; Anthony and Haworth 2020; Vidgen and Yasseri 2020). The motivation behind these studies is to group together parliamentary constituencies that exhibit similar concerns and feedback to politicians some of the dominant characteristics of the feelings within their constituency.

3. Methods and data

This study identifies the 1575 e-petitions that opened before 24 February 2022 and mentioned the term “covid”, thereby restricting this analysis to e-petitions that explicitly reference COVID-19. The strength of support for the e-petition is judged by its number of signatures. For those e-petitions that have closed, this is simply the total received, for e-petitions that were open on 24 February, the number of signatures by 9 June, 2022 is used. The justification for this cut-off is provided by Yasseri, Hale, and Margetts (2017) who in their study of the growth rate of e-petition signatures show that most e-petitions reach at least 90% of their eventual signatures after 2,500 h, and 9 June is 15 weeks after 24 February, which is 2,520 h.

This process identifies in excess of 1,500 e-petitions (for context, by 24 February 2022 around 6,600 e-petitions in total had been hosted on the platform since March 2020), and the task of individually scrutinising each e-petition and its supporting text for the themes it covers would be a time consuming and subjective task. Instead, here the technique of latent Dirichlet allocation (LDA) topic modelling is applied to these texts to identify common topics of concern and quantify how much each e-petition is concerned with each topic (Blei, Ng, and Jordan 2003). LDA is just one of a range of topic models available (Egger and Yu 2022) and has been successfully used by others to establish topics within e-petition texts (Hagen et al. 2016; Clark and Lomax 2020) and to extract COVID-19 related topics from twitter data (Xue et al. 2020). The candidate number of topics contained in the body of e-petition texts is established by reference to both the optimal values of various metrics and a consideration of the meaningfulness and utility of emergent

topics. To provide re-assurance in this task, this process uses the texts of 75% of the e-petitions to train a model and the remaining 25% are used to test the ability of the model to identify topics within unseen texts. The approaches outlined in Vidgen and Yasseri (2020) can then be used to apportion the signatures that each e-petition receives to its various topics. Summed over all the e-petitions, this provides the support for each topic over the 2 year period of this study in each constituency. Only the 533 constituencies in England are used in this analysis since the concerns revealed by many of the topics were applied differently in the other nations of the UK (Tatlow et al. 2021).

To establish a commonality of concerns across the constituencies the support for the topics in each constituency is standardized as a z-score, as outlined in Vidgen and Yasseri (2020). The first task is to recognize that these counts of signatures cannot be used directly since the size of the electorates on which they are based are unequal, the largest constituency is the Isle of Wight which has an electorate of 113k, whilst the smallest, Stoke-On-Trent Central has an electorate of just 55k (Baker, Uberoi, and Crackness 2020). This correction is applied by converting the number of signatures for each topic within a constituency to a percentage distribution, showing how the signatures from these constituencies distribute across the topics. Following the notation of Vidgen and Yasseri (2020), we have:

$$Sp_{ci} = \frac{s_{ci}}{s_c} \quad (1)$$

Where c is the constituency.

i is the issue (topic)

s_c is the number of signatures in constituency c

s_{ci} is the number of signatures in constituency c on issue (topic) i

These percentages are then converted to z-scores by the use of an average and a variance of the percentages calculated across all constituencies, again following Vidgen and Yasseri (2020) notation:

$$\mu_i = \frac{\sum_{c=1}^C Sp_{ci}}{C}$$

$$\sigma^2 = \sqrt{\frac{\sum_{c=1}^C (Sp_{ci} - \mu_i)^2}{n - 1}}$$

$$z_{ci} = \frac{Sp_{ci} - \mu_i}{\sigma_i}$$

Where C is the number of constituencies.

n is the number of constituencies.

The z-scores then represent the relative importance of each topic within each constituency measured against the average importance across all constituencies (μ_i), where μ_i

captures the support for a “typical” constituency. We can now use these z -scores to group the constituencies into those whose z -scores are the most similar. In this study, hierarchical classification is used to group together constituencies with similar levels of concern for each topic (Everitt, Landau, and Leese 2001). If two topics are highly correlated then, in effect, this up weights the concern of these topics over others and in reality just one of these topics would be sufficient to capture the concern. To account for this, before the classification, those topic pairs with a strong correlation (a Pearson correlation greater than 0.60) are identified, and the one of the pair that has the strongest average correlation with the remaining topics is removed.

