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**A mailshot in the dark? The impact of the UK  
government's leaflet on the 2016 EU referendum**

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# A mailshot in the dark? The impact of the UK government's leaflet on the 2016 EU referendum

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## Abstract

In this paper I explore the causal effect of exposure to the UK government's mailshot on vote preference in the 2016 EU referendum. I find that exposure caused a drop in the probability of voting leave by 3 percentage points. The effect was stronger in individuals who were exposed to few other sources of referendum information. For instance, females and the risk averse were even less likely to vote leave after exposure. The effect was also larger for Conservative party supporters who consumed many other sources of information. The evidence is consistent with voters being liable to persuasion. On the mechanism, I show that exposed individuals experienced a "persuasion-through-knowledge" effect, which changed beliefs on topics of contention.

*Key Words:* Mass media; Mailshot; Leaflet; European Union; Brexit

*JEL Classification:* D72; J10; L82

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# 1 Introduction

There is an array of evidence that exposure to mass media can influence voting decisions and therefore political outcomes. This is true across various outlets, for instance, newspapers (Gerber et al., 2009; Gentzkow et al., 2011), biased news programs and television (DellaVigna and Kaplan, 2007; Enikolopov et al., 2011; Durante et al., 2017; Martin and Yurukoglu, 2017; Peisakhin and Rozenas, 2018) and radio (DellaVigna et al., 2014; Yanagizawa-Drott, 2014; Adena et al., 2015). In addition, there is evidence that the effects of exposure can vary across demographics (DellaVigna et al., 2014; Yanagizawa-Drott, 2014; Kearney and Levine, 2015), which is attributed to certain groups being more susceptible to persuasion bias (Gerber et al., 2011; Barone et al., 2015; Galasso and Nannicini, 2016).

In this paper I show that government mass media regarding the 2016 EU referendum influenced voting behaviour. I exploit an individual's exposure to the Government's mailshot that was sent to UK households before the referendum and I show that exposure, on average, lead to a drop in the probability of voting leave by 3 percentage points. Britain voting to leave the European Union was a seismic event in European politics. A clear majority of economists and the UK government had warned that leaving the EU would depress the economy and create a lengthy period of uncertainty, and the Government was keen to convey their stance to voters. The mailshot, in the form of a leaflet, contained information on the benefits of EU membership and the reasons why the government officially backed the "Remain" side. The leaflets were sent to all households before the referendum day, but, either unintentionally or by chance, not every person was exposed to the mailshot. Hence, this event offers a unique opportunity to isolate the impact of the leaflet on voting behaviour.

I employ both a matching and difference-in-differences approach, which allows me to address endogeneity concerns caused by selection issues and to estimate the causal effect of exposure to

the leaflet on voting preference. In order to strengthen the inferences of the results, I conduct a number of placebo and robustness checks throughout the analysis. For the first part of the main analysis, I use all available individuals and find that exposure to the leaflet leads to individuals being about 3 percentage points more likely to vote to remain in the EU. This effect is economically and statistically significant, and is robust to various specifications and placebo tests. In the second part, to explore what is driving this effect, I identify a group of respondents that had a low degree of exposure to other sources of referendum information but were exposed to the leaflet. Here, I allow for a heterogeneous treatment effect across different fixed demographic groups. I show that there is a much larger drop in the probability of voting leave for females, low income, the risk averse and those who expressed a preference to vote leave prior to treatment date. Moreover, when focusing on those individuals with a pre-existing Brexit preference, I find that the leaflet was effective in changing their voting intention. I argue that a “persuasion-through-knowledge” mechanism is a plausible explanation for this evidence, which allows certain groups to be more affected than others. In fact, the evidence of heterogeneous effects echoes, and is complementary to, the work of [Yanagizawa-Drott \(2014\)](#), [Barone et al. \(2015\)](#), [Martin and Yurukoglu \(2017\)](#), [Adena et al. \(2015\)](#) and [Peisakhin and Rozenas \(2018\)](#). Using the high exposure sample of individuals who were exposed to multiple sources of information and the leaflet, I show that Conservative partisans were also significantly impacted, by about 6.2 percentage points. This occurs due to the visible splits in the Conservative party, thus party supporters took the leaflet as a signal from the Conservative government to back a remain vote.

To explore the “persuasion-through-knowledge” mechanism by which the leaflet impacted vote preference, I contribute new understanding on how this type of media changed political beliefs. Evidence of this persuasive mechanism is unaddressed in the existing literature, with the exception

of [Peisakhin and Rozenas \(2018\)](#). I isolate the mechanism by showing how individual beliefs on information contained in the leaflet were altered to align with the arguments presented in the leaflet. For example, the leaflet made the case that unemployment would be higher if the UK were to leave the EU, and the results suggest that exposed individuals were more likely to believe that this would indeed be the case. I confirm these as channels of impact, by showing that beliefs were only altered for scenarios and information contained in the leaflet by conducting a number of placebo tests.

This research makes significant contributions to the literature in three distinct ways. First, it shows that clear, objective and realistic information from the government can have a significant impact on vote intention, and explore the possible explanations for why this effect exists. In this manner, the findings sit somewhere between the previous contributions by [Barone et al. \(2015\)](#) on the negative impact of digital TV on Berlusconi's vote share, and by [Gerber et al. \(2011\)](#) on the positive impact of campaign mail on the Democratic candidate for the 2006 attorney general election in Kansas. Uniquely, in this research I diverge from the current mass media literature on the television and radio mediums by showing that a government mailshot with objective information can also be a persuasive strategy for changing political preferences in the context of a referendum. Moreover, my identification strategy allows me to identify the specific effect given that I can pinpoint exposure to the leaflet unlike in some of the previous media literature.

Second, the findings contribute to the work on inherent cognitive biases ([DellaVigna and Gentzkow, 2010](#); [Choi et al., 2014](#); [Galasso and Nannicini, 2016](#)) and the heterogeneous effects of media. In particular, this paper contributes further evidence that certain demographic groups are heterogeneously affected due to the varying degrees of persuasion bias. The findings shed new light on which groups are affected by persuasive media, and are directly supported by the findings of, for example, [Barone et al. \(2015\)](#), [Adena et al. \(2015\)](#) and [Peisakhin and Rozenas \(2018\)](#).

Third and finally, this research contributes to the quickly expanding literature on the determinants of Brexit and the support for populist policies (see, e.g., [Goodwin and Heath 2016b](#); [Antonucci et al. 2017](#); [Los et al. 2017](#); [Becker et al. 2017](#); [Colantone and Stanig 2018](#)). All current work has focused on the characteristics of an individual, or the population itself, in determining their vote preference. This is the first exploration into the impact of direct government intervention in a quasi-natural experimental setting for the 2016 EU referendum.

The remainder of this paper is organized as follows. Section 2 provides some background on the referendum and leaflet itself. Section 3 describes the data and identification strategy used in the empirical analysis. Section 4 presents the main findings and various robustness tests. Section 5 presents results regarding the mechanisms and section 6 concludes.

## 2 Background

On June 23rd 2016, UK citizens were offered the opportunity to vote in a referendum as to whether the UK should “Remain a member of the European Union” or “Leave the European Union”. The “Leave” side prevailed by 51.9% to 48.1%. Figure A1 present maps of vote shares by local authority district.<sup>1</sup> Since this time, there has been a vast amount of debate in the media and amongst academics as to what drove the referendum result. Much of the empirical academic work has focussed on drivers at the regional-level and only a small portion at the individual-level (see, e.g., [Langella and Manning 2016](#) for an overview of vote leave determinants). For instance, [Goodwin and Heath \(2016b\)](#) show that support for leave closely mapped that of past support for UKIP, and [Antonucci et al. \(2017\)](#) highlight the role of educational attainment. [Los et al. \(2017\)](#) provide

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<sup>1</sup>The referendum count was made for 382 local authority districts, I exclude Northern Ireland, Gibraltar and the Isles of Scilly.

evidence that areas with a higher density of leave votes were areas that were relative beneficiaries of EU funds. Similarly, [Colantone and Stanig \(2018\)](#) show that areas that were more exposed to globalisation had a greater tendency to vote to leave. [Becker et al. \(2017\)](#) focus on the vote break down at the counting areas (by local authority) and find evidence that key fundamentals of the population were at the heart of the leave vote, rather than exposure to immigration or their education profiles. [Liberini et al. \(2017\)](#) suggest that it was in fact dissatisfaction with one's own financial situation rather than general unhappiness that contributed to Brexit. Additionally, they show that it was only the young that were substantially pro-remain. On the whole, the academic work confirms much of the narratives in the media about "who voted for Brexit".

Despite the growing scholarly focus on individual and regional determinants no other research has been conducted into the impact of the government's EU leaflet. It is of particular interest not only because of the impact it may or may not have had on the final result, but the leaflet came at significant cost to the UK taxpayer of £9.3 million. The leaflet, entitled "Why the Government believes that voting to remain in the European Union is the best decision for the UK", was sent to all UK households on Monday 11th to Wednesday 13th April 2016. The 16-page document contained information on the benefits on EU membership and likely scenarios should Britain leave the EU with a particular focus on jobs, the economy and security. Examples of the front and back page of the leaflet are shown in [Figure A2](#) and [A3](#). Even at a glance, in no uncertain terms, the leaflet makes the case for remaining a member of the EU. The back page in particular makes clear the aforementioned three areas of focus, which the government believed would be better if the UK remained a member of the EU. The leaflet was intended to make clear the Government's position and therefore persuade voters to back a remain vote by providing a fair assessment of EU

membership and likely scenarios should the UK vote to leave.<sup>2</sup> This, however, is not the first leaflet of its kind. In the 1975 EU referendum, Harold Wilson’s Labour government sent a pamphlet to all UK households that made the case for remaining a member of the European Community, see Figure A4.<sup>3</sup> The pamphlet-backed “remain” side won with 67.2% of the vote, this apparent success may have acted as a catalyst in prompting the Government into action to repeat the past.

The exploration of this particular type of media is a distinct divergence from the current mass media literature which analyses the effects ideologically biased media consumption. However, in accordance with evidence in the related literature, I would expect certain demographics that are more likely to be affected by persuasion bias to change their voting behaviour to a greater extent, as in, for example, [Kearney and Levine \(2015\)](#), [Barone et al. \(2015\)](#) and [Durante et al. \(2017\)](#). This is expected as different groups will suffer to various degrees of inherent cognitive biases regarding decision making quality ([Dohmen et al., 2010](#); [Choi et al., 2014](#)). There is also evidence that supports the idea that persuasion bias is larger for voters than for, say, consumers of a product ([DellaVigna and Gentzkow, 2010](#)).

## 3 Data and identification strategy

### 3.1 Data

#### 3.1.1 Individual-level data

The empirical analysis in this paper draws on data from the British Election Study (BES) internet panel survey. It is a nationally representative survey of individuals that contains extensive informa-

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<sup>2</sup>The leaflet was independently assessed to contain largely factual and realistic content ([Giles, 2016](#)).

<sup>3</sup>A full transcript of the leaflet can be found here: <http://www.harvard-digital.co.uk/euro/pamphlet.htm>.

tion on personal political preferences, identity and demographics. I focus on one particular wave, wave 8 – á la [Colantone and Stanig \(2018\)](#). This wave was conducted between 6th May and 22nd June 2016, prior to the 23rd June referendum and contains a total of 33,502 individuals.<sup>4</sup>

The main advantage of these data, particularly for this paper, is that wave 8 contains a variety of questions relating to the EU referendum. More specifically, there are questions regarding voting intention, exposure to referendum information and sets of questions aimed at measuring opinions about the campaign and the EU as a whole. Moreover, the respondents can be linked to their parliamentary constituency and EU referendum counting area, which allow controls for regional factors.

