



The association between the proportion of Brexiters and COVID-19 death rates in England[☆]

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ABSTRACT

Rationale: A cultural divide may exist between a set of people who accept and a set of people who reject the advice of experts. This cultural divide may have important consequences and policy implications, especially in times of severe crisis.

Objective: Ecological study of whether there exists a significant conditional correlation between two variables that appear unrelated except for attitude towards experts: (1) Proportion of people voting in favour of remaining in the European Union in 2016 and (2) COVID-19 outcomes measured by death rates and vaccination rates. A significant conditional correlation would indicate that polarized beliefs have important consequences across a broad spectrum of societal challenges.

Methods: This study uses simple descriptive statistics and multiple linear regression, considering confounders suggested in the related literature, with data at the District level in England.

Results: Districts where people voted most heavily in favour of remaining in the EU (top quintile) had nearly half the death rate of districts in the bottom quintile. This relationship was stronger after the first wave, which was a time when protective measures were communicated to the public by experts. A similar relationship was observed with the decision to get vaccinated, and results were strongest for the booster dose, which was the dose that was not mandatory, but highly advised by experts. The Brexit vote is the variable most correlated with COVID-19 outcomes among many variables including common proxies for trust and civic capital or differences in industry composition across Districts.

Conclusions: Our results suggest a need for designing incentive schemes that take into consideration different belief systems. Scientific prowess – such as finding effective vaccines – may not be sufficient to solve crises.

1. Introduction

Experts can be biased and, at times, outright corrupted. An example in the health domain is the US opioid crisis, with four million people suffering from opioid-related substance abuse disorders and over 400,000 people dying from overdoses in the last 15 years. Seven executives and employees of an opioids maker (Insys) were found guilty of masterminding a scheme to bribe doctors to prescribe their drug. The most famous consulting expert, McKinsey & Company, agreed to pay \$573 million to resolve investigations into its alleged role in the sale of

opioids. Economics experts are in a similar situation. Sapienza and Zingales (2013) show that economists have preferences that are not aligned with the rest of the population, can be ‘captured’, and they suffer from groupthink. In addition, the likely corruption of regulators has been widely discussed, starting with Stigler (1971).

Meanwhile, we observe an increased polarization of opinions, with narratives centred around us (vox populi) versus them (the experts) gaining widespread traction. This polarization has been highly visible in the US, especially during the COVID-19 crisis. Many empirical studies have shown the correlation between Trumpism (vox populi) and

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Table 1
Timeline of events.

Week #	Year	End date	Main event(s)	Remarks
1	2020	January 3		
5		January 31	First COVID-19 death reported	
13		March 27	Start first lockdown	Mass testing not available
15		April 10	More systematic death reports	8k COVID-19 death that week
22		May 29	End first wave	1.6k COVID-19 death that week
26		June 26	End first lockdown	0.5k COVID-19 death that week
42		October 16	Start second wave	Wider testing available
45		November 6	Start second lockdown	2k COVID-19 death that week
49		December 4	End second lockdown	
50		December 11	Start Vaccination	
60	2021	February 19	Vaccination opens if underlying health conditions or over 65	Nearly 15mn primo vaccinated
67		April 9	Switch focus from 1 st to 2 nd dose	Nearly 6mn double vaccinated
70		April 30	End second wave	
77		June 18	Start third wave	Vaccination opens to all adults
90		September 16	Start booster vaccination campaign (https://www.england.nhs.uk/2021/09/nhs-begins-covid-19-booster-vaccination-campaign/)	
113	2022	February 25	Domestic legal restrictions end Covid is treated as other infectious diseases such as flu (https://www.gov.uk/government/news/prime-minister-sets-out-plan-for-living-with-covid) End of our sample period Third wave is still ongoing	44mn primo vaccinated 41mn double vaccinated Nearly 32mn booster vaccinated

Note. Timeline of COVID-19 related events in England. Weeks are from Saturday to Friday.

Source: <https://www.instituteforgovernment.org.uk/sites/default/files/time-line-lockdown-web.pdf>

people's behaviour during the pandemic. However, finding a correlation between the Trump vote (or viewership of a pro-Trump show) and health behaviour during the pandemic could be expected on the basis that these two events are related: Trump underplayed the gravity of the virus, and people who voted for him are expected to believe what he says. An alternative hypothesis is that there exists a subset of the population who rejects the experts, and it is the existence of this group culture that increased the Trump vote, the non-acceptance of Non-Pharmaceutical Interventions (NPIs), the anti-expert rhetoric, and TV shows catering to this culture, *etc.*

One way to test this alternative hypothesis is to take another country. In the UK, the Prime Minister during the COVID-19 pandemic was Boris Johnson. Like Donald Trump, Mr. Johnson campaigned in 2016 and won. In addition, Mr. Johnson's campaign used a similar rhetoric as that of Mr. Trump, with his co-campaigner Mr. Gove disparaging experts: 'The people of this country have had enough of experts.' Nonetheless, the 2016 vote was not about electing Mr. Johnson, but about whether the UK should remain in the European Union (Brexit). Mr. Johnson did not become Prime Minister following the referendum; he did so two years later. Finally, although Mr. Johnson did not fully embrace health guidelines, his public interventions during the COVID-19 crisis were

guided by expert advice more than the intervention of Mr. Trump.

In the UK, the head of the Brexit party was Mr. Farage. Following the Brexit vote, this party was sidelined for several months, only to be reborn as Reform UK in 2020 with the new focus being a criticism of the government's handling of the COVID-19 crisis and opposition to lockdowns. More generally, [Foster and Feldman \(2021\)](#) note that the public hostility towards technical expertise witnessed during the COVID-19 crisis is "not a one-off emotional reaction, but part of Brexit's legacy in weakening trust between public and professionals." Relying on the book by [Eichengreen \(2018\)](#), they further argue that people who promote various forms of nationalism also advocate for some apparently polar opposite ideas, but the common point across all their viewpoints is a rejection of expert-informed policymaking and technocracy, particularly from experts born outside the UK. In a nutshell, [Foster and Feldman \(2021\)](#) show that anti-establishment narratives are applied to unrelated topics, from systemic challenges such as Brexit, to spontaneous challenges such as COVID-19. Consistent with this view, [Ansell et al. \(2021\)](#) provide survey-based evidence that the variable most correlated with the declared reluctance to take the vaccine is the Brexit vote.