4. Results

By the 9 June 2022 there have been 1,620 published e-petitions on the topic of COVID, with a total of 12,234,171 signatures (with a mean of 7,552 signatures per e-petition, and a much lower median of just 86). The frequency of these e-petitions by the week of their opening is shown in Figure 1, with the red dashed line indicating the date of the first detected COVID-19 case whilst the green dashed line indicates the week of the Prime Minister’s statement on *living with Covid*. The number of published e-petitions varies over time, with the peak occurring during the winter of 2021. Thereafter there is a sharp decline in the number published, until at the end of this series the frequency is reduced to two or three e-petitions a week. Considering only those e-petitions that

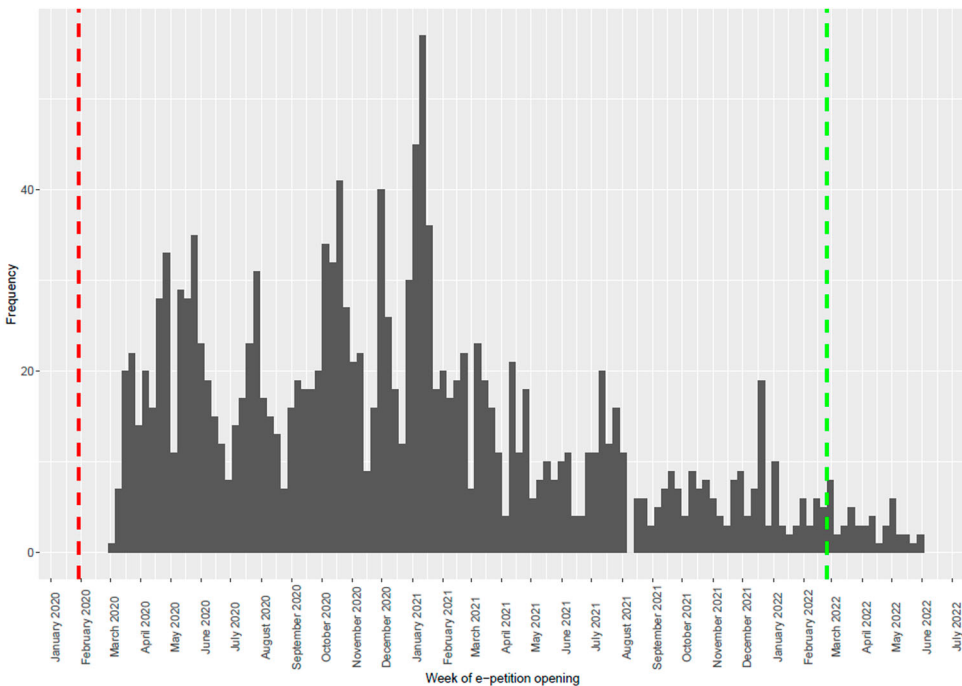


Figure 1. Distribution of COVID-19 e-petition open dates over time, with the vertical red dashed line indicating the week of the first reported domestic case and the green dash the week of the announcement of *living with covid*.

Table 1. Top 10 most popular COVID-19 related e-petitions.

Rank	Petition title	Signatures	Open date
1	End child food poverty – no child should be going hungry	1,113,889	14/10/2020
2	Prevent gyms closing due to a spike in COVID-19 cases	621,440	12/08/2020
3	Reduce University student tuition fees from £9250 to £3000	581,287	05/10/2020
4	Prioritize teachers, school, and childcare staff for COVID-19 vaccination	508,830	20/10/2020
5	Reclose schools and colleges due to the increase in COVID-19 cases	428,789	22/09/2020
6	Do not rollout COVID-19 vaccine passports	375,208	20/01/2021
7	Reimburse all students of this year's fees due to strikes and COVID-19	353,129	23/03/2020
8	Outlaw discrimination against those who do not get a COVID-19 vaccination	347,512	24/02/2021
9	Prevent any restrictions on those who refuse a COVID-19 vaccination	337,144	04/08/2020
10	Seek Europe-wide Visa-free work permit for Touring professionals and Artists	286,797	22/12/2020

opened before 24 February, there are 1,575 such e-petitions with 12,188,336 signatures (mean 7,739 and median 87).

The top 10 most popular COVID-19 e-petitions are shown in [Table 1](#).

There are common themes to many of these top 10 e-petitions, the protection of children, the predicament of University students, and requirements associated with vaccinations.

4.1. Topic models

Topic models are applied to the e-petition title and supplied background text using the LDA function of the *topicmodel* (Hornik and Grün 2011) package in R (R Core Team 2016). To establish the number of topics, a range for the number of topics is applied and the likelihood, Coa Juan (Cao et al. 2009) and Griffiths (Griffiths and Steyvers 2004) metrics are used to suggest an optimal number of topics – much as AIC and BIC metrics can be used to establish a preferred regression type model. The values of these metrics for a candidate range of the number of topics, between 5 and 80 topics, is shown in [Figure 2](#). The objective assessment of these three metrics seeks to maximize the value of the Griffiths and loglikelihood metrics, while the minimum value for the Coa Juan metric is desirable. Both the loglikelihood and Griffith metric suggest the number of topics is between 30 and 35, whilst the Coa Juan metric suggests a range of 25–30. An inspection of the topic results from both 25 and 30 topic solutions suggested that a model for 30 topics provides the most discerning and meaningful topics.

An examination of the keywords most associated with each topic and those e-petitions that are most concerned with the topic allows topic labels to be suggested. These top keywords within each topic and the suggested topic title are shown in [Figure 3](#). The labels are subjective but useful summaries of each topic and are commonly used in this field of work to provide meaning to results which are the sum of many component inputs (e.g. Clarke et al. 2017). In our study, topic labels were discerned independently by each of the co-authors based on the model outputs, and subsequently any differences were resolved through discussion.