In this wave, respondents are asked about their voting intention in the EU referendum. Respondents are asked “If you do vote in the referendum on Britain’s membership of the European Union, how do you think you will vote?” To create the primary dependent variable of voting intention, I code a dummy variable 1 for respondents who replied “Leave the EU”, and 0 for those who reply “Remain in the EU”. Those who responded “Don’t know” are removed from the sample.

Another unique feature of the dataset is that respondents are asked about their exposure to the Government’s EU leaflet, which made the case for the government-backed remain campaign. The relevant question reads as follows: “Have you received and read the UK Government’s leaflet ‘Why the Government believes that voting to remain in the European Union is the best decision for the UK’?” Those replying “Yes, I received and read it” are coded 1, whereas those who respond “Yes, I received it but I haven’t read it” and “No, I haven’t received it” are coded as 0.<sup>5</sup> This forms the

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<sup>4</sup>Due to missing responses the number of analysed respondents is smaller than the full sample, which is a result of the number of covariates used. Moreover, the missing responses to questions which create the sample of 6,123 individuals is not systematic, that is, there is no particular question or questions that exclude people from the sample. Formatively, results do not change when models are re-estimated with survey weighting.

<sup>5</sup>Around 56% of the sample received and read the leaflet, 31% received but did not read it and 13% did not receive it.

primary explanatory variable in this paper. Given that the leaflet was received by households at least 1 month before the survey was conducted, it is very unlikely that an individual would read the leaflet after completing the survey.

I follow much of the previous literature on voting and partisanship in selecting the set of individual-level control variables (Clarke et al., 2017; Aidt and Rauh, 2017; Liberini et al., 2017; Colantone and Stanig, 2018) and use individual-level data of aggregates used by Langella and Manning (2016) and Becker et al. (2017). I also include some other potentially relevant variables, such as a dummy for whether the respondent has friends from the EU and whether they speak another language other than English. To control for partisanship, I include a person’s vote from the 2015 general election, which follows from the intuition that people who voted for Brexit typically voted for the right-leaning parties in the 2015 general election.<sup>6</sup> In order to capture this effect, I rank parties based on their Euroscepticism. More specifically, they are ranked by the percent of negative mentions of the European Union in that party’s 2015 general election manifesto, taken from the Manifesto Project Database by Volkens et al. (2017).<sup>7</sup> The variable is centered by normalization (mean of 0 and standard deviation of 1). The non-normalized ranks are reported in Table A2. I also include measures of the Big Five personality traits for each individual, this helps to further unpick the “black-box” of factors that influenced a individual’s referendum vote. Given the importance for these traits in determining partisan support (Bakker et al., 2015; Aidt and Rauh, 2017), it is entirely plausible that persons of particular fixed personality traits favoured one side more than the other in the referendum.<sup>89</sup>

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<sup>6</sup>This is arguably better than using a persons party affiliation due to the small number of UKIP supporters.

<sup>7</sup>Here, alternative rankings were tested, such as: negative mentions of multiculturalism and internationalism. The interpretation of a positive and significant effect is unchanged regardless of the information used to rank the parties.

<sup>8</sup>For a discussion of the extent to which the Big Five personality traits can be considered ‘fixed’, and therefore exogenous, see Brown and Taylor (2014). If we are to assume they are indeed fixed throughout an individual’s adult life, this coincides with their ability to participate in the referendum, as voters must have been over the age of 18.

<sup>9</sup>In Appendix C, I perform a machine learning procedure to select the covariates, the results are unaffected.

### 3.1.2 Descriptive statistics

As a basic statistical point of motivation for this paper, I split the summary statistics by exposure status in Table 1. It shows that exposed individuals are less likely to express a preference for a leave vote compared to non-exposed people. Moreover, on average, people exposed to the leaflet are more likely to be male, older and to hold a university degree than those non-exposed individuals; they are also less likely to have children but more likely to be a home owner relative to individuals who were not exposed to the leaflet; there is no difference across exposure status for the income groups. These are in line with expectations as those with a degree are expected to be more interested in information regarding the referendum, whereas those with children and who are employed are typically busier. A balance test of these covariates is reported later when I introduce the identification strategy. The leave-remain vote split is much closer to the actual result compared to other works on Brexit that have used individual-level data, such as [Liberini et al. \(2017\)](#). Further analysis of who voted for Brexit is conducted in Appendix B.

Table 1: Summary statistics for selected variables

	Full sample		Exposed = 1		Exposed = 0	
	mean	sd	mean	sd	mean	sd
Vote leave	0.496	0.500	0.488	0.500	0.507	0.500
Male	0.539	0.499	0.555	0.497	0.518	0.500
Age	55.911	14.140	58.126	13.495	53.140	14.438
Age <sup>2</sup> / 100	33.260	14.901	35.608	14.573	30.322	14.787
Married	0.549	0.498	0.580	0.494	0.510	0.500
Widowed	0.044	0.206	0.050	0.219	0.037	0.188
Non-white	0.071	0.257	0.065	0.247	0.078	0.268
Employed	0.501	0.500	0.450	0.498	0.566	0.496
Kids01	0.198	0.399	0.176	0.381	0.225	0.418
Ln(household size)	0.720	0.472	0.712	0.455	0.730	0.491
Home owner	0.728	0.445	0.763	0.425	0.684	0.465
Degree – education	0.454	0.498	0.469	0.499	0.434	0.496
A-level – education	0.195	0.396	0.193	0.395	0.197	0.398
GCSE – education	0.265	0.441	0.258	0.438	0.272	0.445
Friends from the EU	0.506	0.500	0.530	0.499	0.476	0.500
None – education	0.087	0.282	0.080	0.271	0.097	0.296
Speaks another language	0.229	0.421	0.252	0.434	0.201	0.401
Partisan	-0.069	1.014	-0.018	1.011	-0.132	1.014
Household income (Over £70k)	0.080	0.272	0.085	0.279	0.075	0.263
Household income (£40-70k)	0.217	0.412	0.219	0.414	0.214	0.410
Household income (£20-40k)	0.378	0.485	0.371	0.483	0.387	0.487
Household income (£0-20k)	0.325	0.468	0.324	0.468	0.325	0.469
Agreeableness	6.133	1.784	6.191	1.769	6.061	1.800
Conscientiousness	6.847	1.854	6.972	1.830	6.689	1.873
Extraversion	4.106	2.207	4.140	2.235	4.065	2.172
Neuroticism	3.612	2.219	3.470	2.211	3.790	2.217
Openness	5.526	1.745	5.553	1.722	5.492	1.773
Referendum interest	0.947	0.223	0.968	0.176	0.922	0.269
Pre-existing Brexit pref.	0.431	0.495	0.420	0.494	0.444	0.497
Observations	6,132		3,408		2,724	

*Notes:* *Exposed* refers to the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote.

Figure 1a and 1b present the spatial distribution of the share of respondents that received and read (were exposed to) the leaflet, by local authority district. These are constructed using all individuals in the BES, not the UK population. Darker shades represent local authorities that contain a greater proportion of exposed people. As the leaflet was sent to *all* households, there is no concern about the possible targeting of areas expected to be marginal or strong leave areas.<sup>10</sup> The leaflet reached a wide and diverse audience across the UK,<sup>11</sup> the mean value of exposure by local authority is 52%, the largest and smallest proportions are 74% and 24%, respectively.

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<sup>10</sup>In this instance, there was no targeted campaign because the referendum was decided by absolute majority based on a national, rather than regional, vote. This is unlike a general election in the UK, which is conducted under a majoritarian system, where marginal areas are targeted with political party leaflets to win parliamentary seats.

<sup>11</sup>The leaflet was sent to Northern Ireland households throughout the week commencing 9 May to avoid disruption ahead of their local elections. All individuals in Northern Ireland are therefore removed from the sample.

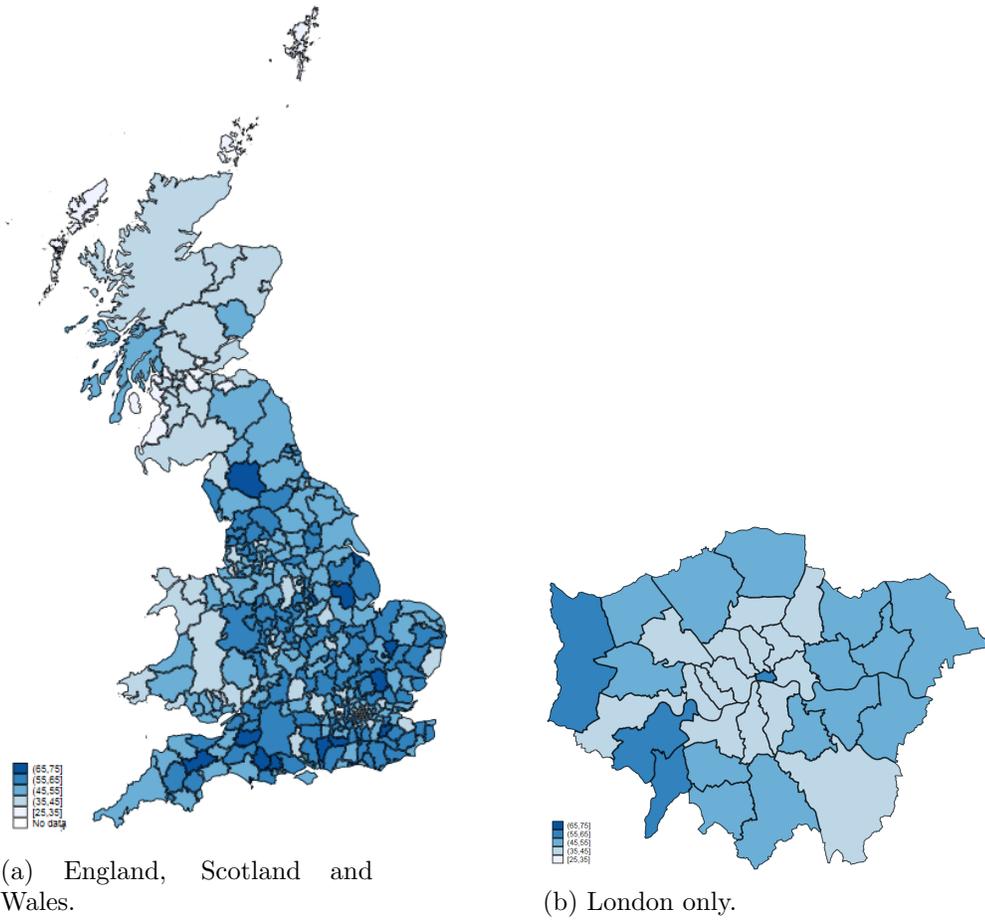


Figure 1: Spatial distribution of the share of exposed to total respondents per local authority district (as a %).

### 3.2 Identification strategy

This research question poses a difficult puzzle in identifying a causal effect of leaflet exposure. As the leaflet was sent to all UK households there are no areas intentionally untreated nor a particular discontinuity to exploit. The variation in treatment assignment comes from the selection into treatment i.e. a persons decision to read the leaflet if they received it. Thus, in order to apply a causal reading to the impact of exposure to the leaflet on voting behaviour, I implement a matching strategy based on the observed characteristics that select an individual into treatment (Angrist and Pischke, 2008). This relies on there being no selection into treatment and so the difference in means of the exposed and control groups has a causal interpretation (Imbens and Wooldridge, 2009). This strategy does not, however, deal with the possible bias that is a result of self-reporting exposure status.