In this paper, we focus on England and study whether a measure of anti-expert views – as proxied by either abstaining or voting in favour of Brexit – is related to both death rates and willingness to accept the expert's solution (a vaccine) across districts during a large-scale pandemic (COVID-19).

The rest of the paper is organized as follows: Section 2 describes the data and methods, Section 3 presents the results, Section 4 discusses the related literature and the limitations of our study, and Section 5 concludes by summarizing the main findings of the paper.

2. Methods

Weeks are delineated from Saturday to Friday. We number weeks starting from the week ending on January 3rd, 2020. In the United Kingdom (UK), deaths that are directly attributable to the COVID-19 virus began being systematically recorded as of week 15. [Table 1](#) shows important milestones: Week 26 is the end of the first lockdown in the UK, week 42 is the start of the second wave in the UK, followed by the second lockdown in the UK from week 45, vaccination in the UK starts week 50, and we reach a plateau in the UK as of week 76. The booster vaccination campaign starts in week 90. Our sample ends in week 113 (ending on 25 February 2022), which is when all the restrictions were lifted.

Our level of analysis is a Local Authority District, which we simply refer to as District. For the main analysis, we focus on England, whose population represents 85% of that of the UK. There are 22 Districts in Wales, and 32 Districts in Scotland, but some of the variables are missing for these nations and we show results separately in the robustness section. We exclude the 11 districts of Northern Ireland entirely, because their District Brexit votes data are not available.

There are 307 Districts in England made up of 36 metropolitan boroughs, 32 London boroughs, 181 non-metropolitan Districts, and 58 unitary authorities. The total population of England is 56 million, hence the average District has about 200,000 inhabitants. A District is the smallest geographical zone for which we can collect our key variables: voting record on the Brexit referendum and COVID-19 case, death, and vaccination rates.

The Office for National Statistics (ONS) publishes the number of COVID-19 deaths. Vaccination and COVID-19 infection data are collected from the UK government website. [Fig. 1](#) plots the time-series of our five variables of interest: number of deaths, number of infection cases, number of primo vaccinated people, number of double vaccinated people, and number of people with the booster dose.

For ease of reading, we refer to Anti-Brexiter as people who cast a vote in favour of the UK remaining in the European Union during the 2016 referendum (Brexit referendum). We pool together abstentionists with people who voted for Brexit under the banner 'Brexiter.' The

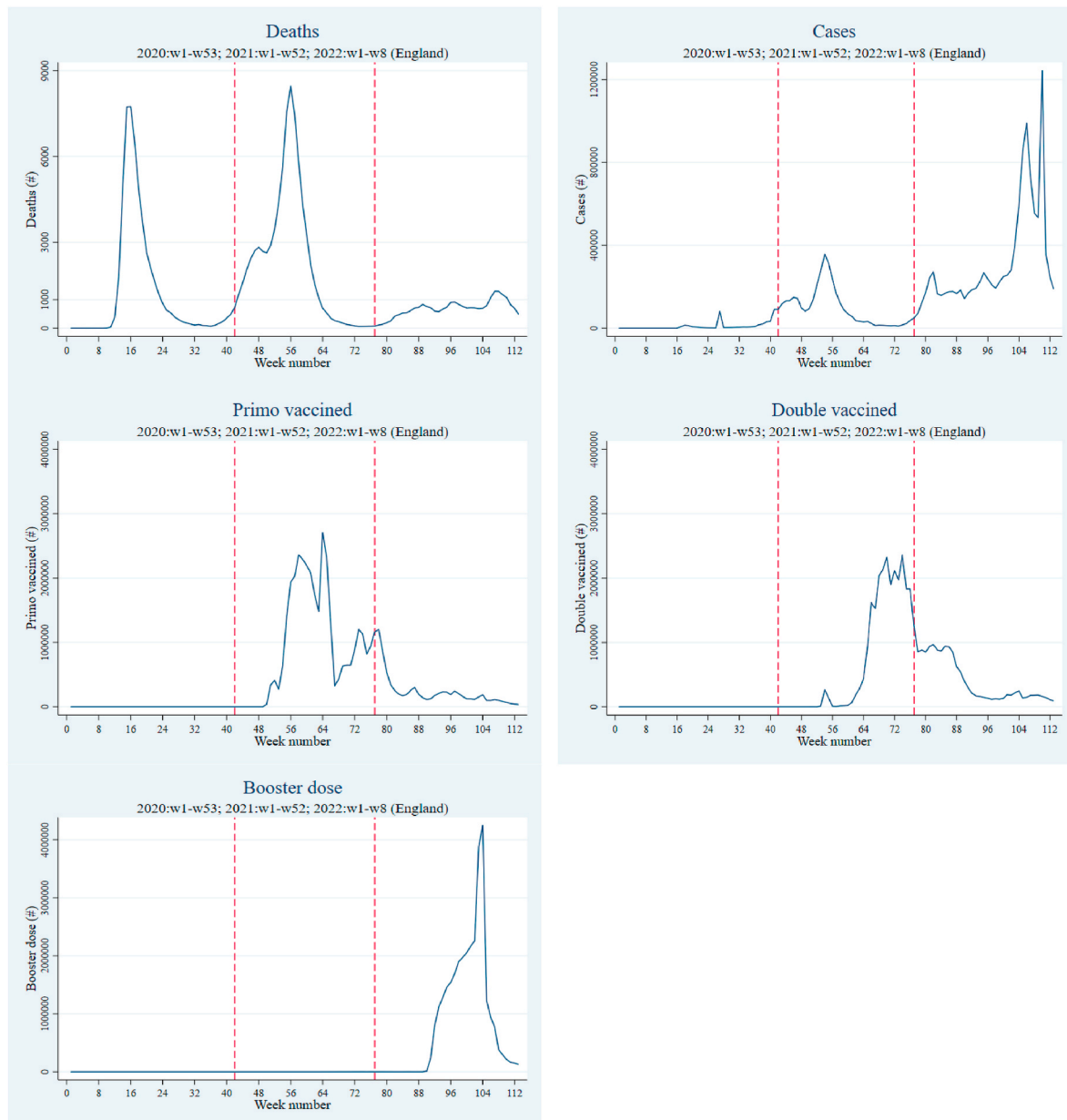


Fig. 1. Time-series statistics for key COVID-19 variables. **Note.** Plotted are time series of the variables that we use as dependent variables in the regression analysis. Week count starts in January 2020. Weeks 42 and 77 are marked by a dashed vertical line, indicating the start of the second wave and the third wave, respectively.

rationale is that people who did not express their views on the referendum might be equally sceptical of experts’ (or mainstream) advice since most experts advised people to vote to remain in the EU. Therefore, our central variable is the ratio of Brexiters so defined to registered voters.