These topics relate well to the specific issues and concerns around COVID-19 that were introduced earlier and contrast with the generality of topics reported on similar data in other studies (here there is an absence of topics around matters such as foreign affairs or rural concerns) (Anthony and Haworth 2020; Vidgen and Yasseri 2020). The ability of the health system to deal with the pandemic is covered by those

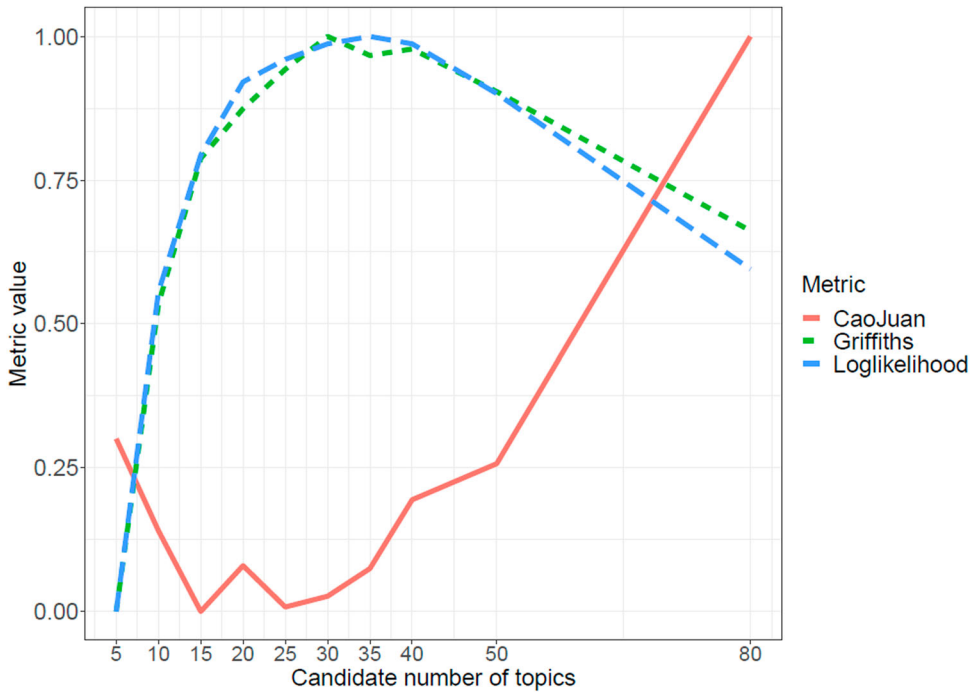


Figure 2. Value of metrics for the number of e-petition topics.

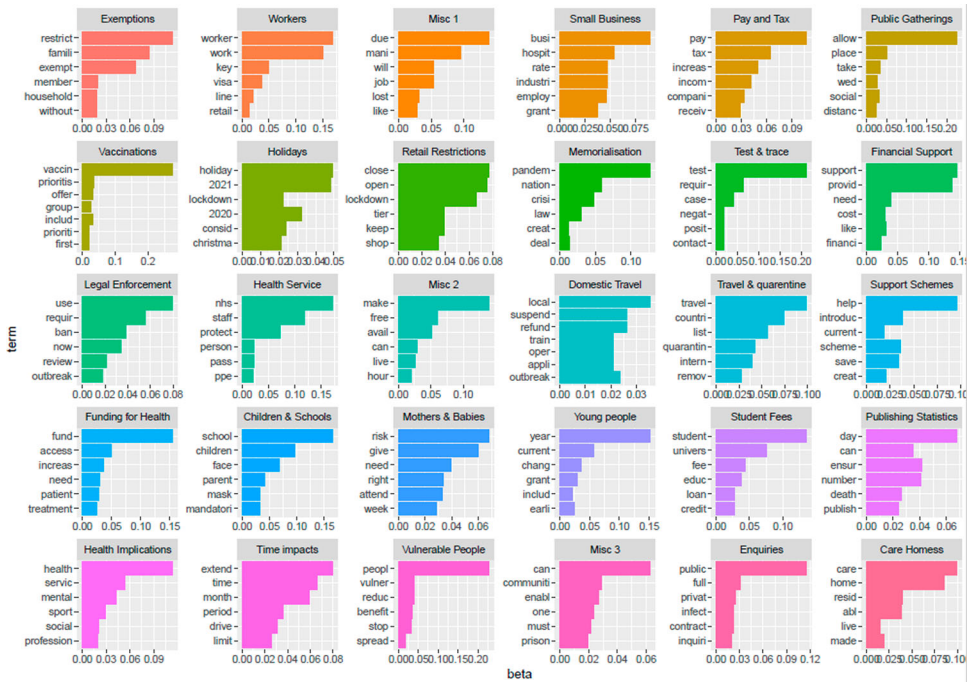


Figure 3. Topic keywords and titles.

e-petitions with topics around Health Service, Funding for Health and Treatments, and Wider Health Implications. Life events are captured by topics such as Public Gatherings, Restrictions & Exemptions, Mothers & Babies and Memorialisation. The topics of Workers, Pay & Tax, Small Businesses, and Support Schemes relate to concerns about work and employment. There are two topics for education, those covering Young People & Education and the Refunding of Student Fees. Travel is also covered by two topics, separately Domestic Travel and then Travel & Quarantine. Other topics seen in results are also expected, e.g. Test & Trace and Vaccination Access & Priority. There are three miscellaneous topics that are difficult to define because there is no clear consensus emerging from the keywords or petition titles (these are similar to the topics with low interpretability as discussed in Hagen (2018)).