In order to match homogeneous individuals with one-another, I use the comprehensive set of observed characteristics in Table 1 and I crucially include two extra matching covariates: an individual’s pre-existing Brexit preference, which is captured by their voting intention from a previous wave before treatment and an indicator variable of referendum interest.<sup>12</sup> It is possible that those who report themselves as interested in the referendum are more likely to select themselves into the treatment. The pre-existing Brexit preference is included as a control to ensure that individuals are matched to like-minded voters. This explicitly accounts for the fact that voters who are more likely to vote remain are more likely to select into a pro-remain treatment. Both of these variables are powerful predictors of treatment status.<sup>13</sup> I employ 5 nearest-neighbour matching where the

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<sup>12</sup>I match, with replacement (each control observation can serve as the counter-factual for more than one treated observation), on the following set of variables: male, age,  $age^2 / 100$ , married, widowed, non-white, employed, kids01,  $\ln(\text{household size})$ , home owner, degree, a-level, gcse, friends from the EU, speaks another language, partisan, 3 categories of household income, agreeableness, conscientiousness, extraversion, neuroticism, openness, a dummy for pre-existing Brexit preference and a dummy for referendum interest.

<sup>13</sup>A concern is that there may be some unobserved characteristic correlated with treatment status and vote

nearest neighbours are identified from their propensity scores, conditional on the full set of control covariates. The propensity scores are obtained from a probit regression of the form:

$$Pr(Exposed_i = 1 | Z_i) = \Phi(\psi X_i + \delta Brexit\_pref + \zeta ReferendumInterest_i + \epsilon_i) \quad (1)$$

where  $Exposed_i$  is the indicator of exposure status to the Government’s EU leaflet for individual  $i$ ;  $Z_i$  is a function of all covariates that effect treatment status;  $\Phi$  is the cumulative distribution function of a standard normally distributed random variable;  $X_i$  is a vector of control variables from Table 1;  $Brexit\_pref$  is the pre-exposure Brexit preference (whether the individual would vote leave from a wave prior to treatment);  $ReferendumInterest_i$  is a dummy for a respondent’s interest in the referendum; and  $\epsilon_i$  is the error term.

I also track a reduced number of individuals to a previous wave before the leaflet was sent out. I can therefore use a difference-in-differences (DiD) approach to further strengthen my suppositions.

Exposure to the government’s EU leaflet should reduce an individuals probability of voting leave by making the case for remaining in the EU because individuals will be persuaded by the information provided, therefore internalizing the government’s remain position. I do not expect this effect to be unambiguous. As the related literature has shown (Barone et al., 2015; Durante et al., 2017; Peisakhin and Rozenas, 2018), to name but a few, certain demographics are more susceptible to persuasion. This is entirely plausible in this scenario given that the Brexit literature has established that there are ‘core’ leave and remain supporters. If this is indeed the case, one would expect a heterogeneous effect across the different population groups. I allow for this in the analysis that follows.

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intention. To examine this I present placebo tests and assess the sensitivity of the matching approach. I also address the importance of unobservables in Table A12.

## 4 Results

### 4.1 The impact of the government’s EU leaflet on voting behaviour

In Table 2 I examine the effect of leaflet exposure on voting for Brexit. First, by using OLS in columns (1) and (2), the coefficient is negative and statistically significant: being exposed to the leaflet is associated with about a 1.8 percentage point decrease in probability of voting for Brexit.

In columns (3)-(6), I implement the propensity score matching strategy outlined above.<sup>14</sup> The coefficients report the average treatment effect on the treated (ATT) for leaflet exposure. In column (3) individuals are matched on their individual characteristics. In columns (4), (5) and (6) to impose restrictions that the matched control observations must come from the same day of survey response, same county as the treated individual, and then both same day and county. The point estimates are precisely estimated, remain negative and highly statistically significant. The coefficients are now larger in absolute magnitude, compared to the OLS estimates, which indicates that the matching approach has been successful in reducing the endogeneity bias. Exposure to the leaflet reduces the probability of voting for Brexit by about 3 percentage points.

Table A5 reports the covariate balance checks before and after matching. Column (1) reports the mean for the treated group, column (2) reports the mean for individuals that have not been treated, the control group. Column (4) reports the mean for the control group individuals that have been matched at least once using the nearest neighbour matching procedure. The columns of interest are (3) and (5), which report the p-values from formal t-tests of the differences in means before and after matching, respectively. After matching, all covariates balance. Therefore,

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<sup>14</sup>The corresponding propensity score estimations are shown in Table A4.

I fail to reject the balancing hypothesis for all variables that enter the propensity score equation, which confirms that the matching procedure has been successful in matching together homogeneous individuals and reducing the covariate bias. Figure [A6](#) and [A7](#) provide a graphical illustration of covariate balance before and after matching.

Thus far, the results establish that individuals became around 3 percentage points less likely to vote for Brexit after being exposed to the leaflet. I can now proceed to focus on particular groups of the population which may be driving this result.

Table 2: The impact of the government’s EU leaflet on voting behaviour

	OLS		Matching			
	(1)	(2)	(3)	(4)	(5)	(6)
Exposed	-0.016* (0.009)	-0.021** (0.009)	-0.030*** (0.011)	-0.024** (0.011)	-0.029*** (0.011)	-0.039*** (0.011)
County FEs?	No	Yes	No	Yes	No	Yes
Ref. proximity FEs?	No	Yes	No	No	Yes	Yes
Treated/control	3,408/2,724	3,408/2,724	3,408/2,724	3,408/2,724	3,408/2,724	3,408/2,724
Observations	6,132	6,132	6,132	6,132	6,132	6,132

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The dependent variable is a dummy for whether an individual will vote to leave the EU. The set of matching variables, with replacement, in all columns includes male, age, age<sup>2</sup> / 100, married, widowed, non-white, employed, kids01, ln(household size), home owner, degree, a-level, gcse, friends from the EU, speaks another language, partisan, 3 categories of household income, agreeableness, conscientiousness, extroversion, neuroticism, openness, pre-treatment voting intention and a dummy for interest in the referendum. Standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (1) and (2) report estimates from OLS regressions, variables omitted are the full set of controls, pre-treatment voting intention and a dummy for interest in the referendum as well as country-level and proximity to referendum date fixed effects in column (2). Columns (3)-(6) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. In column (3) there is no fixed effects. Column (4) and (5) includes county-level and referendum proximity fixed effects, respectively. In column (6) the specification includes both county-level and proximity to referendum fixed effects. The propensity scores are obtained from a probit regression. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

#### 4.1.1 Placebo analysis

As a mean of testing the robustness of the results, I conduct a number of placebo tests. If the documented effect on voting behaviour is due to the leaflet, I should observe no effect of exposure to the leaflet on earlier political outcomes for the governing Conservative party or earlier incumbent governments. Moreover, as the leaflet constituted a short term shock, one would not expect the leaflet to affect voting intention in the months after the referendum.

In Table 3, columns (1), (2) and (3) I repeat the analysis but use whether a respondent voted for the Conservative party in the 2005, 2010 or 2016 May local elections as the dependent variable, respectively. I find no such evidence that there were any prior treatment effects driving the results, even in the local elections which allow for examination of voting behaviour just a month before the referendum. In column (4), I check whether there is an effect on an individual’s vote intention in wave 10 of the BES, where individuals were surveyed in November and December 2016. Under the

identifying assumption that exposure exclusively affected referendum voting behaviour, I find no effect that exposed individuals were more likely to support remain in the months after the referendum. The placebo tests suggests that the findings are in fact due to the leaflet acutely conveying it’s pro-remain information.

Table 3: Placebo analysis

	Con 2010 (1)	Con 2005 (2)	Con Local 2016 (3)	Post ref. vote (4)
Exposed	-0.007 (0.012)	0.009 (0.012)	0.028 (0.021)	-0.017 (0.014)
Observations	6,018	5,608	2,318	3,974

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The matching strategy follows the baseline specification in Table 2 column (3). Standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (1)-(4) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

## 4.2 Low degree of exposure to other information sources

To further examine the factors which are driving this result, I restrict the sample to individuals who had a low degree of exposure to other sources of referendum information. To be specific, individuals are dropped from the sample who report themselves to have watched any of the 5 major televised EU debates; have heard about the EU from television, newspaper, radio, the internet or talked to other people; or have been contacted by referendum campaigners. This leaves a sample of 513 individuals.<sup>15</sup>

Table 4 shows the ATT of exposure to the Government’s EU leaflet on the likelihood of voting leave. For the full low degree of exposure sample, column (1), the coefficient suggests that exposure

<sup>15</sup>The summary statistics and spatial distribution for this sample are shown in Table A3 and Figure A5a and A5b, respectively. When comparing the summary statistics of the full and low exposure sample, the statistics show that low exposure sample are made up of individuals of similar characteristics to the full sample and are located across the UK.

is negatively related to voting leave, although, the effect is statistically insignificant. In order to test how the leaflet impacted demographics that are more or less susceptible to persuasion bias, I split the sample across various groups to allow for a heterogeneous treatment effect. In column (2), I find that females are 8.8 percentage points less likely to vote leave after exposure, whereas no significant effect is found for males. This is consistent with the findings of [Galasso and Nannicini \(2016\)](#), that females respond better than men to a campaign with positive rather than negative message. Low income and the risk averse are also less likely to vote leave after exposure relative to the control group at conventional significance levels, with the effects 11.4 and 10.2 percentage points, respectively. As voting in favour of leaving the EU was widely perceived as a risky outcome, perhaps it is not surprising that risk averse individuals were less likely to vote in favour of Brexit once they received information from the government advising them not to. The estimates are statistically significant and far larger than the effect for the whole sample in [Table 2](#). The findings here match with my priors that particular groups will be more affected by exposure due to a greater susceptibility to persuasion bias, which is also consistent with much of the previous literature.

In columns (8) and (9) I explore how different partisan groups were affected. At this stage, I find no increase in the likelihood of voting leave for either Conservative or Labour partisans following exposure.

As a final investigation, I examine the effectiveness of the leaflet of changing voting intention for individuals who have a pre-existing Brexit preference. This goes some way to deal with the selection concerns as I only use individuals who reported that they would vote leave in pre-exposure wave. If the leaflet was effective I should observe that these voters have a significant negative drop in the probability of voting leave after reading the leaflet. The results are shown in column (11). I find that after exposure, such individuals are 9.3 percentage points less likely to vote to leave the

EU than those who were not, which is significant at the 1% level. This is an interesting finding given that the primary aim of the leaflet was to garner support for the remain side.

Overall, the above results confirm that there is a larger drop in the probability for voting for Brexit amongst individuals that had a low degree of exposure to other sources of referendum information and to the leaflet, and show that these people may be driving the previous result.<sup>16</sup> This is, again, consistent with the hypothesis put forward by Gerber et al. (2011) – that the effects of the mailshot should be larger in a low information environment. I also confirm that the leaflet had an especially salient effect on demographics that are more susceptible to a persuasion bias, which is in accordance with the existing literature.