We collect a set of District characteristics that may be related to either the Brexit vote or the COVID-19 infection rate. From the ONS, we obtain the following District level characteristics: (1) fraction of retired people – measured as the fraction of people who are 65 years of age or more; (2) fraction of non-white people (Minority); (3) fraction of unemployed people; (4) 20th percentile and average income; (5) population density; (6) fraction of adults with a university degree (level 4 or more); (7) fraction of employees in each industry; (8) gross annual pay for all employees.

We collect data on the number of deaths per District published by the ONS since January 2018. We compute the death rate for the period January 2018 to December 2019 for each District. This variable is

important because it should be a good proxy for co-morbidity risk.

To measure partisanship, we use the composition of the District Council obtained from the Open Council Data UK website. This data shows the fraction of Conservatives (the party of Boris Johnson), and the fraction of seats from *other* parties. The category ‘other’ includes Independent, Green Party, UK Independence Party, and several others, and excludes Labour and Liberal Democrats.

From the Care Quality Control (CQC) website, we compute the number of beds in care homes in each District and scale this number by the District population. Adler and Ansell (2020) shows that areas that voted against Brexit were areas with the highest increase in house prices (computed using data from HM Land Registry); we then use this variable as well.

Finally, we use the Townsend deprivation score. Woodward et al. (2021) argue that there is a strong association between social deprivation as measured by this score, and communicable diseases, such as COVID-19. This score is available from the national census and is

Table 2
Proposed explanatory variables. Panel A: Definitions and average values of explanatory variables.

Variable	Definition	Average	SD
% Brexiter	$100 \times$ Number of people who voted for Brexit or abstained in the 2016 Brexit referendum divided by number of registered voters	66.3	7.7
Retired	$100 \times$ Number of people who are 65 years of age or more, divided by the district population	19.7	4.9
Density	$\ln 1 +$ Number of people per hectare in 2011	2.2	1.2
Minority	$\ln 1 + 100 \times (1 - (\text{White (British or Other in 2016)})/\text{Population})$	2.0	1.0
Bad living std	Living environment average score in a District (see Table A1)	20.6	8.7
Death rate '18-'19	$1000 \times (\text{Number of deaths in 2018 and 2019})/\text{Population}$	18.7	4.2
Conservative	$\ln 1 + 100 \times$ Fraction of district council seats occupied by a member of the conservative party	3.3	1.1
Other party	$\ln 1 + 100 \times$ Fraction of district council seats occupied by someone not affiliated to one of the three major parties	2.0	1.3
Information&Com.	$\ln 1 + 100 \times$ Fraction employees in the information and communication industry in 2015	1.4	0.5
Construction	$\ln 1 + 100 \times$ Fraction employees in the construction industry in 2015	1.8	0.3
High education	Fraction of adults with a university degree or equivalent	39.0	10.9
Unemployed	$100 \times$ Unemployment rate	3.8	1.2
Care home beds	$1000 \times (\text{Number of care home beds})/\text{Population}$	8.7	3.2
House prices	Growth in average house price between 1995 and 2019	3.6	1.1
Mean Income	Mean of gross annual pay for all employee jobs/1000	30.9	7.0
Low Income	20 th percentile of annual pay for employee jobs/1000	13.2	2.2
Socially deprived	Dummy variable that is one if the Townsend Deprivation Score in 2011 is 4 or 5 (out of 5), and is zero otherwise	0.4	0.5

Panel B: Pairwise Correlation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 % Brexiter	1.00															
2 Retired	0.22	1.00														
3 Density	-0.11	-0.79	1.00													
4 Minority	-0.27	-0.83	0.75	1.00												
5 Bad living std	-0.13	-0.21	0.27	0.25	1.00											
6 Death rate '18-'19	0.50	0.88	-0.61	-0.75	-0.18	1.00										
7 Conservative	0.07	0.46	-0.47	-0.34	-0.22	0.29	1.00									
8 Other party	0.11	0.51	-0.48	-0.53	-0.13	0.47	0.16	1.00								
9 Information&Com.	-0.61	-0.50	0.43	0.50	-0.07	-0.62	-0.08	-0.31	1.00							
10 Construction	0.30	0.48	-0.48	-0.45	-0.38	0.41	0.32	0.25	-0.33	1.00						
11 High education	-0.86	-0.32	0.23	0.37	0.11	-0.57	-0.05	-0.18	0.62	-0.29	1.00					
12 Unemployed	0.33	-0.45	0.52	0.41	0.18	-0.18	-0.40	-0.23	-0.13	-0.30	-0.24	1.00				
13 Care home beds	0.19	0.73	-0.51	-0.55	-0.22	0.80	0.27	0.39	-0.35	0.29	-0.27	-0.24	1.00			
14 House prices	-0.52	-0.45	0.41	0.45	0.15	-0.61	-0.10	-0.23	0.42	-0.23	0.55	-0.05	-0.40	1.00		
15 Mean Income	-0.66	-0.33	0.25	0.33	-0.02	-0.56	0.11	-0.12	0.62	-0.17	0.71	-0.17	-0.28	0.55	1.00	
16 Low Income	-0.43	-0.47	0.36	0.38	0.02	-0.57	-0.04	-0.18	0.52	-0.24	0.55	0.01	-0.39	0.42	0.76	1.00
17 Socially deprived	0.14	-0.61	0.68	0.57	0.32	-0.36	-0.51	-0.32	0.07	-0.48	-0.07	0.66	-0.38	0.16	-0.11	0.08

Note. The following variables are collected from the ONS: Retired, Density, Minority, Death rate 2018–2019, Unemployed, High education, Industries, Income. Care home beds are from the CQC website. Composition of the District Council seats is taken from the Open Council Data UK website. Referendum results, the score on living environment, and house prices are from the UK government website. Townsend Deprivation Score is from the national census. All the variables are as of 2019 unless indicated otherwise. Population is that of the District and includes all inhabitants. Mean income is winsorized at £60,000 (three London outliers).