Distributing the number of signatures for each e-petition amongst the 30 topics, according to the topic proportions appropriate for the e-petition, allows the signatures for over 1,500 e-petitions, each covering a range of topics, to now apply to just the 30 topics, and these counts are available for each of the 533 constituencies. The distribution of these constituency signature counts for each topic is shown in Figure 4. The distribution within all topics is highly skewed. The topic of Refunding Student Fees gains the highest number of signatures on average, followed by Vaccine Access & Priority and Retail & Services Restrictions.

As illustrated here, there were many popular e-petitions that asked for students to be compensated for disruption to their education during various lockdowns, through reduced or refunded tuition fees and accommodation charges. The number and popularity of such e-petitions, from an affected audience well-versed in social engagement,

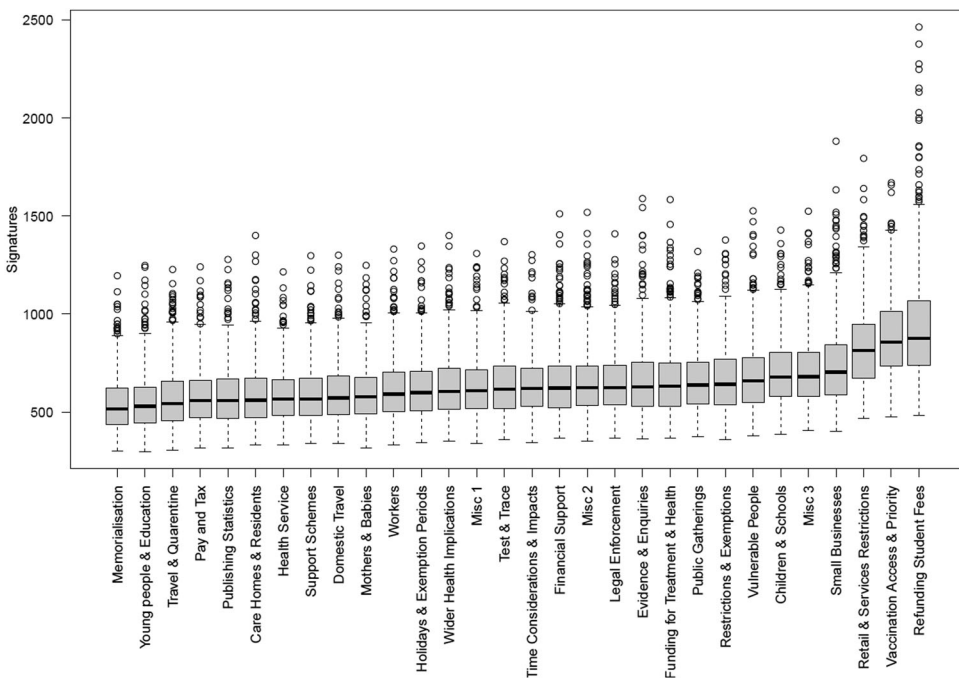


Figure 4. Distribution of constituency signatures by topic.

has caused this topic to feature highly. The next most popular topic is concerned with vaccination and vaccines, and this topic emerges once vaccines became available in early 2021. The popular e-petitions for this topic ask that there be no vaccine requirements in order to undertake certain activities (so-called vaccine passports for work and travel purposes (de Figueiredo, Larson, and Reicher 2021)) and also who should have priority access to vaccines. The third most popular topic, on retail and restrictions, contains e-petitions that run through the whole period of the COVID-19 pandemic and are concerned with the closure of retail and leisure facilities to members of the public.

4.2. Grouping of constituencies

To form clusters of constituencies a hierarchical clustering algorithm is used on a subset of 21 topics, with nine topics identified as having strong correlations with at least one other topic. Ward's criteria (Murtagh and Legendre 2014) is used to identify and form the linkages between groups of constituencies. This provides the dendrogram shown in Figure 5.

Of the 21 available criteria to assess the number of groups in these data, the R package NbClust (Charrad et al. 2014) suggests four or five groups for 8 of the 21 criteria used. Here, the five-group solution has been adopted since it allows for there to be an enhanced degree of differentiation between the constituencies whilst still being well supported by these criteria. Table 2 provides the z-scores of the group centres.