#### 4.2.1 Difference-in-difference

To further support the matching strategy in applying a causal inference to the results, I now employ a DiD approach. I identify a number of individuals in the low degree of exposure sample who also completed wave 6 (pre-treatment) of the BES as well wave 8 (post-treatment), this however reduces the total number of individuals ( $N = 430$ ). I now estimate the following regression model:

$$Vote\ Leave_{it} = \alpha_i + \beta_1 Post_t + \beta_2 Exposed_i + \beta_3 (Post_t \cdot Exposed_i) + \psi X_{it} + \epsilon_{it} \quad (2)$$

where  $t = 0, 1$ .  $Vote\ Leave_{it}$  denotes the outcome variable, whether individual  $i$  will vote to leave at time  $t$ . The model includes individual fixed effects ( $\alpha_i$ ), a vector of controls ( $X_{it}$ ), which includes pre-existing Brexit preference and referendum interest, and an error term ( $\epsilon_{it}$ ).  $Post_t$  takes the

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<sup>16</sup>In all columns covariate balancedness is achieved for all variables, thus homogeneous individuals have been matched together and covariate bias reduced – these diagnostic results are available on request. The placebo tests from the previous section are also passed, the results are in Table A6.

Table 4: Low exposure sample and heterogenous effects of the government's EU leaflet on voting behaviour

	Gender		Income group		Risk aversion			Partisan		
	Full isolated (1)	Female (2)	Male (3)	£0-20k (4)	> £20k (5)	Avoider (6)	Taker (7)	Con (8)	Lab (9)	Wave 6 Leavers (10)
Exposed	-0.037 (0.038)	-0.088*** (0.030)	0.072 (0.047)	-0.114*** (0.036)	0.052 (0.046)	-0.102*** (0.029)	0.063 (0.058)	0.005 (0.155)	-0.033 (0.064)	-0.093*** (0.030)
Treated/control	173/340	98/203	75/137	81/146	92/194	94/183	79/157	42/58	60/94	84/167
Observations	513	301	212	227	286	277	236	100	154	251

Notes: *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The dependent variable is a dummy for whether an individual will vote to leave the EU. The set of matching variables, with replacement, in all columns includes male, age, age<sup>2</sup> / 100, married, widowed, non-white, employed, kids01, ln(household size), home owner, degree, a-level, gcse, friends from the EU, speaks another language, partisan, 3 categories of household income, agreeableness, conscientiousness, extroversion, neuroticism, openness, pre-treatment voting intention (excluded in column (10)) and a dummy for interest in the referendum. Standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (1)-(10) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. Robust standard errors are reported in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

value 1 for the post-treatment period and  $Exposed_i$  takes the value 1 for all individuals who were exposed, 0 otherwise. The coefficient of interest is  $\beta_3$  which is the DiD estimate of the effect of the leaflet on voting behaviour for the exposed. The models are estimated using a fixed effects estimator to account for unobserved individual heterogeneity. I focus on separating individuals by their inherent characteristics (risk aversion and gender) rather than attempt to split the sample by characteristics that plausibly vary over time (partisanship and income). Given the imbalance of certain variables between the treated and untreated groups, I also balance the sample using each an individual's propensity score from a probit regression and re-estimate equation 2 in a linear probability model (LPM).

Table 5 reports the estimates from the DiD analysis. The point estimates from the fixed effects specifications are similar to those from the matching approach. They show that females and the risk averse are 11.1 and 9.6 percentage points less likely to vote to leave than the relevant control group. In the balanced sample the DiD term again shows results qualitatively the same to those produced in the matching approach.

On the whole, the difference-in-differences results confirm what has been shown previously. That is, a negative and significant impact on the exposed group, which is a significantly larger drop if an individual belongs to a demographic that is affected more by persuasion bias, on their probability of voting leave.

### 4.3 High degree of exposure to other information sources

I can now take the analysis a step further and investigate whether individuals who were exposed to other sources of information during the referendum campaign were impacted differently by the

Table 5: DiD estimates of the effect of the government’s EU leaflet on voting behaviour

	Fixed effects			Balanced sample LPM		
	Full isolated (1)	Female (2)	Risk avoider (3)	Full isolated (4)	Female (5)	Risk avoider (6)
Post × Exposed	-0.036 (0.040)	-0.111** (0.055)	-0.096* (0.051)	-0.071 (0.061)	-0.132** (0.064)	-0.148** (0.073)
$R^2$	0.016	0.036	0.054	0.672	0.812	0.821
Observations	860	502	472	668	386	368

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. All regressions include the full set of controls from Table 1, pre-treatment voting intention and a dummy for interest in the referendum. In columns (4) - (6) the regressions also include government office region dummies. The dependent variable is a dummy for whether an individual will vote to leave the EU. Robust standard errors, clustered at the individual-level, are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

leaflet. Given that there was an array of media sources discussing the referendum during the campaign this is an interesting exercise. I use the set of 5,619 individuals who were excluded from the previous sections as these individuals were treated with multiple sources of information as well as the leaflet. Explicitly, I keep individuals who have watched any of the televised debates, heard about the EU from various sources or had been contacted by referendum campaigners, as well as being exposed to the leaflet. I repeat the same matching approach as before for this “heavily” treated sample.

The corresponding results are reported in Table 6. In column (1) the coefficient is now absolutely smaller in size than the low exposure sample and statistically insignificant. In this sample, however, the results suggest some effect for males. In the groups where a large or significant effect is found in the low exposure sample, the coefficients are now severely demeaned or insignificant at the conventional levels, with the exception of Conservative partisans. Why might this be? For at least two decades there has been a rift between supporters of the Conservative party on the party’s stance on the EU and this split was replicated in the referendum campaign.<sup>17</sup> In this high exposure sample, individuals will have seen various Conservative party members on either side of the referendum

<sup>17</sup>In contrast, all other major political parties ran a united campaign about how their supporters should vote. The Labour Party (only 10 members backed leave), the Liberal Democrats, the Scottish National Party and the Green party all supported remain. UKIP and the Democratic Unionist Party supported leave.

debate. For instance, in the 5 major debates, there was a Conservative MP on both the remain and leave side in every debate. Thus, exposed individuals will have interpreted the leaflet as a signal from the Conservative Party, who were in government at the time and sanctioned the leaflet, to vote to remain. They were, on average, 6.2 percentage points less likely to vote to leave after exposure.

On the whole, this suggests that the impact of the leaflet was far less pronounced in respondents who were exposed to other sources of information regarding the referendum. The affect is attenuated because the information is lost in the sea of other prominent forms of media. The null-result here goes some way to explain the ultimately marginal impact of the leaflet on the outcome of the referendum as many individuals were not uniquely exposed to the leaflet as a source of referendum information.

Table 6: High exposure sample and heterogenous effects of the government's EU leaflet on voting behaviour

	Gender		Income group			Risk aversion			Partisan		
	Full inverse (1)	Female (2)	Male (3)	£0-20k (4)	> £20k (5)	Avoider (6)	Taker (7)	Con (8)	Lab (9)	Wave 6 Leavers (10)	
Exposed	-0.018 (0.011)	0.006 (0.017)	-0.059*** (0.015)	-0.000 (0.019)	-0.027** (0.013)	-0.024 (0.015)	-0.010 (0.015)	-0.062*** (0.023)	0.003 (0.021)	-0.022** (0.011)	
Treated/control	3,235/2,384	1,417/1,111	1,818/1,273	1,023/704	2,212/1,644	1,362/1,022	1,873/1,362	951/560	1,051/731	1,348/1,042	
Observations	5,619	2,528	3,091	1,763	3,856	2,384	3,235	1,511	1,782	2,390	

Notes: *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The dependent variable is a dummy for whether an individual will vote to leave the EU. The set of matching variables, with replacement, in all columns includes male, age, age<sup>2</sup> / 100, married, widowed, non-white, employed, kids01, ln(household size), home owner, degree, a-level, gcse, friends from the EU, speaks another language, partisan, 3 categories of household income, agreeableness, conscientiousness, extroversion, neuroticism, openness, pre-treatment voting intention (excluded in column (10)) and a dummy for interest in the referendum. Standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (1)-(10) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. Robust standard errors are reported in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## 4.4 Robustness checks

I now perform a series of checks to further assess the robustness of the main findings. First, in the full sample, I consider alternate matching strategies, including Epanechnikov kernel matching and a fewer number of nearest neighbour matches. The results obtained from these alternate strategies, in Table A7, support the findings from the previous section: exposure leads to a significant reduction in the probability of voting to leave the EU.

Second, in the full sample, I alter the set of matching covariates. I systemically exclude certain characteristics, such as income and personality traits, and allow various fixed effects to enter the propensity score equation. The results remain the same – the exposed group, on average, became significantly more likely to vote to remain than the control group. The results are shown in Table A8.

Similarly, I repeat the systematic exclusion and inclusion of matching variables for the low exposure sample, whilst allowing for heterogeneous treatment effects. I also introduce government office region fixed effects in all estimations.<sup>18</sup> The results are presented in Table A9. The results here support that of the previous section: for individuals who were only exposed to the leaflet, certain demographics who are more susceptible to persuasion bias, were even more likely to vote to remain than the control group.

Fourth, I include calipers of varying sizes into the matching strategy in an attempt to improve the quality of the matching. The corresponding results are shown in Table A10. Here, the results remain qualitatively the same and a slightly larger coefficient is produced when the caliper is 0.005 and 0.001.

And fifthly, I repeat the analysis whilst removing individuals from Wales and Scotland, where

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<sup>18</sup>There is no distinction between party supporters due to the small sample size, therefore being unable to locate sufficient matches.

exposure is lower on average. I expect an unambiguous treatment effect regardless of the region an individual is located in. I drop individuals from Scotland, then Wales and then both simultaneously. The results, presented in Table A11, remain the qualitatively the same.

## 5 Mechanisms

The results presented thus far establish that exposure to the Government’s EU leaflet reduced an individual’s probability of voting leave in the 2016 EU referendum. The leaflet presented information on key topics that were of concern to voters and this section assess how the leaflet altered beliefs on each of these issues. I also conduct some falsification tests of these channels and consider some alternative mechanisms.

### 5.1 The effect of the leaflet on perceptions of leave vote outcomes

I now explore the mechanism through which the leaflet could have influenced an exposed individual’s referendum vote. To do so, I return to the full sample of individuals.<sup>19</sup> By being exposed to the leaflet it should have highlighted particular areas of contention which could be worse off if a leave vote were to win. For instance, one area highlighted by the leaflet was job security, the word “job” was used 8 times on 5 separate pages.<sup>20</sup> The leaflet made the case that jobs would be protected conditional on the remain side winning. By making minor changes to the econometric strategy, I can examine these channels of impact by examining the differences in a person’s opinion on unemployment if the UK were to leave the EU by their exposure status.<sup>21</sup> The relevant question

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<sup>19</sup>Estimates are produced where the answers to the survey questions are non-missing.

<sup>20</sup>The words “economy” and “economic” were used a total of 12 times, and “security” was used 5 times.

<sup>21</sup>Results remain qualitatively same when using an LPM or probit estimator.

reads: “Do you think the following [unemployment] will be higher, lower, or about the same if the UK leaves the European Union?” From this I create a variable coded 1 for respondents who believe that unemployment will be “higher” or “much higher” if the UK were to leave and 0 otherwise.<sup>22</sup> This is repeated for other key areas covered in the booklet: the general economic situation, security, whether they believe the referendum to be final, their personal financial situation, UK workers working conditions and world influence.