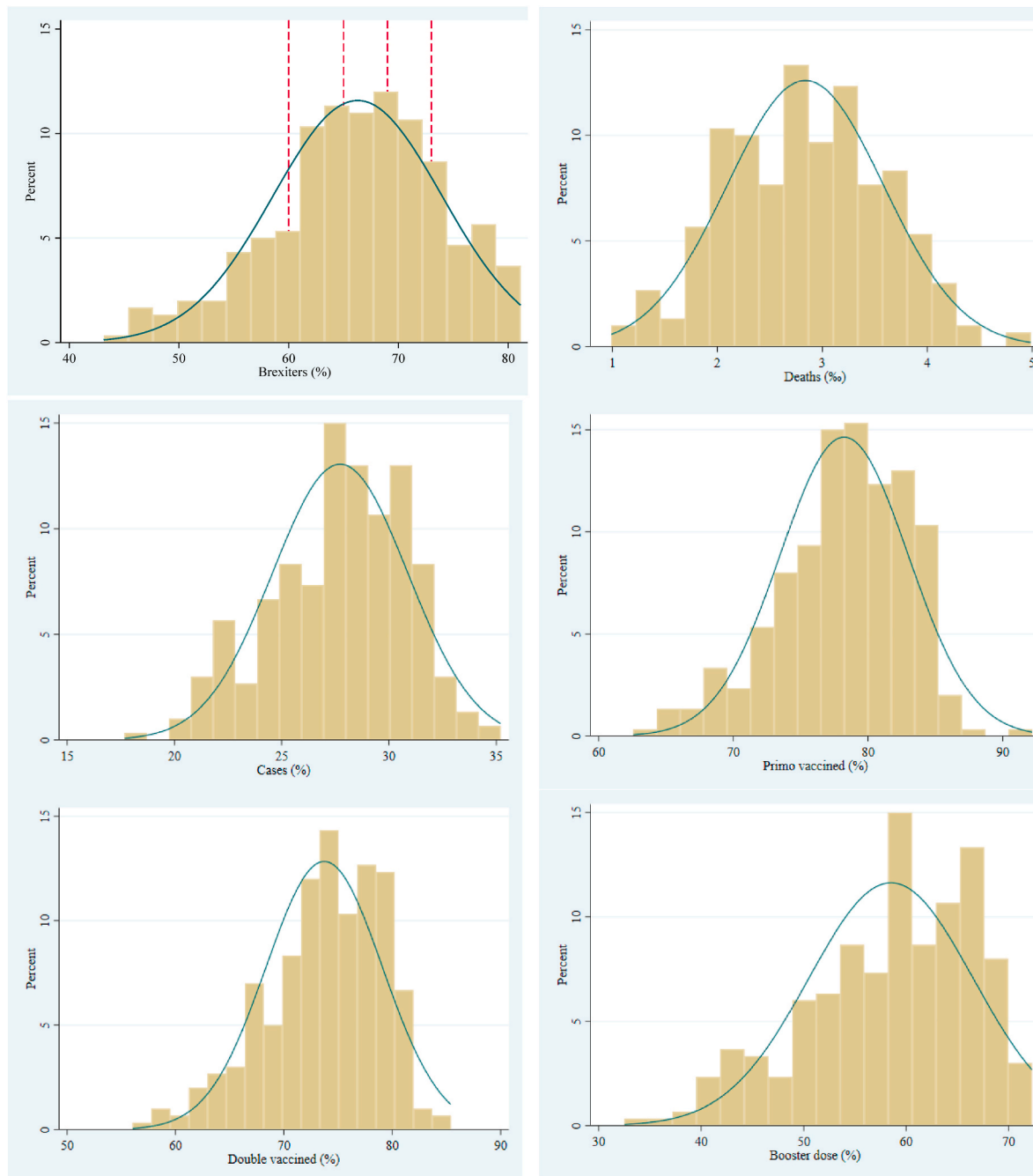


Fig. 2. Distribution of key COVID-19 variables. *Note.* Histogram of the variables across the 300 Districts. All the histograms are fitted with a Normal distribution. Quintile breakpoints are marked by dashed vertical lines.

provided for each District except for nine of them; it accounts for unemployment, overcrowding, non-car ownership, and non-home ownership. In addition, the Ministry of Housing, Communities and Local Government publishes a large set of deprivation indices. Each District in England is scored and ranked according to their level of deprivation relative to that of other areas. There are 68 separate indicators, organized across seven distinct domains of deprivation, which are detailed in Appendix Table A1. Controlling for either one of these does not change our results.

Note that some Districts have been modified between 2016 and 2021. When Districts have been merged, we aggregate their characteristics by weighting their respective number of inhabitants. Some Districts created after 2016 cannot be included in our study (e.g., North Northamptonshire and West Northamptonshire were created in 2021).

Five Districts have one characteristic missing and thus excluded: Buckinghamshire (COVID data), Dorset (Density), Epsom and Ewell (Income), Runnymede (Income), and West Suffolk (House prices).

We also construct three variables proposed in the literature to proxy for civic capital, risk perception, and understanding of science. First, blood donation registration is generally seen as a good proxy for civic capital (e.g., Campos-Mercade et al. (2021); Durante et al. (2021)). Here we use the fraction of people registered for blood donation in 2019–2020 (from the NHS). Second, we use theft of a motor vehicle in 2019–2020 (from gov.uk), which has been used as a proxy for risk perception (e.g., Müller and Rau (2021)). Third, we use the fraction of university graduates whose subject of study is classified as physical sciences, for the period 2018–2019 (from the HESA/Jisc) to measure understanding of science (e.g., Eichengreen et al. (2021)).

Table 3
Descriptive statistics – Brexiters and COVID-19. Panel A: Definitions and average values of dependent variables.