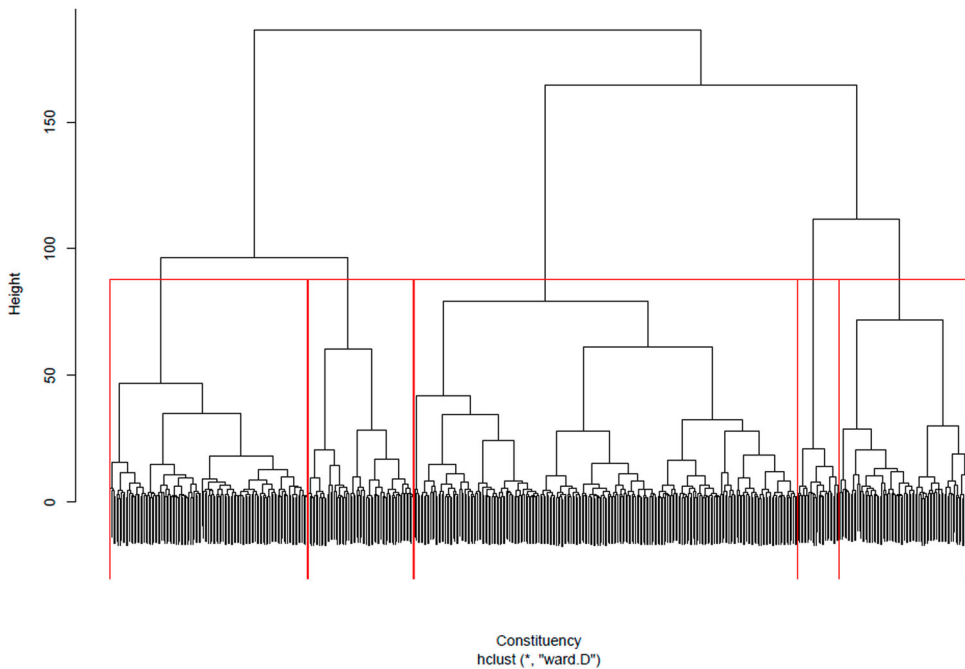


Figure 5. Dendrogram of hierarchical classification solution where the red line denotes the value at which Ward's criterion has been applied, revealing five distinct clusters.

Table 2. Z-score for group centres.

Topic	Theme	Equity of support	Middle England	Education	Funding	Covid Policy
Children & Schools	Education	0.6185	0.0014	-0.4945	-1.3682	-0.0192
Young People & Education	Education	-0.1008	-0.3322	1.6715	0.3818	-0.7909
Refunding Student Fees	Education	-0.0045	-0.3776	1.7726	-0.2097	-0.6962
Workers	Financial	-0.5759	0.6039	-0.3449	0.7580	-0.9851
Small Businesses	Financial	-0.6386	0.1604	-0.1478	2.5231	-0.2030
Pay & Tax	Financial	0.4051	-0.1146	0.5797	-0.3546	-0.9047
Financial Support	Financial	-0.3502	0.1791	-0.9289	1.7708	0.4350
Support Schemes	Financial	-0.1747	0.3924	-0.9541	0.3457	-0.0690
Vaccination Access & Priority	Health & Care	-0.1488	0.6811	-1.0447	-0.7063	-0.6341
Test & Trace	Health & Care	-0.1011	0.1318	-1.0323	-0.0696	0.9919
Health Service	Health & Care	0.1441	0.5220	-1.0889	-1.4994	-0.2405
Funding for Treatment & Health Service	Health & Care	-0.1569	-0.1768	-0.1581	1.2663	0.6228
Mothers & Babies	Health & Care	0.9468	-0.3378	-0.3561	-0.9278	0.2508
Wider Health Implications	Health & Care	0.0056	0.3366	-0.4865	1.3148	-1.1527
Vulnerable People	Health & Care	-0.0740	-0.3680	-0.0464	0.2215	1.4341
Care Homes & Care Home Residents	Health & Care	-0.1710	-0.2443	0.4919	1.7342	-0.0799
Publishing Statistics	Information	0.0667	-0.4440	0.3206	0.2574	0.9869
Evidence & Enquiries	Information	-0.3370	-0.3499	1.2750	0.9654	-0.0361
Restrictions & Exemptions	Restrictions	-0.0316	-0.2703	0.7855	-0.5669	0.3048
Public Gatherings	Restrictions	-0.0037	0.5346	-1.1099	-1.3178	-0.0566
Holidays & Exemption Periods (stamp duty)	Restrictions	0.8057	-0.5188	-0.1849	-1.1612	1.0508
Retail & Services Restrictions	Restrictions	0.1879	-0.1255	-0.7750	-1.1346	1.4888
Legal Enforcement	Restrictions	-0.1234	0.3513	-1.0165	-0.3773	0.3438
Time Considerations for Exogenous Impacts	Restrictions	0.7627	-0.0499	0.0203	-1.5956	-0.6374
Domestic Travel	Travel	-0.2680	0.2337	0.7022	-1.1412	-0.7448
Travel & Quarantine	Travel	-0.7790	0.3641	0.1479	1.1527	-0.4946
Memorialization	Miscellaneous	-0.3186	0.1042	-0.0661	0.5762	0.0712
Miscellaneous 1	Miscellaneous	0.6908	-0.4673	0.4457	-0.9250	0.2218
Miscellaneous 2	Miscellaneous	0.3323	-0.1024	-0.8735	1.8117	0.0952
Miscellaneous 3	Miscellaneous	-0.0975	0.1522	-1.1551	0.5841	0.8031
<i>n</i>		123	238	80	26	66
Min		-0.7790	-0.5188	-1.1551	-1.5956	-1.1527
Max		0.9468	0.6811	1.7726	2.5231	1.4888
Range		1.7258	1.1999	2.9278	4.1187	2.6415

Looking at the range and distribution of these z-scores allows for an interpretation of the meaning for each grouping. These are:

Equity of Support (123 constituencies). This group is concerned with the provision of stamp duty, temporary exemptions, and extensions to support people and the economy. The timing of any exemptions and support required as a result of COVID-19 is a key consideration. There is a particular concern amongst this group around support for mothers, babies, children, and schools.

Middle England (238). This group is typified by support for a broad range of topics related to workers, public gatherings, health services, vaccine priority, and travel. There is less concern here for groups at either end of the age spectrum with low values for topics associated with young people or the elderly and vulnerable people. This is the largest and, with the narrowest range of z-scores, the one most in line with a “typical” constituency.

Education (80). Support for topics around education, primarily for school pupils and university students, is much larger in these constituencies than in a typical constituency, with high z-scores for Young People & Education and Refunding student fees.

Funding (26). Topics that call for further funding and support to assist businesses during the pandemic are supported by constituencies in this group. That support is wide ranging, for small businesses, health treatments and care homes, and their residents, but is especially strong for small business support. This is the least typical group, with a wide range of z-scores amongst the topics.

Covid Policy (66). There is a strong preference for policy related directly with COVID-19 for this group. This includes holiday and exemption periods, restrictions on retail, and support for Test and Trace as well as support for vulnerable people. This group are those most concerned with the publication of COVID-19 related statistics.

The spatial distribution of these groups can be assessed at Parliamentary Constituency level. The map of the location of constituencies by these groups is shown in [Figure 6](#). There is a concentration of those constituencies in the Funding group in inner London. The Middle England group is predominant in the larger more rural constituencies, particularly in the south of England. The Education group is located in constituencies that are largely urban in nature and contain a university or university residences. The two remaining groups, Covid Policy and Equity of Support are largely to be found in the urban and sub-urban areas in northern England.

The cross tabulation of the group allocated to the constituency and the party of the MP in each constituency is shown in [Table 3](#). A composite Index of Multiple Deprivation (IMD) is available for each constituency (Francis-Devine 2019) and the final column provides the mean rank on a deprivation scale for constituencies in the group, where a higher value denotes lower levels of deprivation.

The groups that have similar concerns typified as Middle England and around Equity of Support are more typically right of centre Conservative supporting constituencies, whilst Education and Funding are more likely to be left leaning and Labour supporting.

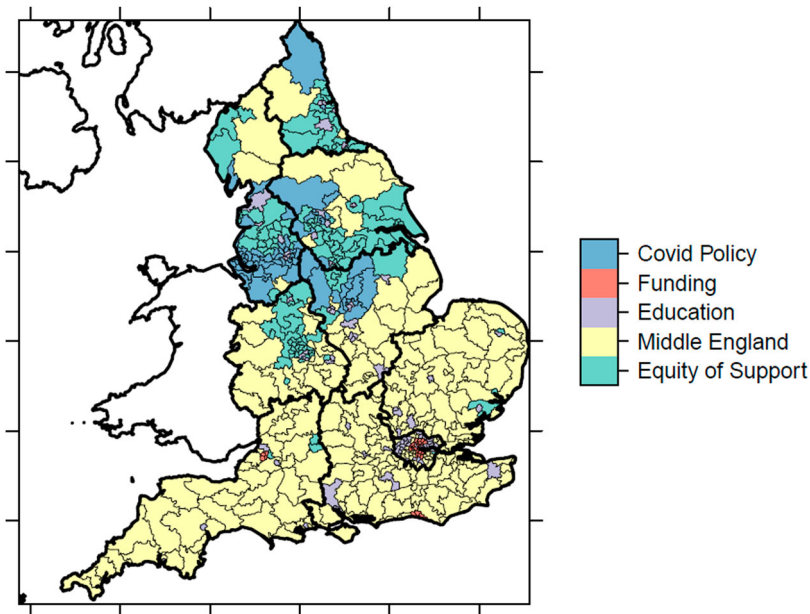


Figure 6. Group for each constituency.

Table 3. : Cross tabulation of group with political party (n and row %) and the mean IMD rank.

Group	Conservative	Labour	Liberal Democrat	Other [†]	Total	IMD [‡]
Equity of Support	73 (59%)	49 (40%)	0 (0%)	1 (1%)	123 (100%)	170.5
Middle England	220 (92%)	13 (5%)	5 (2%)	0 (0%)	238 (100%)	361.5
Education	18 (23%)	60 (75%)	2 (3%)	0 (0%)	80 (100%)	203.1
Funding	2 (8%)	23 (88%)	0 (0%)	1 (4%)	26 (100%)	183.2
Covid Policy	32 (48%)	34 (52%)	0 (0%)	0 (0%)	66 (100%)	216.5
Total	345 (65%)	179 (34%)	7 (1%)	2 (0%)	533 (100%)	

[†]One constituency is for a Green MP and one for the (largely uncontested) constituency of the Speaker of the House of Commons.

[‡]Average rank, where 1 = most deprived, 533 = least deprived, so a low rank indicates greater deprivation.

The remaining group on Covid Policy is evenly split between the two parties. The spread in the mean deprivation within each group is large. Deprivation is highest in the two groups that call for support, both in its application and availability of funding. The least deprived group is the Middle England group which is the most typical group, with concerns that are not particularly concentrated within a particular range of topics.

5. Discussion and conclusions

In this article, use has been made of the signatures to COVID-19 related e-petitions hosted on the UK Parliament's online platform in order to identify common topics of concern and measure their strength amongst the electorate. It is not intended as a methodological article, as we make use of methods that are reported elsewhere (Vidgen and Yasseri 2020). Rather this work seeks to show how such method can capture the political sentiment of the general public during and unrepresented time where policy and legislation was quickly devised and implemented in the context of social upheaval and turmoil. This is in contrast to the usual expectations, as noted by Cristina Leston-Bandeira (2019) "Changing policy is rarely a linear and quick process", but in a time of COVID-19 policy was not evolutionary and was quick.

In total 27 interpretable topics were identified. The three most popular topics were those associated with education, vaccinations, and restrictions around retail activities. The topic to receive the most signatures was associated with the plight of university students, where existing students and those starting in Autumn 2020, were still required to pay full tuition and accommodation fees whilst being denied both face-to-face tuition and the opportunity to engage in traditional student social activities (Nixon et al. 2021). Many thought the transition to online tuition, whilst still requiring the student to take up university accommodation, at some potential distance from their parental home, unfair. This was compounded by an inability to access social venues at their new home due to the closure of entertainment venues such as pubs, bars, clubs, gyms, cafes, and restaurants.

The second most popular topic was concerned with the vaccination programme that started in earnest in early 2021 (Ajana et al. 2022). This topic covered two issues: who should have priority for access to limited vaccination doses; and once vaccinations became possible and widespread, what requirements for vaccinations should be imposed on people before they undertook their employment or accesses certain facilities. On this latter point, there were two divergent opinions, one that such requirements were proportionate and reasonable and the contrasting opinion that they were a

draconian impingement of the right of individuals to choose what medical “procedures” to agree to.

The third topic was the restrictions on access to services (both governmental and commercial) and retail opportunities in order to try and minimize the spread of the virus. Latterly, these topics overlapped with the vaccination topic in regard to the use of vaccine passports to access services or premises (Osama, Razai, and Majeed 2021).

Whilst it is possible to obtain “headline” indicators of the support for each topic, the availability of signature counts for individual constituencies means that the strength of these concerns can also be measured at the scale of each individual constituency, with some topics being seen to spatially cluster in relevant locations. Looking to identify a grouping of constituencies with similar concerns, five groupings of constituencies have been established. Those constituencies that disproportionately support topics that call for financial and equity of support, to help people through the pandemic, tend to be the most deprived, indicating the feeling that there is a need for greater government assistance in such areas.

The largest cluster is Middle England which is predominantly Conservative voting, southern and affluent but is not characterized by strong scores for any particular topic, and represents the views of a large proportion of the electorate, who are concerned with a wide range of topics. The Equity of Support Group is also Conservative leaning but is more northern and less affluent than the Middle England group. Two clusters are characterized as being predominantly Labour voting. The Education group is the larger of the two, with heavy representation in Outer London constituencies as well as a geographical spread around the rest of England, including a number of student dense constituencies (e.g. Canterbury, Colchester, Norwich, Southampton, Lancaster, and York). In an assessment of 2019 General Election voting patterns, Carl Baker (2020) finds that of 77 “student seats” the vote share for Labour was twice that of Conservative (49.8% vs 25.9%). In this context, the focus on education and specifically the reimbursement of student fees is understandable. The Funding group is small (24 constituencies) and tightly clustered in Inner London, Brighton, and Bristol. A focus on the importance of funding for small business is not surprising for this group given the concentration of small businesses in inner London: of £11 billion paid out in Small Business Grant Funds and Retail, Hospitality, and Leisure Business Grant Funds to September 2020, £804 million (7.2%) was paid to businesses in Inner London Boroughs (Department for Business Energy and Industrial Strategy 2020). That this cluster is predominantly Labour voting is likely a product of its London focus, where Labour tend to do better than the Conservatives. There is a more even political split for the Covid Policy group. This shows that here we are able to differentiate by various dimensions (e.g. geography, voting, or deprivation) the level of support for various COVID-19 specific topics. Some are obvious – tuition fees in university towns, whilst others are less so – Middle England and Equity of Support are both largely Conservative, the former is more southern and affluent whilst the latter is more northern and less affluent.

Cristina Leston-Bandeira (2019) provides an analytical framework that proposes four types of roles that e-petitions can perform. Here, we use this framework to consider how the topics and strength of support for the topics correspond to these roles as summarized in Table 4. Perhaps the most important role is that Parliament should be recognized as a legitimate body, working in collaborations with other legislators, to enact the kinds of

Table 4. E-petitions roles and associated topics.

Type	Role	Observation	Topics
Linkage	Legitimacy	Parliament needed to establish itself as the only legitimate authority to implement the radical legislation unseen in peacetime	Retail & Services Restrictions; Public Gatherings; Legal Enforcement; Financial Support; Domestic Travel and Travel & Quarantine
	Safety-value Grievance resolution	To allow electors to give voice to frustrations, but in a time of crises accept the subservience of individual grievances to a collective good	Refunding Student Fees, Vaccination Access & Policy and Children & Schools
	Education Public engagement	The function and understanding of Parliament and how to engage with the Parliamentary process during COVID-19	Evidence & Enquiries and Publishing Statistics
	Political participation	Normal party politics largely suspended, but replaced by engagement with Policy – see below	Memorialization
Campaigning	Mobilization Group identity strengthening Dissemination	To articulate and contribute, through e-petition signing, concerns to politicians Other avenues primarily used to justify legislation, e.g. Prime Ministerial addresses and main-stream media	All NA
	Recruitment	Whilst it is not directly possible to identify specific individuals to help a cause, a well-publicised and supported e-petition provides a vehicle for others to support a campaign	NA
	Scrutiny	Fast pace of legislation may by-pass some scrutiny A largely agreed agenda on COVID-19 priorities Parliaments reliance on scientific evidence but also e-petitions allow and expression of the economic/social impact of legislation This role becomes more evident as the pandemic proceeds and citizen more willing to challenge	Evidence & Enquiries and Publishing Statistics All Small Businesses; Financial Support; Workers; Pay & Tax; Support Scheme; Vulnerable People; and Care Homes & Residents Evidence & Enquiries and Publishing Statistics
Policy	Policy review Policy improvement Policy influence Policy change	Initial policy dictated by science and largely accepted. Latterly, a balance of health priorities with those of a social and economic nature. This can be seen through the strength of support for various e-petition topics	Funding for Treatment & Health; Wider Health Implications; Health Services

legislation required to tackle the pandemic. Without this legitimacy, the impact of any legislation would be compromised. Impactful topics around access to retail and services, travel restrictions, and the provision of financial aid and support are most relatable on this role. Safety valve, grievance, and fire-alarm are the next most important roles given that some topics of concern were heartfelt but individuals and communities felt these concerns were not being addressed. This is exemplified by the most supported topic concerned with the financial and social plight of students, unable to access education in a traditional form. The third group of roles are around education, public engagement, and questioning, with two topics emerging: a desire to have statistics published and evidence and enquires to be prioritized. There will be some roles that encompass almost all topics, for example, agenda setting is behind all e-petitions that seek to persuade and influence legislators to give due consideration to particular concerns.

Whilst these associations have been formulated in the generality of the more than two years of the COVID-19 pandemic, it does not mean that roles did not change over time. Initial deference caused by the confusion of dealing with a novel pandemic and a need to coalesce can be replaced over time with a willingness to question and advocate for alternatives as more is known about the nature of the pandemic.

What this study has not brought to bear is the sentiment that each e-petitions bring to its topics. Thus, for example, on the topic of Travel & Quarantine, there will be some e-petitions calling for a strengthening of travel restrictions and others calling for a relaxation. This distinction is not recognized here, since we are just noting that each topic is a concern and measuring how much the signatories are engaging with the topics.

This approach to gauging public opinion is not just limited to a study of COVID-19. There is an on-going potential for events of a similar scale to occur, both domestically and in the wider world. At the moment these would include for example the war in Ukraine, which in August 2022 is the subject of 87 open e-petitions, or the cost of living crisis, the subject of 111 open e-petitions. Using the same approach as outlined here the topics and support for e-petitions on many issues, can be easily established. Since the UK Parliament's e-petition platform makes available, in real time, the details of the current e-petitions and the number of signatures that each gains, this allows for the identification of emerging, strengthening and weakening areas of concern.

The extensions of the work described here are not just limited to other events that affect the UK population but also to other governments, from supra-national to local, that provide similar successful governmental e-petition platforms, e.g. the European Union (European Union 2022), the German Bundestag (Schmidt and Johnsen 2014), Ukraine (Reshota et al. 2021), and also municipalities within countries e.g. Bristol City Council (Bristol City Council 2022). However, there are at least two aspects of the UK platforms that make it particularly useful for such research questions. Firstly, there is a richness of data relating to the hosted e-petitions that are made available, which varies by platform, with the UK being a good example of the timeliness and geographic detail of these data. Secondly, the UK platform enjoys considerable popularity, which is in contrast to some other platforms, notably the largely defunct United States federal "We the People" e-petitioning platform.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author, SDC. The data are not publicly available due to restrictions on the rights to re-distribute data and the specifics of the time of data collection.

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