The results are reported in Table 7. Column (1) shows that those who were exposed to the leaflet were, on average, 2.7 percentage points less likely to believe that the UK economy would be better off if the UK were to leave, relative to the unexposed control group and is significant at 5% level. Analogous results are obtained to suggest that exposure results in individuals being more likely to believe that there would be higher unemployment, column (2); the risk of terror would be higher, column (3); the referendum is the final say on the EU, column (4); and UK workers would not be better off, column (6). No effect is found for personal financial situation and the UK’s world influence. For the former, this is plausibly due to the macro focus of the leaflet, with only minimal mentions of the cost of living impacts of leaving the EU. And for the latter, it may be due to lack of clarity in the leaflet about the UK’s role in the EU’s actions on the world stage, for example. There is only a very brief mention about the EU’s role in the Iranian nuclear deal and tackling climate change.

These results suggest that the leaflet was effective at conveying its persuasive message about contentious issues on the referendum campaign trail. Voters idealized the government’s position on certain scenarios and therefore became less likely to vote to leave. In essence, individuals experience a “persuasion-through-knowledge” effect. This is perhaps testament to the fair and objective

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<sup>22</sup>The responses: “about the same/unchanged”, “lower” and “much lower”, are coded as 0.

nature of the leaflets content.

## 5.2 Falsification tests and alternate mechanisms

The results of the previous subsection suggest that by reading government’s media on particular areas of contention influenced a voter’s perceptions of likely scenarios should the leave side win the referendum. To further support these results as channels of impact, I now consider some falsification tests and alternate mechanisms. First, as a falsification test, I explore whether a reader’s views of specific outcomes that were not addressed in the leaflet were affected. Second, whether readers became more or less receptive to prompts from the government after exposure. And third, after being exposed, readers may take favourable views of prominent leave campaigners as an act of rebellion against the leaflet and the Government.

To investigate these hypotheses, I exploit additional questions in the BES. I estimate the specifications as in Table 7 but similarly change the outcome measure. The results are presented in Table 8. In columns (1)-(4) I show the falsification tests of the channels of impact. I regress whether a person believes that: there will be more international trade if the UK leaves the EU; the EU would be better off if Turkey were to join; the EU has undermined UK parliamentary sovereignty; and immigration is increasing, on exposure status. All of which were extreme areas of discussion in the televised debates and in the wider media during the campaign trail, however, –critical to the placebo test assumption– no information on these topics were provided in the leaflet.<sup>23</sup> As expected, there is no systematic evidence of an effect. I now attempt to rule out alternate mechanisms. In column (5) I test whether exposed individuals became more trusting in general and no significant effect

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<sup>23</sup>In the survey, respondents were asked what is the most important issue in the referendum. About 20% of individuals said the economy (in the leaflet) and another 20% said UK sovereignty (not in the leaflet).

Table 7: Exposure to the government's leaflet and opinions of a leave vote outcome

	Better UK economy (1)	Higher unemployment (2)	Higher risk of terror (3)	Referendum is final (4)	Better personal financial situation (5)	UK workers better off (6)	Higher UK world influence (7)
Exposed	-0.027** (0.012)	0.038*** (0.013)	0.039*** (0.012)	0.038** (0.016)	0.011 (0.007)	-0.020* (0.01)	0.009 (0.011)
Treated/control	3,302/2,598	3,272/2,560	3,327/2,612	2,896/2,315	3,245/2,533	3,340/2,619	3,341/2,652
Observations	5,900	5,832	5,939	5,211	5,778	5,959	5,993

Notes: *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The matching strategy follows the baseline specification in Table 2 column (3). The dependent variable in columns (1)-(7) is a dummy for whether the respondent thinks that if the UK were to leave the EU: the UK economy will generally be better off; there will be higher unemployment, the UK will be at a higher risk of terror, whether they believe the referendum is final, the respondents personal financial situation will generally be better off. UK workers will be better off and the UK's voice in the world would be larger. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

from exposure is found. In columns (6) and (7) I also find no evidence that individuals take more favourable views of prominent leave campaigners, Boris Johnson or Michael Gove, after exposure.

These findings suggest that the government's message was acutely conveyed to voters. The transmission mechanism was through the information provided rather than altering voters sense of trust or pushing them toward the leave campaign as an act of dissent. Importantly, I also show that exposure did not affect voter's opinions of scenarios not mentioned in the leaflet.

Table 8: Placebo tests and alternate mechanisms of exposure to the government's EU leaflet

	More int. trade (1)	EU better if Turkey joined (2)	EU undermined UK sovereignty (3)	Immigration is increasing (4)	Generally trusting (5)	Like Boris Johnson [0-10] (6)	Like Michael Gove [0-10] (7)
Exposed	-0.009 (0.013)	0.004 (0.005)	0.005 (0.012)	-0.008 (0.012)	0.006 (0.027)	-0.039 (0.082)	0.149* (0.08)
Treated/control	3,270/2,566	3,125/2,439	3,363/2,678	3,357/2,639	864/711	3,374/2,664	3,177/2,410
Observations	5,836	5,564	6,041	5,996	1,575	6,038	5,587

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The matching strategy follows the baseline specification in Table 2 column (3). The dependent variable in all columns is a dummy for whether the respondent believes the following: in column (1) it is whether a respondent believes that there will be more international trade if the UK votes to leave. In column (2) it is whether the respondent believes the EU would be better off if Turkey were to join and (3) whether the EU has undermined UK sovereignty. In column (4) whether they believe that the level of immigration is increasing and in column (5) the dependent variable is whether the respondent is generally trusting. And in columns (6) and (7) respondents rank on a scale of 0-10, where 10 is the most favourable view, how much they like Boris Johnson and Michael Gove, respectively. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

## 6 Conclusions

While much research has been undertaken on mass media’s impact on political outcomes, the impact on a single political event is largely unexplored. Moreover, much of the work on Brexit has been focussed on individual or regional characteristics that drove the leave vote, this work is a distinct aberration from this strand as I offer causal estimates from a quasi-natural experiment around the time of the 2016 EU referendum.

This paper has addressed the role of the UK Government’s mailshot to households on the 2016 EU referendum. I find that those individuals who were exposed to the leaflet displayed a higher probability of voting to remain in the EU than the untreated control group. The effect is economically significant, about 3 percentage points, and statistically robust across different specifications. When exploring the groups that are driving this result, I find that the individuals who were exposed to other referendum information to a low degree and exposed to the leaflet displayed a much lower probability of voting leave. Those with demographics that make them susceptible to persuasion bias were affected to a larger extent, which is consistent with the literature by [DellaVigna et al. \(2014\)](#), [Barone et al. \(2015\)](#), [Galasso and Nannicini \(2016\)](#) and [Peisakhin and Rozenas \(2018\)](#). Specifically, I find that the effect is larger in absolute terms for females, low income and the risk averse. I also show that the leaflet was indeed effective at changing individuals voting intention using data from prior to exposure. I present evidence that, in the midst of Conservative party in-fighting over the party’s position, exposed Conservative supporters were more likely to vote remain as they took the leaflet as a signal from the Conservative Government. Moreover, the lack of a result for the individuals that were exposed to multiple sources of information shows that these other sources, such as the debates, attenuated the leaflet’s impact.

In terms of the mechanism at work, I provide evidence for a “persuasion-through-knowledge”

effect. That is, the leaflet was effective at conveying the likely scenarios of a leave vote and highlighting the benefits of EU membership, which persuaded voters into voting to remain in the EU. This is because of the realistic, objective nature of the information provided. This is also consistent with the idea that the media altered individual political beliefs about key referendum topics. I also reject alternate mechanisms and can hence be confident that the channel of impact was through leaflet exposure.

Whilst this research is specific to the referendum, my analysis provides more general insights into the economic allocation of scarce public resources and strategies for political campaigning based on persuasion bias. In a possible second EU referendum, a more targeted campaign, for example, based on reaching specifically those demographics who were more likely to believe the information and change their voting behaviour accordingly may be more fruitful. Nonetheless, the results suggest that the objective information contained in the leaflet was effective. As this paper considers only a single source of referendum information, there are several possible areas for future research. The sheer number of sources of information on the referendum may prove to be an interesting area to explore. The televised debates, the murder of Jo Cox MP or the role of a declining industrial sector all warrant further exploration. [Allcott and Gentzkow \(2017\)](#) consider ‘fake news’ in the context of the 2016 US election. Here, there are obvious parallels to the EU referendum where fake news was ingrained in the campaign trail.

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Online Appendix

Appendix A

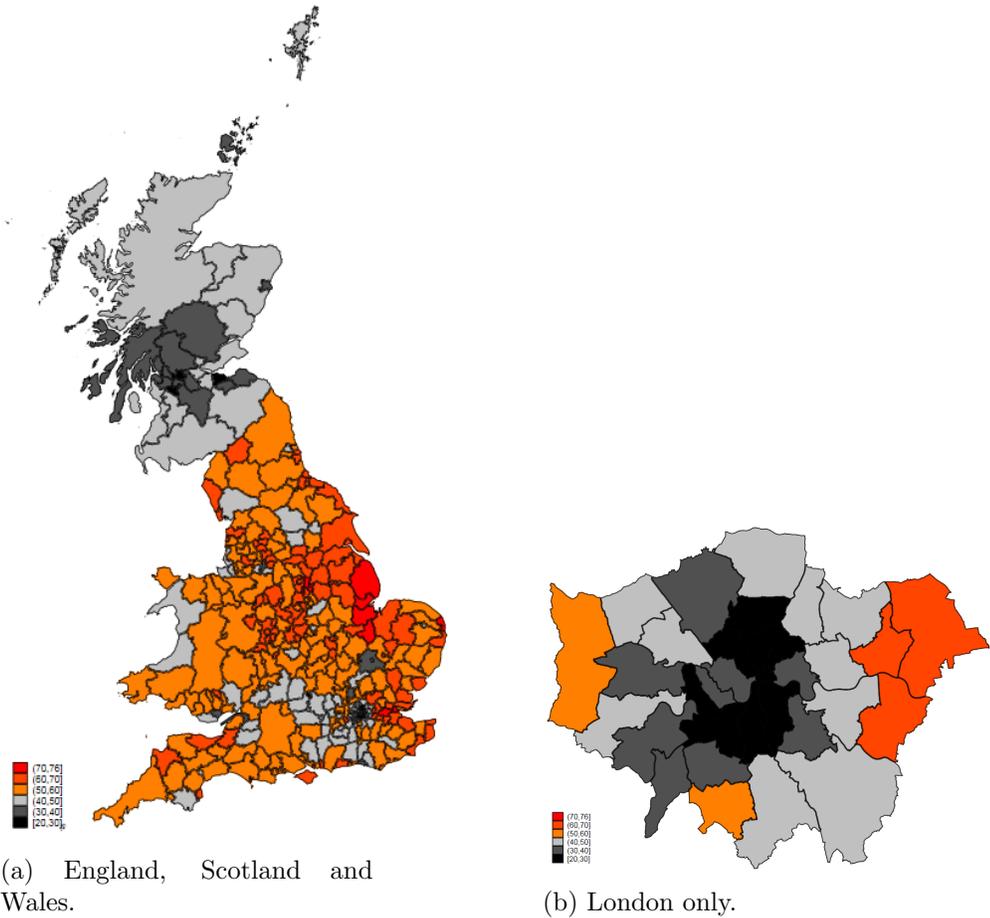


Figure A1: Spatial distribution of the Leave share (in %) across local authority districts in the 2016 EU referendum.



HM Government

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# Why the Government believes that voting to remain in the European Union is the best decision for the UK.

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The EU referendum, Thursday, 23rd June 2016.

Figure A2: Example front cover of the government's 2016 EU leaflet.



HM Government

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## The Government believes that voting to remain in the European Union is the best decision for the UK.