Variable	Definition	Average	SD
Deaths	Number of people reported deceased from COVID-19, divided by district population, multiplied by 1000.	2.8	0.8
Cases	Number of people with a positive COVID-19 virus test, divided by district population, multiplied by 100.	27.7	3.2
Primo vaccinated	Number of people who have received a first dose of COVID-19 vaccine, divided by district population, times 100.	78.2	4.8
Double vaccinated	Number of people who have received a second dose of COVID-19 vaccine, divided by district population, times 100.	73.7	5.4
Booster dose	Number of people who have received the booster dose of COVID-19 vaccine, divided by district population, times 100.	58.5	8.0

Panel B: Brexiter-based quintile analysis

% Brexiter	Low	Quintile 2	Quintile 3	Quintile 4	High
	43%–61%	61%–65%	65%–69%	69%–73%	73%–81%
Deaths	2.2	2.7	2.8	3.0	3.5
From week 42	1.4	1.8	1.9	2.1	2.5
Adults only	2.7	3.3	3.4	3.7	4.4
Cases	26.9	26.7	27.2	28.4	29.4
From week 42	26.5	26.2	26.5	27.7	28.6
Adults only	33.2	33.0	33.4	35.2	36.5
Primo vaccinated	79.3	79.7	78.9	77.3	75.9
Adults only	97.7	98.0	96.6	95.3	94.1
Double vaccinated	74.6	75.3	74.6	72.8	71.3
Adults only	91.9	92.7	91.2	89.7	88.4
Booster dose	59.7	60.9	59.8	57.2	55.0
Adults only	73.5	74.9	73.1	70.4	68.0
Number of districts	60	60	60	60	60

Note. Districts are grouped in quintiles based on the fraction of Brexiters in the district. The quintile ranges are shown in the first line. If not specified, statistics are computed from inception (January 2020) and population is that of the District in 2019 and includes all inhabitants. Data are from the UK government website. Week 42 of year 2020 coincides with the start of the second wave. Adults only variables are constructed the same way by we use adult population instead of the total population of a District to scale the data.

3. Results

3.1. Description of the sample

Fig. 2 – Panel A shows the distribution of Brexiters (including abstainers). Dotted vertical lines show the quintile breakdowns. One-fifth of the Districts have less than 60% Brexiters, and one-fifth of the Districts have more than 73%. The average fraction of Brexiters across Districts is 66%. Specifically, 34% voted to remain in the EU, 40% voted in favour of Brexit, and 26% abstained. Table 2 – Panel A gives the definition of the explanatory variables we use in our regression analysis. Table 2 – Panel B shows pairwise correlations between these variables. We observe that the fraction of Brexiters correlates with District characteristics. Results are consistent with those reported in the literature and in the media. Areas that voted to remain in the European Union have more people with university degrees (86% correlation with the fraction of the ‘high education’ variable), high income (66%), and growth in house prices (52%). Importantly, we also note a strong correlation between the industry composition of an area and the vote. Appendix Table A2 shows the pairwise correlation between the fraction of Brexiters and the fraction of jobs in each industry in the same district.

Areas that voted more to remain in the European Union are also more densely populated, vote for Labour and Liberal Democrats, have more

minorities, less unemployment, fewer care home beds, lower living standards, and are less socially deprived. We also note a strong negative correlation between death rates pre-COVID-19 and the proportion of Brexiters. Hence, even in normal time, death rates are higher in Districts that voted more for Brexit, but this is mostly an age effect: older people voted more in favour of Brexit. Finally, we observe that some characteristics are highly correlated with one another. Areas with more retired people have fewer minorities, are less densely populated, have more care home beds, and have higher death rates in 2018–2019 (correlation is 88%).

Next, we compute the number of COVID-19 cases and deaths in each District from January 1, 2020 to February 25, 2022, scaled by the total District population. We also collect data on vaccination at the District level, including first dose (primo vaccinated), second dose (double vaccinated), as well as the booster dose. The distribution of these five dependent variables is shown on Fig. 2. Their definition and mean are shown in Table 3 – Panel A. In Table 3 – Panel B, we break down Districts into quintiles based on the fraction of Brexiters. We observe that COVID-19 death rates strictly increase with the fraction of Brexiters. The spread is large: The death rate is more than 50% higher in high-Brexit Districts (high quintile; >73%) than in low-Brexit Districts (low quintile; <61%). Case frequency shows a similar pattern. Appendix Figure A1 shows the death rate and the fraction of Brexit votes by Districts in England.

NPIs were widely disclosed (and perhaps also understood) only during the first lockdown, so cases and deaths in the first wave are less likely to be related to the views of experts. When we start death and case counts in week 42 – the start of the second wave – we observe that death rates are nearly 80% higher in high Brexiter Districts compared to low Brexiter Districts (2.5‰ vs 1.4‰). The effect is also slightly stronger if we scale the number of deaths by the adult population instead of the whole population.

3.2. Results

In a multiple regression setting, we add the confounding variables discussed in the previous section. We observe that the death rate is higher in Districts that have higher death rates pre-pandemic, have more minorities, are more densely populated, have lower living standards, and have more votes allocated to small political parties. We also include two industries (among 18 in total) that are significant at a 1% level test. However, none of these variables are as significantly related to death rates as the fraction of Brexiters (Table 4).

Fig. 3 shows the evolution over time of the regression coefficient on the top and bottom quintiles of Brexiters. That is, we run the regression in specification 5, stopping at different dates, and record the coefficient on the low and high Brexiter quintiles. During the first wave, the difference is small; during the second wave it becomes large and statistically significant; and then it stabilizes.

Table 4 specification 2 shows that the results with ‘case rates’ as the dependent variable are similar to those with death rates. One notable difference is that retired people had a lower probability to catch the virus. The fraction of minorities, living standards, and industry are significantly related to case rates. The fraction of Brexit voters is the third most highly statistically significant variable, and the magnitude of the association is 0.11, suggesting that a 10% increase in the fraction of Brexit voters is associated with a 1.1% increase in the rate of cases. For vaccination rates, a key determinant is age, with older people being prioritized for vaccination. Older people are more likely to be Brexiters. It is, therefore, particularly important to analyse the vaccination rates in a multiple regression setting. We find that Districts with a higher proportion of Brexiters have a lower fraction of vaccinated people, and that the effect is particularly strong for the booster dose (specifications 4 and 8). The Brexit vote is about as strong an explanatory variable as the fraction of retirees. Given the high priority given to retirees and the higher need for vaccines among the elderly, it is quite a remarkable result.

Table 4
Main findings: The association between the fraction of Brexiters and COVID-19 outcomes.