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Protecting jobs    A stronger economy    Providing security

The EU referendum is a once in a generation decision. The Government believes it is in you and your family's best interests that the UK remains in the European Union.

Vote on Thursday, 23rd June 2016.

If you would like further information, please visit the Government's EU referendum website at [EUReferendum.gov.uk](http://EUReferendum.gov.uk)

Figure A3: Example back page of the government's 2016 EU leaflet



Figure A4: Example front and back page of the government's 1975 EU pamphlet

Table A1: 2016 Timeline

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8th May 2015	•	BES wave 6 begins
26th May 2015	•	BES wave 6 ends
11-13th April	•	Government's EU leaflet is sent out to all UK households
14th April	•	BES wave 7 begins
4th May	•	BES wave 7 ends
5th May	•	Local elections
6th May	•	BES wave 8 begins
4th June	•	BES wave 9 begins
9th June	•	Postal vote registration ends
22nd June	•	BES wave 8 ends
23rd June	•	Referendum day
4th July	•	BES wave 9 ends

Table A2: Partisan ranking

Party name	% of negative	
	EU mentions	Coding
United Kingdom Independence Party (UKIP)	16.53	8
Conservative Party	4.594	7
Liberal Democrats	0.782	6
Other	-	5
Green Party of England and Wales	0.403	4
Plaid Cymru (The Party of Wales)	0.387	3
Scottish Nationalist Party	0.112	2
Labour Party	0.099	1

*Notes:* The table shows the percent of the corresponding party's 2015 general election manifesto dedicated to negative mentions of the European Union, taken from the variable *per110* as coded in the Manifesto Project Database by [Volkens et al. \(2017\)](#). Other, refers to all other parties that were voted for in the 2015 general election by respondents.

Table A3: Summary statistics for matching variables in isolated sample

	Full sample		Exposed = 1		Exposed = 0	
	mean	sd	mean	sd	mean	sd
Vote leave	0.526	0.500	0.509	0.501	0.535	0.499
Male	0.413	0.493	0.434	0.497	0.403	0.491
Age	50.897	14.682	52.728	14.385	49.965	14.765
Age <sup>2</sup> / 100	28.056	14.812	29.860	15.034	27.138	14.635
Married	0.470	0.500	0.480	0.501	0.465	0.499
Widowed	0.043	0.203	0.052	0.223	0.038	0.192
Non-white	0.074	0.262	0.069	0.255	0.076	0.266
Employed	0.579	0.494	0.555	0.498	0.591	0.492
Kids01	0.275	0.447	0.266	0.443	0.279	0.449
Ln(household size)	0.745	0.500	0.742	0.488	0.747	0.508
Home owner	0.614	0.487	0.659	0.475	0.591	0.492
Degree – education	0.292	0.455	0.306	0.462	0.285	0.452
A-level – education	0.230	0.421	0.225	0.419	0.232	0.423
GCSE – education	0.339	0.474	0.329	0.471	0.344	0.476
None – education	0.138	0.346	0.139	0.347	0.138	0.346
Friends from the EU	0.349	0.477	0.422	0.495	0.312	0.464
Speaks another language	0.127	0.333	0.127	0.334	0.126	0.333
Partisan	-0.118	1.033	-0.065	1.034	-0.145	1.032
Household income (Over £70k)	0.053	0.224	0.029	0.168	0.065	0.246
Household income (£40-70k)	0.164	0.370	0.173	0.380	0.159	0.366
Household income (£20-40k)	0.341	0.475	0.329	0.471	0.347	0.477
Household income (£0-20k)	0.442	0.497	0.468	0.500	0.429	0.496
Agreeableness	6.150	1.812	6.064	1.709	6.194	1.863
Conscientiousness	6.741	1.819	6.832	1.795	6.694	1.832
Extraversion	4.117	2.129	4.121	2.189	4.115	2.101
Neuroticism	3.862	2.170	3.746	2.168	3.921	2.172
Openness	5.327	1.678	5.306	1.594	5.338	1.721
Referendum interest	0.823	0.382	0.879	0.328	0.794	0.405
Pre-existing Brexit pref.	0.489	0.500	0.486	0.501	0.491	0.501
Observations	513		173		340	

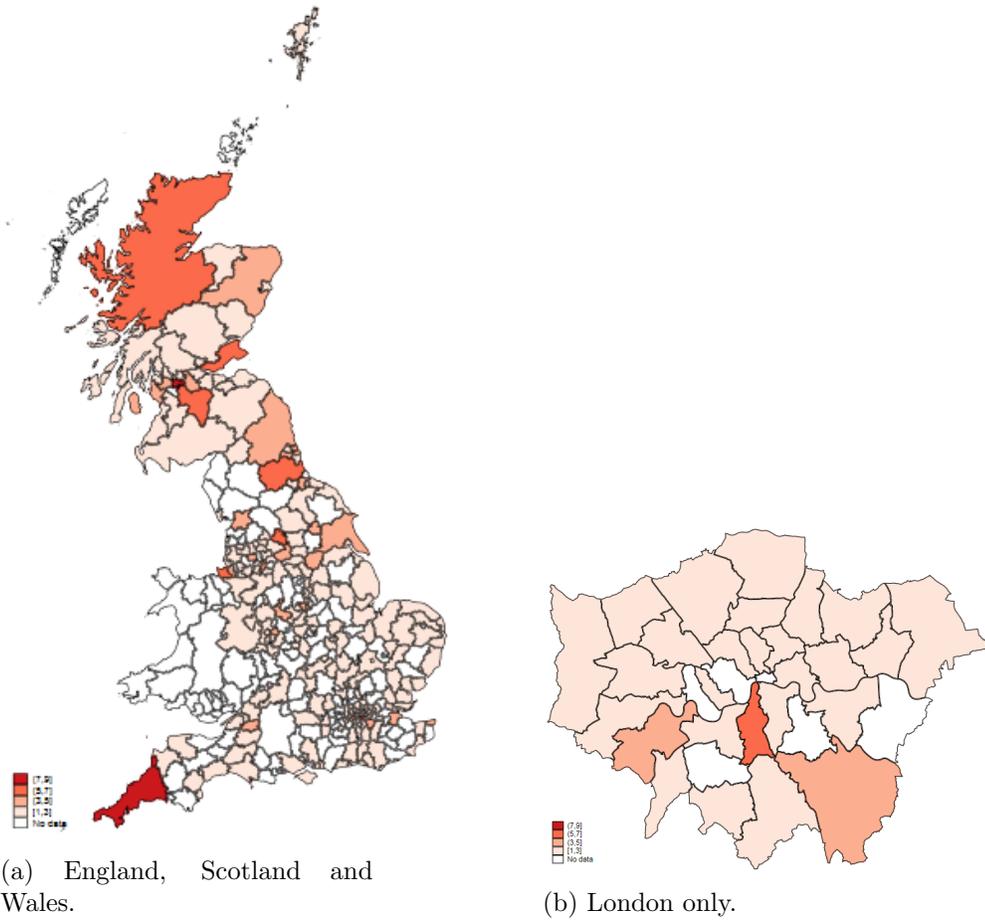


Figure A5: Spatial distribution of the low exposure sample, the number of respondents by local authority district

Table A4: Propensity score estimation

	(1)	(2)	(3)	(4)
Male	0.078** (0.035)	0.091*** (0.035)	0.076** (0.035)	0.089** (0.036)
Age	0.011 (0.008)	0.011 (0.008)	0.010 (0.008)	0.010 (0.008)
Age <sup>2</sup> / 100	0.002 (0.008)	0.002 (0.008)	0.003 (0.008)	0.003 (0.008)
Married	0.028 (0.043)	0.036 (0.044)	0.021 (0.043)	0.030 (0.044)
Widowed	0.055 (0.088)	0.068 (0.089)	0.043 (0.089)	0.056 (0.089)
Non-white	-0.072 (0.065)	-0.059 (0.066)	-0.064 (0.066)	-0.052 (0.067)
Employed	-0.151*** (0.042)	-0.157*** (0.042)	-0.158*** (0.042)	-0.163*** (0.042)
Kids01	-0.062 (0.052)	-0.074 (0.052)	-0.053 (0.052)	-0.066 (0.053)
Ln(household size)	0.086* (0.050)	0.069 (0.050)	0.083* (0.050)	0.066 (0.051)
Home owner	0.080* (0.042)	0.085** (0.043)	0.092** (0.043)	0.098** (0.043)
Degree – education	0.288*** (0.067)	0.306*** (0.068)	0.279*** (0.068)	0.298*** (0.068)
A-level – education	0.236*** (0.069)	0.258*** (0.070)	0.237*** (0.070)	0.260*** (0.071)
GCSE – education	0.171*** (0.065)	0.172*** (0.065)	0.172*** (0.065)	0.175*** (0.066)
Friends from the EU	0.086** (0.035)	0.089** (0.036)	0.089** (0.036)	0.091** (0.036)
Speaks another language	0.078* (0.043)	0.077* (0.043)	0.081* (0.043)	0.079* (0.044)
Partisan	0.069*** (0.018)	0.032* (0.019)	0.075*** (0.018)	0.037* (0.019)
Household income (Over £70k)	-0.031 (0.074)	-0.011 (0.076)	-0.035 (0.075)	-0.017 (0.077)
Household income (£40-70k)	-0.032 (0.054)	-0.017 (0.055)	-0.032 (0.055)	-0.017 (0.056)
Household income (£20-40k)	-0.072* (0.043)	-0.063 (0.044)	-0.079* (0.043)	-0.070 (0.044)
Agreeableness	0.004 (0.010)	0.003 (0.010)	0.006 (0.010)	0.005 (0.010)
Conscientiousness	0.031*** (0.010)	0.028*** (0.010)	0.029*** (0.010)	0.027*** (0.010)
Extraversion	0.002 (0.008)	0.002 (0.008)	0.002 (0.008)	0.002 (0.008)
Neuroticism	-0.011 (0.008)	-0.011 (0.008)	-0.011 (0.008)	-0.011 (0.009)
Openness	0.009 (0.010)	0.010 (0.010)	0.008 (0.010)	0.009 (0.010)
Referendum interest	0.503*** (0.076)	0.490*** (0.076)	0.501*** (0.076)	0.487*** (0.077)
Pre-existing Brexit pref.	-0.144*** (0.039)	-0.157*** (0.039)	-0.155*** (0.039)	-0.170*** (0.040)
County FEs?	No	Yes	No	Yes
Ref. proximity FEs?	No	No	Yes	Yes
Observations	6,132	6,132	6,132	6,132

Notes: Coefficients reported show the average marginal effect from a probit regression. *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. Columns (1) - (4) correspond to Table 2 columns (3) - (6).

Table A5: Covariate balancedness

	Before matching			After matching	
	Treatment group mean (1)	Control group mean (2)	p-value difference in means (3)	Control group means (4)	p-value difference in means (5)
<b>Matching covariates</b>					
Male	0.555	0.518	0.003	0.563	0.526
Age	58.126	53.140	0.000	58.108	0.955
Age <sup>2</sup> / 100	35.608	30.322	0.000	35.600	0.983
Married	0.580	0.510	0.000	0.582	0.840
Widowed	0.050	0.037	0.009	0.050	0.947
Non-white	0.065	0.078	0.060	0.069	0.536
Employed	0.450	0.566	0.000	0.450	0.992
Kids01	0.176	0.225	0.000	0.174	0.828
Ln(household size)	0.712	0.730	0.121	0.718	0.586
Home owner	0.763	0.684	0.000	0.760	0.772
Degree – education	0.469	0.434	0.005	0.468	0.892
A-level – education	0.193	0.197	0.669	0.191	0.820
GCSE – education	0.258	0.272	0.211	0.262	0.724
Friends from the EU	0.530	0.476	0.000	0.536	0.645
Speaks another language	0.252	0.201	0.000	0.257	0.668
Partisan	-0.018	-0.132	0.000	-0.017	0.971
Household income (Over £70k)	0.085	0.075	0.130	0.085	0.979
Household income (£40-70k)	0.219	0.214	0.582	0.223	0.718
Household income (£20-40k)	0.371	0.387	0.226	0.366	0.648
Agreeableness	6.191	6.061	0.005	6.167	0.569
Conscientiousness	6.972	6.689	0.000	6.957	0.723
Extraversion	4.140	4.065	0.186	4.112	0.600
Neuroticism	3.470	3.790	0.000	3.457	0.811
Openness	5.553	5.492	0.171	5.552	0.974
Referendum interest	0.968	0.922	0.000	0.922	0.764
Pre-existing Brexit pref.	0.420	0.444	0.063	0.425	0.663
Observations	3,408	2,724		2,724	

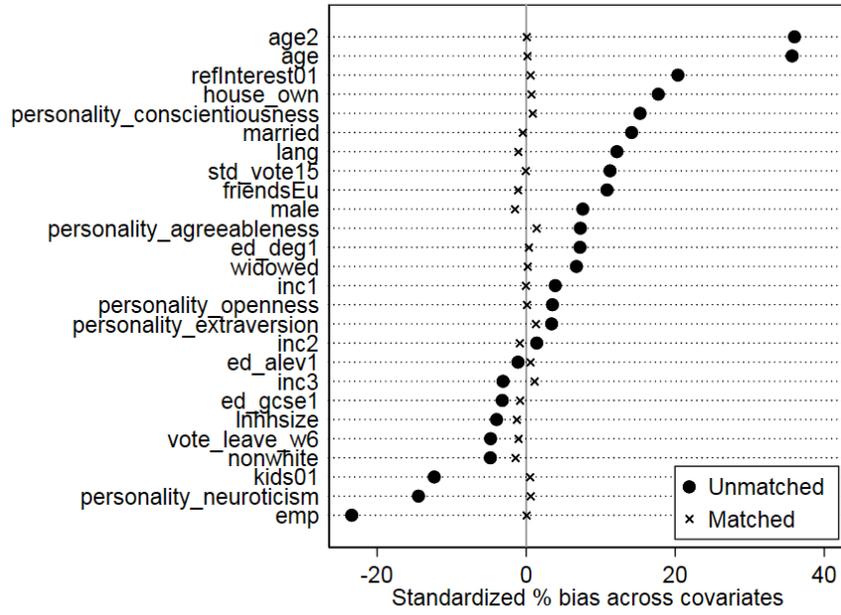


Figure A6: Bias before and after propensity score matching – Table 2 column (3).

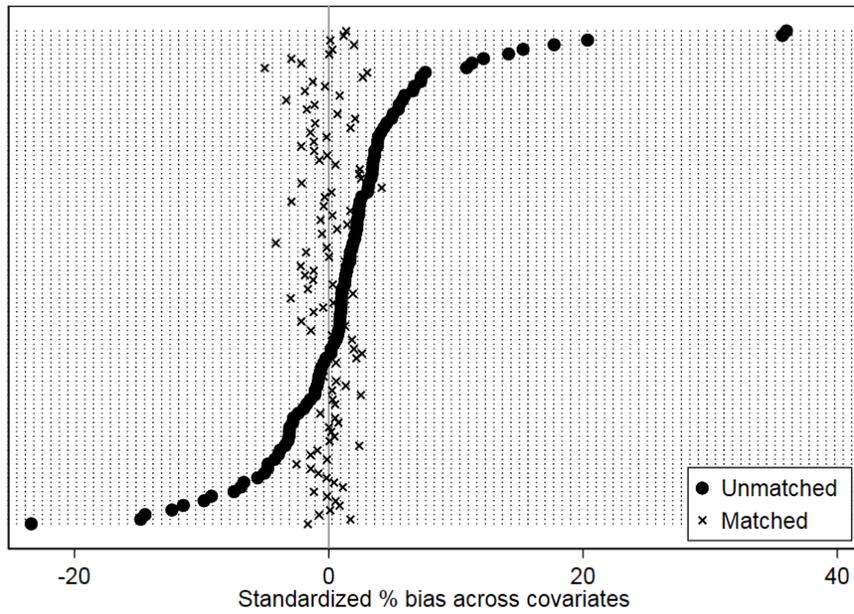


Figure A7: Bias before and after propensity score matching, with county and referendum proximity fixed effects – Table 2 column (6).

Table A6: Placebo analysis: low exposure sample

	Con 2010 (1)	Con 2005 (2)	Con Local (3)	Post ref. vote (4)
Exposed	-0.023 (0.039)	0.041 (0.039)	-0.005 (0.052)	-0.043 (0.041)
Observations	494	448	190	361

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The set of matching variables, with replacement, in all columns includes male, age, age<sup>2</sup> / 100, married, widowed, non-white, employed, kids01, ln(household size), home owner, degree, a-level, gcse, friends from the EU, speaks another language, partisan, 3 categories of household income, agreeableness, conscientiousness, extroversion, neuroticism, openness, pre-treatment voting intention and a dummy for interest in the referendum. Standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (1)-(4) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Table A7: Alternate matching strategies

	Epanechnikov kernel		Propensity score	
	50 reps (1)	150 reps (2)	4 neighbours (3)	3 neighbours (4)
Exposed	-0.029** (0.014)	-0.029** (0.013)	-0.031*** (0.011)	-0.025** (0.012)
Treated/control	3,408/2,724	3,408/2,724	3,408/2,724	3,408/2,724
Observations	6,132	6,132	6,132	6,132

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The set of matching variables, with replacement, in all columns includes male, age, age<sup>2</sup> / 100, married, widowed, non-white, employed, kids01, ln(household size), home owner, degree, a-level, gcse, friends from the EU, speaks another language, partisan, 3 categories of household income, agreeableness, conscientiousness, extroversion, neuroticism, openness, pre-treatment voting intention and a dummy for interest in the referendum. In column (1) and (2) standard errors are bootstrapped using 50 and 150 replications, respectively. Columns (1) and (2) report the average treatment effect on the treated using Epanechnikov kernel matching. In column (3) and (4) standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (3) and (4) report the average treatment effect on the treated using propensity score matching, with 4 and 3 nearest neighbours, respectively. The propensity scores are obtained from a probit regression. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Table A8: Full sample matching with alternate matching covariates

	(1)	(2)	(3)	(4)
<i>Panel A</i>				
Exposed	-0.023** (0.010)	-0.027** (0.011)	-0.021* (0.011)	-0.031*** (0.011)
<i>Panel B</i>				
Exposed	-0.023** (0.011)	-0.034*** (0.011)	-0.027** (0.011)	-0.034*** (0.011)
<i>Panel C</i>				
Exposed	-0.022* (0.011)	-0.028** (0.011)	-0.021* (0.011)	-0.039*** (0.011)
County FEs?	No	Yes	No	Yes
Ref. proximity FEs?	No	No	Yes	Yes
Treated/control	3,408/2,724	3,408/2,724	3,408/2,724	3,408/2,724
Observations	6,132	6,132	6,132	6,132

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The dependent variable is a dummy for whether an individual will vote to leave the EU. Standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (1)-(4) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. The set of matching variables, with replacement, in Panel A is the same as those in Equation 1, but exclude the big 5 personality traits. In Panel B, the matching covariates are the same as Panel A, but exclude the big 5 personality traits and whether the respondents has friends from the EU and whether they speak another language. In Panel C, the matching covariates are the same as Panel A, but exclude income dummies. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Table A9: Low exposure sample matching with alternate matching covariates

	Full isolated (1)	Gender		Income group		Risk aversion		Wave 6 Leavers (8)
		Female (2)	Male (3)	£0-20k (4)	> £20k (5)	Avoider (6)	Taker (7)	
<i>Panel A</i>								
Exposed	-0.051 (0.042)	-0.102** (0.042)	0.032 (0.094)	-0.049 (0.102)	0.024 (0.050)	-0.160*** (0.038)	0.051 (0.042)	-0.093** (0.043)
<i>Panel B</i>								
Exposed	-0.068 (0.042)	-0.069* (0.036)	0.027 (0.051)	-0.081*** (0.023)	0.017 (0.050)	-0.119*** (0.036)	0.084 (0.084)	-0.093** (0.043)
<i>Panel C</i>								
Exposed	-0.020 (0.041)	-0.088** (0.043)	0.008 (0.105)	-0.084*** (0.029)	0.041 (0.043)	-0.109*** (0.037)	0.043 (0.067)	-0.088** (0.039)
<i>Panel D</i>								
Exposed	-0.018 (0.039)	-0.063 (0.045)	-0.013 (0.028)	-0.128* (0.078)	0.030 (0.042)	-0.087*** (0.020)	0.030 (0.066)	-0.090** (0.046)
GOR FEs?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Treated/control	173/340	98/203	75/137	81/146	92/194	94/183	79/157	84/167
Observations	513	301	212	227	286	277	236	251

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The dependent variable is a dummy for whether an individual will vote to leave the EU. Standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (1)-(8) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. The set of matching variables, with replacement, in Panel A is the same as those in Equation 1 as well as government office region fixed effects. In Panel B, the matching covariates are the same again, but exclude the big 5 personality traits and includes government office region fixed effects. In Panel C, the matching covariates are the same as Panel A, but exclude the big 5 personality traits and whether the respondents speaks another language or has friends the EU, and includes government office region fixed effects. In Panel D, the matching covariates are the same as Panel A, but now exclude income dummies and include government office region fixed effects. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Table A10: Matching with calipers

	(1)	(2)
<i>Panel A</i>		
Exposed	-0.027* (0.015)	-0.041*** (0.015)
Treated/control Observations	3,393/2,724 6,117	3,401/2,724 6,125
<i>Panel B</i>		
Exposed	-0.026* (0.015)	-0.041*** (0.015)
Treated/control Observations	3,363/2,724 6,087	3,399/2,724 6,123
County FEs?	No	Yes
Ref. proximity FEs?	No	Yes

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The dependent variable is a dummy for whether an individual will vote to leave the EU. Columns (1) and (2) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. The set of matching variables, with replacement, in all Panels, is the same as those in Equation 1. Panel A finds matches using a caliper of 0.005 and Panel B finds matches using a caliper of 0.001. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Table A11: Matching with countries excluded

	(1)	(2)	(3)
Exposed	-0.028** (0.012)	-0.026** (0.011)	-0.029** (0.012)
Country dropped	Scotland	Wales	Both
Treated/control	2,880/2,069	3,397/2,719	2,869/2,064
Observations	4,949	6,116	4,933

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The dependent variable is a dummy for whether an individual will vote to leave the EU. Standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (1)-(3) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. The set of matching variables, with replacement, in Panel A is the same as those in Equation 1. Column (1) drops individuals from Scotland, (2) removes individuals from Wales, and (3) removes individuals from both Scotland and Wales. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

## Selection on unobservables

With a matching strategy it is only possible to balance on observables that select an individual into treatment, therefore it is plausible that there is some unobserved characteristic that drives both exposure status and voting intention. To quantify the degree to which selection bias may be affecting my results, I follow [Altonji et al. \(2005\)](#). Under the assumption that selection on observables is equal to the selection on unobservables, this method produces the ratio of selection on unobservables to observables that would be required to explain away the effect of leaflet exposure on voting intention.