	(1) Deaths	(2) Cases	(3) Vaccines	(4) Booster	(5) Deaths	(6) Cases	(7) Vaccines	(8) Booster
% Brexiter	0.03*** (4.25)	0.11*** (3.27)	-0.11** (-2.21)	-0.32*** (-6.21)				
% Brexiter Low (1/0)					-0.22** (-2.03)	-1.08*** (-2.72)	1.06* (1.75)	2.52*** (3.93)
% Brexiter Quintile 2 (1/0)					-0.03 (-0.30)	-0.32 (-1.12)	0.85** (2.10)	1.60*** (3.53)
% Brexiter Quintile 4 (1/0)					0.14 (1.52)	0.59** (2.23)	0.05 (0.12)	-0.53 (-1.07)
% Brexiter High (1/0)					0.31*** (2.65)	1.30*** (3.50)	0.12 (0.19)	-1.45** (-2.11)
Retired	-0.00 (-0.15)	-0.57*** (-6.77)	0.37*** (2.99)	0.52*** (3.70)	-0.01 (-0.24)	-0.56*** (-6.70)	0.44*** (3.38)	0.62*** (3.96)
Density	0.17*** (2.94)	0.45** (2.59)	-0.82*** (-3.82)	-1.00*** (-3.92)	0.17*** (2.79)	0.42** (2.42)	-0.82*** (-3.85)	-1.00*** (-3.67)
Minority	0.18*** (3.43)	0.45** (2.59)	-0.77*** (-3.44)	-1.85*** (-6.71)	0.19*** (3.39)	0.49*** (2.80)	-0.75*** (-3.43)	-1.87*** (-6.43)
Bad living std	-0.02*** (-3.81)	-0.10*** (-6.95)	-0.06*** (-3.07)	-0.13*** (-5.31)	-0.02*** (-4.11)	-0.10*** (-7.30)	-0.05** (-2.57)	-0.11*** (-4.32)
Death rate '18-'19	0.07** (2.38)	0.22** (2.21)	0.14 (0.94)	0.39** (2.22)	0.07** (2.23)	0.19* (1.87)	0.04 (0.28)	0.27 (1.43)
Conservative	-0.00 (-0.02)	0.16 (1.51)	-0.08 (-0.42)	0.22 (1.08)	0.01 (0.47)	0.18* (1.74)	-0.13 (-0.65)	0.07 (0.33)
Other party	0.05** (2.16)	0.07 (0.89)	-0.06 (-0.54)	-0.03 (-0.21)	0.05** (2.13)	0.08 (0.97)	-0.07 (-0.58)	-0.04 (-0.28)
Information&Com.	-0.22** (-2.36)	0.01 (0.04)	1.59*** (3.15)	1.40** (2.44)	-0.23** (-2.37)	0.05 (0.16)	1.71*** (3.40)	1.59*** (2.62)
Construction	0.33*** (2.92)	1.09*** (3.07)	-1.47** (-2.04)	-0.57 (-0.86)	0.36*** (3.12)	1.14*** (3.28)	-1.71** (-2.33)	-1.09 (-1.52)
High education	0.00 (0.01)	0.03* (1.74)	0.10*** (3.05)	0.07** (2.22)	-0.00 (-0.77)	0.03 (1.60)	0.12*** (3.64)	0.13*** (3.66)
Unemployed	0.03 (0.64)	-0.18 (-1.22)	-0.64*** (-3.00)	-1.06*** (-4.52)	0.03 (0.76)	-0.17 (-1.14)	-0.71*** (-3.31)	-1.17*** (-4.97)
Care home beds	0.03* (1.77)	0.04 (0.83)	-0.10 (-1.36)	-0.17* (-1.84)	0.03* (1.68)	0.06 (1.16)	-0.07 (-1.00)	-0.15 (-1.57)
House prices	0.04 (1.06)	-0.04 (-0.27)	-0.30 (-1.53)	-0.69*** (-3.03)	0.03 (0.78)	-0.05 (-0.35)	-0.24 (-1.30)	-0.57*** (-2.61)
Mean Income	0.01** (2.08)	0.05 (1.58)	-0.06 (-1.26)	-0.04 (-0.80)	0.01 (1.61)	0.04 (1.39)	-0.06 (-1.12)	-0.01 (-0.18)
R ²	0.678	0.803	0.787	0.913	0.672	0.805	0.786	0.906
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	300	300	300	300	300	300	300	300

Note. This table reports results from OLS robust estimations. Dependent variables are reported on the first line, consisting of Deaths: the number of people reported deceased from COVID-19, divided by the district population, multiplied by 100; Cases: the number of people with a positive COVID-19 virus test, divided by the district population, multiplied by 100; Vaccines: the number of people who have received a first dose of COVID-19 vaccine, divided by the district population, multiplied by 100; Booster: the number of people who have received the booster dose of COVID-19 vaccine, divided by the district population, multiplied by 100. In specifications (5)–(8), the Brexiter variable is split into five dummy variables based on quintiles and the quintile 3 group is used as the base group for analysis. Variable definitions are provided in Tables 2 and 3. Region fixed effects are included in all the specifications (and add up to a unity vector): East, East Midlands, London, North East, North West, South West, South East, West Midlands, Yorkshire and the Humber. T-statistics are shown between parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

We observe a lower vaccination rate in areas with more unemployed people, more minorities, less educated people, and more densely populated areas. Areas with people working more in construction have lower vaccination rates despite the higher exposure to the pandemic, and it is the opposite for areas with more people working in information and communication.

The Booster dose results are particularly interesting because the first two doses were quasi-mandatory. Many activities were forbidden for people that were not double vaccinated, but the booster dose was not buying anything other than better protection against the virus. The relationship between the fraction of Brexiters in a district and the vaccination rate in that district is three times as large for the booster dose as it is for the primo vaccination.

As indicated in the Methods section, we collect extra data to construct three variables proposed in the literature - the fraction of people registered for blood donation for civic capital; the fraction of thefts of a motor vehicle for risk perception; the fraction of university graduates whose subject of study is classified as physical sciences for an understanding of science. We reproduce Table 4 and add these variables.

The results are shown in Table 5 – Panel A. The Brexit vote effect remains, despite being slightly weakened with these extra considerations. Note that due to data availability, the sample size drops from 300 to 260, and in Panel B we show the results on this sample of 260 Districts but without these three extra variables. Additional robustness analysis has been conducted and results are shown in the online Appendix.

4. Discussion

In this study, we document a striking relationship between the proportion of 2016 Brexit vote and COVID-19 death, infection, and vaccination rates across Districts in England. Specifically, our analysis suggests that the fraction of Brexit voters is positively associated with death rates and case rates, and it is negatively associated with vaccination rates, in particular the Booster dose. We study two high-stakes events that are a priori unrelated except for the rejection of experts or mainstream media views and find persistence across these two events. This approach allows us to better estimate the effect of a cultural divide on the COVID-19 crisis. There is an extensive and fast-growing related

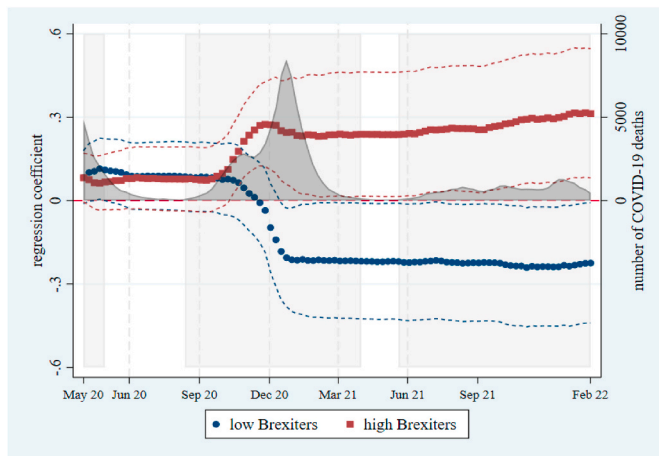


Fig. 3. Evolution over time of the association between proportion of Brexiters and COVID-19 death rates across districts. *Note.* Number of people who died of COVID-19 each week are shown on the grey/shaded area. The round red (resp. square blue) dots are the coefficient on the first (resp. fifth) quintile of Brexiters in the multiple regression analysis when run from week 1 to the week shown on the x-axis (Table 4, spec 5). The 95% confidence interval is displayed around each line. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

literature. Remarkably, the corresponding set of results are highly complementary and consistent with one another. Closest to our work is perhaps Algan et al. (2021), who show that across and within several countries, it is trust in experts rather than trust in government that is most strongly correlated with support of NPIs and vaccines. In addition, Eichengreen et al. (2021) use global survey data and find that exposure to past epidemics has no impact on views of science as an endeavour, but that it significantly reduces trust in scientists. The decline in trust is driven by the respondents with little previous training in science subjects. Epidemic-induced distrust translates into lower compliance with health-related policies (e.g., negative views towards vaccination). Also closely related is the work of Pabayo et al. (2022) who show that several laws in the U.S. create barriers to voting, and in areas where people are more restricted from voting, people had higher COVID-19 case and death rates. They argue that voting restrictions create a disconnect between voter preferences and political representation, resulting in less protective public health policies and funding.

Bursztyjn et al. (2020) show that areas with a higher COVID-19 death rate have greater exposure to the Hannity show on Fox News – a show characterized by unconditional support for Mr. Trump and a significant downplay of the effects of the virus. In addition, there is evidence of a correlation between Trumpism and the rejection of Non-Pharmaceutical Interventions (NPIs), such as social distancing (Allcott et al. (2020); Barrios and Hochberg (2021); Gadarian et al. (2021)). Similarly, Republican governors were slower to shut down at the early part of the pandemic, quicker to open up their economies (Adolph et al. (2021), Grossman et al. (2020)), and less likely to implement mask mandates (Wright et al. (2020)) than Democrat governors.

Goolsbee and Syverson (2021) examine the drivers of the economic slowdown from COVID-19 in the U.S. and find that individual choices were far more important than government-imposed restrictions and seem tied to fears of infection. Ding et al. (2020) show that social distancing increases more in counties where individuals historically demonstrated greater willingness to incur individual costs to contribute to social objectives. Egorov et al. (2021) provide evidence that areas with greater levels of xenophobia and ethnic fractionalization have the greatest reductions in mobility. Mulder and Lokate (2022) find that moral appeal can be a useful tool for increasing vaccination uptake and mandate support among healthcare workers.

Bargain and Aminjonov (2020) examine human mobility and

political trust in Europe (at the regional level) and show that higher political trust is associated with a larger reduction in non-essential mobility, following the implementation of containment policies in March 2020. This effect coincides in magnitude with the effect of trust on the efficacy of policy stringency. Similarly, Ansell et al. (2021) show that across Europe social distancing patterns correlate strongly with populist attitudes and economic security.

In Brazil, Ajzenman et al. (2022) and Mariani et al. (2020) find that following public speeches of the president opposing NPIs, social distancing immediately fell in municipalities with higher support for the president. In Italy, Durante et al. (2021) find that during the early phases of COVID-19, voluntary social distancing was greater in areas with higher civic capital and amongst individuals exhibiting a higher sense of civic duty. Similarly, in Sweden, Campos-Mercade et al. (2021) find that prosociality measured two years before the COVID-19 pandemic predicts health behaviours during the pandemic. In Germany, Müller and Rau (2021) find that risk tolerance, trust, social responsibility, voter turnout, support of vaccination, and compliance with COVID-19 policies are closely correlated variables. Elgar et al. (2020) provide international evidence that social capital and income inequality are associated with both the spread of COVID-19, and associated mortality rates.

4.1. Alternative hypothesis

An important alternative hypothesis is that it was rational for essential workers to vote Brexit, and although they followed medical advice, their job made increased exposure to the virus inevitable. We have used a large set of confounders variables that should capture the share of essential workers. None of these variables eliminate the Brexit effect. It is also not obvious that Brexit is a good outcome for essential workers and our results are strongest if we pool together abstentionists and Brexiters. Hence, abstention should also be a better vote for essential workers, which is difficult to rationalize. In addition, deaths mostly occur among retired people. It would have to be the case that essential workers transmitted the virus to older people who live in their neighbourhood and did not adopt sufficient protective measures. Also, the spread in death rates is significantly larger in the second wave, once all NPIs are known. In the first wave, when everyone was less informed about the countermeasures at their disposal to combat the virus, we do not observe much difference between Districts. Essential workers should have been equally affected across waves.

We do find that areas with more construction workers have a higher death rate, and areas with more workers in information and communication have lower mortality rates. These results are important because the construction industry stayed open throughout the pandemic whereas other industries, like information and communication, could work from home. However, the distribution of jobs across different industries does not explain the Brexit results away. Furthermore, we measure the reaction of stocks in different industries to the Brexit vote to measure which industry was viewed as benefiting from a Brexit vote. We find no relation to death and case rates (non-tabulated).

Contrasting results with the first two vaccination doses and with the Booster dose is also informative because the first two doses were quasi mandatory, and the booster was not. Areas with a lower fraction of Brexit votes only have a slightly lower primo vaccination rate, but a much lower booster vaccination rate. This result is difficult to rationalize.

4.2. Limitations and policy implications

The results of this study should be interpreted with caution due to several limitations. First, the study design is an ecological study, limiting our findings to the District levels. Associations found in this study cannot be inferred at the individual level. Disaggregated data are needed to determine the magnitude of the association between voting choices and health outcomes; see Flaherty et al. (2022) for example.

Table 5
The Brexit vote effect after considering civic capital, risk perception, and understanding of science. Panel A.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Deaths	Cases	Vaccines	Booster	Deaths	Cases	Vaccines	Booster
% Brexiter	0.02** (2.24)	0.08** (2.32)	-0.02 (-0.47)	-0.20*** (-4.26)				
% Brexiter Low (1/0)					-0.10 (-0.87)	-0.97** (-2.32)	0.65 (1.06)	1.78*** (3.05)
% Brexiter Quintile 2 (1/0)					0.05 (0.51)	-0.22 (-0.70)	0.95** (2.00)	1.56*** (3.22)
% Brexiter Quintile 4 (1/0)					0.10 (1.00)	0.51* (1.68)	0.44 (0.96)	-0.20 (-0.44)
% Brexiter High (1/0)					0.21 (1.63)	1.08*** (2.62)	0.91 (1.40)	-0.55 (-0.86)
Blood donation registration	-0.32 (-1.46)	-0.77 (-0.94)	2.55** (2.15)	4.56*** (3.63)	-0.39* (-1.90)	-0.93 (-1.19)	2.74** (2.18)	5.35*** (3.91)
Theft of a motor vehicle	1.43*** (3.75)	4.18** (2.57)	-8.42*** (-3.26)	-12.73*** (-5.15)	1.55*** (4.02)	4.50*** (2.87)	-8.45*** (-3.20)	-14.05*** (-5.33)
HESA: Physical sciences	-0.22 (-0.92)	0.68 (0.91)	2.60** (2.13)	2.65** (2.37)	-0.24 (-1.06)	0.67 (0.91)	2.59** (2.11)	2.91** (2.55)
R-square	0.673	0.784	0.797	0.931	0.672	0.789	0.802	0.930
Confounder variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	260	260	260	260	260	260	260	260

Panel B								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Deaths	Cases	Vaccines	Booster	Deaths	Cases	Vaccines	Booster
% Brexiter	0.03*** (3.93)	0.11*** (3.10)	-0.12** (-2.25)	-0.35*** (-6.48)				
% Brexiter Low (1/0)					-0.22* (-1.78)	-1.20*** (-2.89)	1.45** (2.26)	3.05*** (4.52)
% Brexiter Quintile 2 (1/0)					0.01 (0.14)	-0.29 (-0.94)	1.18** (2.41)	1.95*** (3.59)
% Brexiter Quintile 4 (1/0)					0.13 (1.22)	0.52* (1.75)	0.22 (0.49)	-0.56 (-1.11)
% Brexiter High (1/0)					0.27** (2.08)	1.20*** (2.90)	0.46 (0.71)	-1.33* (-1.85)
R ²	0.654	0.776	0.775	0.914	0.647	0.778	0.776	0.906
Confounder variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	260	260	260	260	260	260	260	260

Note. Dependent variables are reported on the first line. Confounder variables are the same as in Table 4. Blood donation registration is the number of people registered for blood donation (2019/20), divided by the district population, multiplied by 100 (winsorized at the 1% level). Theft of a motor vehicle is the offence count of theft of a motor vehicle (2018/19: Q3&Q4 and 2019/20: Q1&Q2), divided by the district population, multiplied by 100 (winsorized at the 1% level). HESA: Physical sciences is natural logarithm of one plus 100 * the number of university-graduates whose subject of study is classified as physical sciences, divided by the number of graduates in the same year (2018/19). Panel B is like Panel A but without these three extra variables and keeping the same sample. T-statistics are shown between parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Second, we do not demonstrate causation – a vote is obviously an endogenous variable. Our evidence is, however, very robust, consistent with a fast-growing body of literature, and a conditional correlation nonetheless indicates that there may be a common driver behind apparently two unrelated events (Brexit voting and health behaviour). As a result, we argue that a cultural divide seems to exist between a set of people who accept and a set of people who reject the advice of experts, whether that advice is on Brexit, NPIs, or vaccines.

Irrespective of the exact characterization of the Brexit/Abstentionist vote, our results suggest a need for designing incentive schemes that account for different cultures and belief systems. For example, for future crises, increasing academic evidence (e.g., research on the efficacy of a vaccine, or the effect of climate change), or punishment (e.g., fining non-vaccinated people), or bribes (e.g., paying people to be vaccinated) may have disappointing results. Worse, an increase in the reliance on experts or anything that could support the elite corruption view may further polarize the population and cement the cultural divide. Future research may focus on belief and culture formation and build so-called effective mechanism designs that take an engineering approach to solving problems that involve individuals, markets, and institutions.

Interestingly, during the COVID-19 crisis we have observed different approaches to incentivize people to be vaccinated. Some governments

offered money to get vaccinated or fired employees refusing to be vaccinated. Both approaches run the risk of confirming the corruption view. Another approach, taken by the Singapore government, simply respected the fact that some people did not want to be vaccinated, but unvaccinated people seeking COVID-19 treatment would not be refunded for the costs. The latter is an example of a government focusing more on belief and culture formation, and designing accordingly an incentive mechanism.

5. Conclusions

We uncover a striking relationship between the proportion of 2016 Brexit vote and COVID-19 death, infection, and vaccination rates across Districts in England. We find persistence across two high-stakes events (exit a federation of states, dealing with a pandemic) that are a priori unrelated except for the rejection of experts and its close relatives (e.g., rejection of mainstream media views). Our variable (Brexit vote) has more explanatory power to explain death rates and vaccination choices than any other variables proposed in the literature to capture dimensions such as trust and civic capital. The effect is stronger after the first wave once protective measures are known and available, especially for the vaccine booster dose, which is the least needed one. Our results

suggest a need for designing incentive schemes that take into consideration different belief systems. Scientific prowess – such as finding effective vaccines – may not be sufficient to solve future health crises.

Credit author statement

Ludovic Phalippou: Conceptualization, Methodology, Formal analysis, Interpretation, Writing. **Betty Wu:** Methodology, Formal analysis, Investigation, Interpretation, Writing.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2023.115826>.

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