To implement this, I estimate OLS regressions using two sets of covariates. In the first regression, I include only the treatment indicator, and in the second I use the full set of covariates. I then repeat this exercise using the same two specifications but now include referendum proximity fixed effects. I am testing how likely is a bias due to unobserved factors beyond the observed characteristics and referendum proximity fixed effects. The estimated coefficient on the treatment indicator from the two regressions are  $\hat{\beta}_{full}$  and  $\hat{\beta}_{limited}$ . Using these coefficients I compute the selection ratio (SR) by  $\frac{\hat{\beta}_{full}}{\hat{\beta}_{limited} - \hat{\beta}_{full}}$ .

I report the Altonji-Eder-Taber ratios in [Table A12](#). The smallest ratio is 3.8 and the median value is 4.8. The smallest ratio implies that selection on unobservables needs to be 3.8 times as strong as the selection on observables to fully explain away the relationship between exposure and vote intention.

Table A12: Sensitivity to selection-on-unobservables

Controls in limited set	Controls in full set	SR
None	All controls	4.3
Ref. proximity FEs	Ref. proximity FEs + All controls	4.6
None	All controls excluding income	5.95
Ref. proximity FEs	Ref. proximity FEs + All controls excluding income	6.05
None	All controls excluding the big 5	3.8
Ref. proximity FEs	Ref. proximity FEs + All controls excluding the big 5	4.06
None	Only core controls	5.09
Ref. proximity FEs	Ref. proximity FEs + Only core controls	5.16

*Notes:* All controls refers to all controls in Equation 1. Core controls refers to all controls in Equation 1 but excludes the big 5 personality traits, whether ther respondents has friends from the EU and whether they speak another language.

## Appendix B

### Who voted for Brexit?

Here, I establish the individual characteristics that drove a person into voting in favour of Brexit. This is a useful exercise for getting to grips with the data in terms of quality and representativeness. Table B1 shows the results for LPM regressions testing the various determinants. Column (1) reports a relatively parsimonious specification, which includes only basic demographics, education and partisanship. Column (2) and (3) then introduce household income and the Big Five personality traits, respectively. Columns (4), (5) and (6) progressively include an array of fixed effects to soak up various degrees of unobserved heterogeneity. In column (4) I include local authority fixed effects to control for local authority characteristics, this was also the aggregation at which the referendum votes were counted at. 11 local authorities of the 379 are dropped as they contain no respondents in this sample. Column (5) includes county fixed effects to soak up more regional trends, for instance, Scotland's overwhelming preference for remain, 39 counties are included. Column (6) introduced proximity to referendum date fixed effects, this a dummy for the day the respondent completed the survey. The inclusion of these dummies is in order to capture one-off day-to-day events that would influence ones vote preference. For example, the murder of pro-remain MP, Jo Cox, on the June 16th caused referendum campaigning to be suspended.<sup>24</sup><sup>25</sup> Casting an eye across these 6 columns it appears that regardless of the fixed effects included the point estimates remain qualitatively the same. The elderly are more likely to vote leave, although this is at a decreasing rate. The average turning point, across columns (1)-(7) is estimated to be about 59 years old. This is in line with the findings of Liberini et al. (2017), who argue that it was only the very young that were

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<sup>24</sup>Details on the murder in context of the referendum are provided here: <https://www.theguardian.com/politics/2017/may/21/jo-cox-uk-general-election-campaign-pause>.

<sup>25</sup>Results remain the same when removing individuals who responded after 16th June.

substantially pro-remain. More educated people are associated with a lower likelihood of voting leave, relative to those with no formal academic qualifications, highlighting the educational gap in voting preference. Those with a degree are, on average, about 26 percentage points less likely to vote leave than those with no formal qualifications.<sup>26</sup> Home owners are also less likely to report that they would vote leave. For those individuals with a household income of over £70,000 per annum, they are about 14 percentage points more likely to vote to remain than those with a yearly income of 0-£20,000, holding everything else constant. Conversely, those who voted for relatively more eurosceptic parties in the previous general election are associated with a higher probability of voting leave. Briefly, in terms of the Big Five personality traits, the direction of the effects are in accordance with the prior expectations. Those individuals who are more conscientious or extroverted are, on average, more likely to favour a leave vote. Whereas some weak evidence is found for those who are more agreeable and more open are less likely to vote to leave. No significant effect is found for neuroticism.

The results presented here confirm the media tropes about “who voted for Brexit” and are consistent with what has been shown the existing literature.

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<sup>26</sup>This is close to the estimate by [Goodwin and Heath \(2016a\)](#), who estimate an effect of 30 percentage points.

Table B1: Who voted for Brexit?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Male	-0.021*	-0.010	-0.009	-0.012	-0.009	-0.013	-0.012
	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Age	0.015***	0.016***	0.016***	0.015***	0.015***	0.015***	0.015***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Age <sup>2</sup> / 100	-0.012***	-0.012***	-0.013***	-0.012***	-0.012***	-0.011***	-0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Married	-0.010	0.002	-0.000	0.001	-0.001	0.002	-0.001
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Widowed	0.031	0.035	0.034	0.033	0.035	0.030	0.030
	(0.030)	(0.030)	(0.030)	(0.032)	(0.030)	(0.032)	(0.031)
Non-white	0.001	-0.004	-0.003	0.000	0.000	0.002	0.001
	(0.021)	(0.021)	(0.021)	(0.022)	(0.022)	(0.022)	(0.022)
Employed	-0.034**	-0.015	-0.015	-0.011	-0.014	-0.011	-0.014
	(0.014)	(0.014)	(0.014)	(0.015)	(0.014)	(0.015)	(0.014)
Kids01	0.011	0.001	-0.000	-0.000	-0.001	0.002	0.002
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Ln(household size)	0.033**	0.059***	0.059***	0.053***	0.055***	0.051***	0.053***
	(0.017)	(0.017)	(0.017)	(0.018)	(0.017)	(0.018)	(0.017)
Home owner	-0.061***	-0.038***	-0.040***	-0.051***	-0.043***	-0.050***	-0.042***
	(0.014)	(0.014)	(0.014)	(0.015)	(0.014)	(0.015)	(0.014)
Degree – education	-0.291***	-0.261***	-0.257***	-0.248***	-0.253***	-0.248***	-0.252***
	(0.022)	(0.023)	(0.023)	(0.024)	(0.023)	(0.024)	(0.023)
A-level – education	-0.161***	-0.146***	-0.145***	-0.142***	-0.142***	-0.141***	-0.141***
	(0.023)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
GCSE – education	-0.037*	-0.029	-0.028	-0.031	-0.028	-0.028	-0.025
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Friends from the EU	-0.055***	-0.046***	-0.045***	-0.040***	-0.040***	-0.038***	-0.039***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Speaks another language	-0.033**	-0.029**	-0.029**	-0.028*	-0.029**	-0.028*	-0.028*
	(0.014)	(0.014)	(0.014)	(0.015)	(0.014)	(0.015)	(0.014)
Partisan	0.174***	0.176***	0.175***	0.175***	0.174***	0.175***	0.174***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Household income (Over £70k)		-0.153***	-0.160***	-0.140***	-0.142***	-0.143***	-0.144***
		(0.024)	(0.024)	(0.026)	(0.025)	(0.026)	(0.025)
Household income (£40-70k)		-0.108***	-0.111***	-0.098***	-0.101***	-0.099***	-0.101***
		(0.018)	(0.018)	(0.019)	(0.018)	(0.019)	(0.018)
Household income (£20-40k)		-0.051***	-0.053***	-0.049***	-0.048***	-0.050***	-0.049***
		(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)
Agreeableness			-0.003	-0.004	-0.003	-0.004	-0.002
			(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Conscientiousness			0.007**	0.007**	0.007**	0.008**	0.007**
			(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Extraversion			0.005**	0.005*	0.005**	0.005*	0.005**
			(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Neuroticism			0.000	0.000	0.001	0.000	0.000
			(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Openness			-0.005	-0.005	-0.005	-0.005	-0.005
			(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Constant	0.301***	0.287***	0.259***	0.178**	0.319***	0.152	0.289***
	(0.072)	(0.072)	(0.081)	(0.089)	(0.092)	(0.108)	(0.107)
Local authority FEs?	No	No	No	Yes	No	Yes	No
County FEs?	No	No	No	No	Yes	No	Yes
Ref. proximity FEs?	No	No	No	No	No	Yes	Yes
R-squared	0.249	0.255	0.257	0.309	0.267	0.314	0.273
Observations	6,132	6,132	6,132	6,132	6,132	6,132	6,132

Notes: Reported coefficients are from LPM regressions. The dependent variable in all columns is whether an individual will vote leave. Local authority districts are government areas at which the referendum count was reported. County areas are NUTS2 regions. Referendum proximity fixed effects are time fixed effects for the day of survey completion. The omitted category for income is households that earn less than £20k per year. The education variables refer to the respondents highest level of qualification, the omitted category is no formal qualifications. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

## Appendix C

### Matching covariate selection

The variables selected as control variables all have some relevance to the dependent variable of vote preference. They were selected based on an initial “eye test”, that is, were mentioned in the media or in the academic literature with respect to the overall referendum result. The inclusion of the pre-existing Brexit preference and referendum interest are selected as supplementary determinants of treatment status. Whilst it is common in the literature to saturate the matching equation with a large number of relevant characteristics, this may inflate the variance of the estimated probabilities. Thus, in order to optimize the bias-variance trade-off I implement a simple machine learning method to select the variables that enter the matching equation. This best subset selection (BSS) method is performed using the `gvselect` command in Stata. It estimates regressions using all possible combinations of control variables and reports the statistically optimal model, which minimizes Akaike’s information criterion.

The BSS method reports that the optimal model is one that controls for partisanship, having a degree or above, highest level of education is A-levels, age, the three bands of income, having friends from the EU, the natural log of household size, pre-existing Brexit preference and a dummy for referendum interest. The OLS and matching models are re-estimated using these controls and the results are reported in Table C1. In column (1) and (2) I repeat the OLS estimation using the BSS controls, column (2) also includes date and county fixed effects. Columns (3) and (4) show the coefficient for leaflet exposure from the matching procedure using the BSS controls, column (4) also includes date and county fixed effects. Reassuringly, the coefficient estimates remain in line with the previous findings of the models with a more exhaustive set of covariates.

Table C1: Best subset selection

	OLS		Matching	
	(1)	(2)	(3)	(4)
Exposed	-0.015* (0.009)	-0.021** (0.009)	-0.024** (0.011)	-0.030*** (0.011)
Observations	6,132	6,132	6,132	6,132

*Notes:* *Exposed* is the Government EU leaflet dummy, which is an indicator variable that is equal to one if a person has received and read the governments leaflet backing a remain vote. The dependent variable is a dummy for whether an individual will vote to leave the EU. Odd numbered columns include only the BSS control variables, even numbered columns also include referendum proximity and country fixed effects. Columns (1) and (2) reports coefficients from a LPM regression. In columns (3) and (4) standard errors are Abadie-Imbens robust standard errors (Abadie and Imbens, 2008, 2016). Columns (3)-(4) report the average treatment effect on the treated using propensity score matching, with 5 nearest-neighbours. The propensity scores are obtained from a probit regression. Robust standard errors are reported in parentheses; \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .