Did the result of the EU referendum induce precautionary saving?

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Abstract

This dissertation investigates the effect of the shock to economic policy uncertainty caused by the United Kingdom's vote to leave the European Union on household savings decisions in the nine months after the result of the referendum was announced. The results find no evidence of precautionary saving in response to Brexit. That there was no precautionary saving response suggests that households did not believe their jobs were at risk as a result of the Brexit vote.

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1 Introduction

The European Union (EU) referendum, in which a majority of the electorate voted to leave the EU, was held in June 2016 in the United Kingdom. The result of the vote initiated a period in which the United Kingdom's continued participation in EU economic institutions (such as the European Single Market and the European Customs Union) was uncertain. Forecasts made prior to the EU Referendum predicted that Brexit would generate a large negative shock to the UK economy, lower exports and an increase in the unemployment rate (Organisation for Economic Co-operation and Development, 2016). The impact of this shock in uncertainty to household savings in the UK is the focus of this dissertation.

It is not possible to measure uncertainty directly. Knight (1921) defines uncertainty as the inability to forecast the likelihood of events directly. As such, proxies for uncertainty are used. Newspaper based measures, such as the economic policy uncertainty index of Baker, Bloom and Davis (2016), track the frequency with which terms related to economic and policy uncertainty appear in newspapers. Finance based measures use stock market volatility as a proxy for uncertainty. Forecaster disagreement measures use measures of dispersion between forecasts of economic variables to proxy for uncertainty (Moore, 2016). Measures like the Bank of England's principle component indicator are a composite of the aforementioned measures (Forbes, 2016).

Households engage in precautionary saving in response to a decrease in expected lifetime income (Deaton, 1992). This occurs when households anticipate an event, like job loss, that could adversely affect the household's income. Indeed, Carroll, Hall and Zeldes (1992) have offered precautionary saving as an explanation of why consumers do not reduce saving or increase borrowing during a recession. The concept of precautionary saving can explain why uncertainty and consumption are inversely related and why shocks in uncertainty can lead to a severe drop in consumption (Caballero, 1990). Indeed, empirical impulse response functions estimated using Australian macro-data find that the household savings ratio increases in response to an uncertainty shock (Moore, 2016). Furthermore, while precautionary saving can result from an uncertainty shock, if prices are sticky, as in New Keynesian models, then the shock can lead to a recession because prices do not fall enough to clear markets (Bloom, 2014).

While the literature predicts a precautionary saving response to Brexit, the extent to which these predictions materialised in the months after the EU referendum is less clear. In the months preceding the EU referendum, the OECD's (2016) forecast of the UK's economic performance if the UK voted to leave the EU assumed that the result of the referendum would 'hit confidence, leading UK households to undertake additional precautionary saving.' Bloom et al. (2018) note that the effect of an uncertainty shock is likely to be contractionary and imply the possibility of a precautionary saving response with respect to the shock in uncertainty cause by Brexit. In the 10 months following the referendum, Saunders (2017) points out the UK economy's 'marked outperformance compared to expectations after the Brexit vote.' This is partly attributed to a short lived shock in uncertainty following the EU referendum, which is reflected in a rebound in business confidence and hiring attitudes in the 10 months after the Brexit vote.

Evidence for precautionary saving using household level micro-data has been found in the UK and Turkey. Guariglia (2001) proxies for labour income risk (a measure of household earning uncertainty) by interacting individual's subjective probabilities of losing their job and their earnings. She finds evidence of a precautionary saving motive in the UK. A doubling in instrumented labour income risk is associated with an 18.2% increase in household savings rates. Ceritoglu (2011) uses the same proxy for labour income risk. He finds that for households in Turkey, a 10% rise in labour income risk is associated with a 3.3% increase in household savings.

Carroll and Kimball (2007) note in their survey of the empirical literature on precautionary saving that an issue in this literature is identifying exogenous variations in uncertainty across households. Giavazzi and McMahon (2012) overcome this in their study. They observe an increase in uncertainty in the run up to the 1998 German general election, which they argue was caused by the pledge by one of the candidates to revoke recent pension reforms and return the pension system to an unsustainable path. They find that the uncertainty induced households in which the household head is not a civil servant (who are exposed to the proposed pension reforms) to increase their saving rate by 3 percentage points per year compared to households in which the household head is a civil servant.

There are two further studies of precautionary saving that identify exogenous variations in uncertainty across households. Aaberge, Liu, and Zhu (2017) exploit the exogenous shock in political uncertainty in China caused by the Tian'anmen Square Movement in Beijing in 1989. They find that the saving rate increased by 18 percentage points in the month in which the uncertainty shock is observed and that this increase was larger for older household heads, and for households that were wealthier prior to the shock. Mastrogiacomo (2013) studies the high level of uncertainty about reforms to the Dutch mortgage interest relief policy prior to the 2010 elections in the Netherlands. The author claims that the uncertainty is driven by the roughly even split in parliamentary seats between parties that support reforms to mortgage interest relief and those that are opposed to reform. Mastrogiacomo finds that uncertainty about policy reforms increased savings by 6%.

This dissertation exploits the exogenous shock in policy uncertainty caused by the result of EU referendum to investigate whether it induced a precautionary saving response. I study the extent to which UK regions that were more exposed to Brexit saved more in response the shock in uncertainty. Regional EU export concentration in the quarter after the referendum is used to proxy for exposure to Brexit. Data are drawn from the first ten waves of the Understanding Society survey, the HM Revenue and Customs Trade Info database, and the Electoral Commission. The structure of the dissertation is as follows. **Section 2** provides theoretical background. **Section 3** describes the features of the data and provides motivation for the length of the treatment period. **Section 3.1** describes the process of cleaning the *Understanding Society* data; **3.2** provides descriptive statistics; **3.3** motivates the choice to define the treatment period between the day the EU referendum was announced (24th June 2016) to the day the UK government formally notified the EU of its intention to leave (29th March 2017); **3.4** discusses how household characteristics vary in the treatment period compared to the pre-treatment and post-treatment period and how this could affect the estimate of the treatment effect; and **3.5** tests the assumption of parallel trends in the savings across UK regions in the pre-treatment period and discusses how violations of this assumption could affect the estimate of the treatment effect. **Section 4** provides motivation for the use of a shift-share instrumental variables research design. **4.1** outlines an identification strategy; **4.2** discusses how changes in fixed characteristics affect the instrument and how this could affect the estimate of the treatment effect; and

4.3 motivates the choice to use fixed effects instrumental variable estimation over non-linear instrumental variables estimation and two-stage least squares estimation. **Section 5** explains the results, which provide no evidence of a precautionary saving response, and provides discussion these results. **Section 6** provides concluding remarks.

2 Theory

This dissertation considers a permanent income hypothesis consumption model in discrete time and under uncertainty where the representative consumer maximises expected utility over a finite lifetime subject to a budget constraint (Lugilde, Bande and Riveiro, 2019):

$$maxE_t \left[\sum_{i=0}^{T-t} \left(\frac{1}{1+\delta} \right)^i U(C_{t+i}) \right] \tag{1}$$

$$s.t. \sum_{i=0}^{T-t} \left(\frac{1}{1+r} \right)^i C_{t+i} = A_t + \sum_{i=0}^{T-t} \left(\frac{1}{1+r} \right)^i Y_{t+i} \tag{2}$$

where E_t is an expectation conditional of information available in period t, $U(C)$ is the representative consumer's utility function that is additive and strictly increasing ($U'(\cdot) > 0$ and $U''(\cdot) < 0$), δ is the subjective rate of time preference, r is the real interest rate, C_{t+i} is consumption in period $t+i$, Y_{t+i} is labour income in period $t+i$, A_t is the consumers stock of assets apart from human capital in period t, and T is the length of life.

Taking expectations of the representative consumer's budget constraint (2) conditional on information available in period t, Deaton (1992) shows that consumption can be defined as the present value of assets and expected lifetime income:

$$c_t = \left(\frac{r}{1+r} \right) A_t + \left(\frac{r}{1+r} \right) \sum_{i=0}^{\infty} \left(\frac{1}{1+r} \right)^i E_t(y_{t+i}|\Omega_t) \tag{3}$$

where Ω_t is the information available to the consumer at time t (only a subset of which is available to the researcher). Savings in period t are defined as the residual of income and consumption in period t:

$$s_t = \left(\frac{r}{1+r} \right) A_t + y_t - c_t \tag{4}$$

Substituting (3) into (4) yields an equation that relates savings in period t to expected changes in labour income:

$$s_t = -\sum_{i=1}^{\infty} \left(\frac{1}{1+r}\right)^i E_t(\Delta y_{t+i}|\Omega_t) \tag{5}$$

Precautionary savings are made in response to negative shocks in expected lifetime income. When households receive news that induces them to alter their expected lifetime income, they reduce their consumption in the present and save to smooth consumption in the future when they expect their income to be lower. On this point Deaton (1992) notes that 'utility gains from additional consumption now are more than offset by the value of having assets when bad luck strikes.' In relation to the result of the EU referendum, this theory would predict that providing the shock in economic policy uncertainty induced households to decrease their expected lifetime income (because they assume Brexit could increase job insecurity), their savings will increase. This is the hypothesis that will be tested in this dissertation.

3 Data

Household data are drawn from waves 1 to 10 of the Understanding Society survey. The survey provides low frequency, household level micro-data. These data are chosen because the variation in interview dates can be exploited to study the potential difference in savings behaviour of households exposed to the shock in policy uncertainty and those that not exposed. These data are supplemented with trade data and EU referendum vote share data drawn from the HM Revenue and Customs Trade Info database and the Electoral Commission respectively. These data are merged and augmented with the addition of dummy variables capturing the region in which the respondent lives, their assessment of their job security, labour force status, highest qualification and housing tenure.

3.1 Cleaning

Before cleaning, there are 867,970 observations and 86,797 unique households across the first ten waves of the Understanding Society survey. The data are initially restricted for respondents that report being in paid employment across all interviews. The data are then restricted for the observations for which there is data on savings (Table 1). At this stage, all respondents interviewed in 2009 have been removed because data on savings were not collected in the first wave of the Understanding Society survey. The next stage cleans for positive household net labour income. Net labour income is defined as sum of net labour income of all household members. Net labour income aggregates usual net monthly pay, monthly net self-employment earnings, and net earnings from a second job (Fisher, Fumagalli, Buck Avram, 2019). The penultimate stage of cleaning removes data collected after February 2020. This has been done to prevent COVID-19 related effects from affecting the results of my analysis. The last stage of cleaning removes observations where reported monthly savings exceed monthly household labour income less monthly household expenditure on food and groceries. The presence of observations where monthly savings exceed monthly income suggests respondents did not understand the question and reported their total stock of savings rather than their monthly savings. After cleaning, the combined sample is an unbalanced panel of 8,093 observations of 2,557 households from 2010 to 2020.

The number of observations by region and year are reported in Table 2. London has the largest number of households in the sample (329) and the North East has the lowest (80). There are few observations across regions in 2020 because the last interviews of the tenth wave of the Understanding Society survey were carried out in early 2020.

Table 1: Stages of cleaning

Year	Before Cleaning	(1) In continuous paid employment	(2) Respondent reports whether they save	(3) Savings ≥ 0	(4) Net labour income > 0	(5) Data on year	(6) Interviewed before 1st Feb 2020	(7) Savings $<$ income
2009	25,467	733	0	0	0	0	0	0
2010	55,191	1,796	912	884	884	884	884	882
2011	52,826	2,059	876	850	850	850	850	846
2012	47,746	1,994	969	943	939	939	939	937
2013	45,062	1,860	834	809	808	808	808	805
2014	42,515	1,767	771	738	738	738	738	737
2015	42,404	1,778	831	790	789	789	789	786
2016	41,305	1,802	774	711	710	710	710	709
2017	36,870	1,675	745	710	708	708	708	706
2018	34,831	1,714	988	937	929	929	929	925
2019	15,786	1,041	702	661	656	656	656	654
2020	928	189	187	175	175	175	107	106
Total observations	867,970	20,251	8,589	8,208	8,186	8,186	8,118	8,093
Total unique households	86,797	2,667	2,585	2,563	2,561	2,56	2,559	2,557

NOTES: There are households for whom data have not been collected in all years covered in the sample. When the data from waves 1 – 10 of *Understanding Society* have been merged to form the panel, rows of missing values have been generated where data have not been collected in any of the years between 2009 and 2020. (1) restricts the sample for households that report being in paid employment in all years in the sample. There are no observations in 2009 in (2) because the Understanding Society survey did not collect data on savings in its first wave. Respondents that report not saving are assigned the value 0 in the reported savings variable before respondents that report not knowing how much they save or refusing to report are removed in (3). All observations removed in (4) are for observations where derived household net labour income is 0. (5) checks whether any observations have inapplicable values for the date of interview and removes them. (6) removes observations in which the respondent was interviewed before 1st February 2020. (7) removes observations where reported monthly savings are greater than monthly net labour income less reported monthly expenditure on food and groceries.

SOURCE: Understanding Society survey waves 1 – 10.

Table 2: Number of observations and households by region

	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of Eng-lands	London	South East	South West	Wales	Scotland	Northern Ireland
2010	23	59	49	72	84	56	62	99	65	77	111	124
2011	32	80	61	71	78	97	118	95	78	49	66	20
2012	18	67	53	105	91	75	77	91	91	73	103	93
2013	33	65	44	64	89	62	106	111	63	53	70	44
2014	24	54	68	66	86	74	82	69	56	54	55	48
2015	25	59	47	74	60	85	99	97	70	46	77	47
2016	21	68	52	55	86	68	93	84	51	48	56	27
2017	24	47	49	73	70	71	79	76	62	35	52	68
2018	23	82	73	73	84	87	119	92	92	51	95	54
2019	22	61	48	55	65	59	86	83	52	34	45	42
2020	1	15	9	3	17	14	19	10	10	1	5	2
Total observations	246	657	553	771	810	748	940	907	690	521	735	569
Total unique households	80	227	227	236	255	241	329	292	215	165	239	171

SOURCE: Understanding Society survey waves 1 – 10.

3.2 Descriptive statistics

The questions about saving in *Understanding Society* are as follows:

- Do you save any amount of your income, for example by putting something away now and then in the bank, building society, or Post Office account, other than to meet regular bills? Please include share purchase schemes and ISA's.

- About how much on average do you personally manage to save a month?

The data for the second question are censored at zero because the wording of the question does not allow respondents to report below zero monthly savings. Below zero savings can be interpreted as borrowing. As such, households that report zero savings either borrow to finance consumption or they could be hand to mouth consumers.

Of those who save, respondents across all regions save a mean and median of £254.27 per month and £150 per month respectively. Those living in London save the most with a mean and median of £392.97 per month and £200 per month respectively. Those in the North East save the least with a mean and median of £164.42 per month and £100 per month respectively.

One of the variables of interest in this dissertation is whether the respondent saves. Across the sample, 52% of respondents save (Table 3). Respondents in the South West are the most likely to save (57% of respondents in this region save) and those in Yorkshire and the Humber are the least likely to save (44.6%). In all regions apart from Wales, Northern Ireland, and Yorkshire and the Humber more than 50% of respondents save.

The other variable of interest is the savings rate. This is defined as reported monthly savings as a proportion of monthly household net labour income. Histograms of the savings rate by region are reported in Figure 1. Across all the regions the data are positively skewed, showing that respondents are more likely to save a small proportion of or none of their monthly household income. Indeed, half of the respondents in the sample save 0.7% of their income or less every month. The savings rates for respondents in Northern Ireland and London are the most dispersed across all regions (with standard deviations of 0.0795 and 0.0798 respectively) and the data for respondents in the East Midlands are the least dispersed (with a standard deviation of 0.05904).

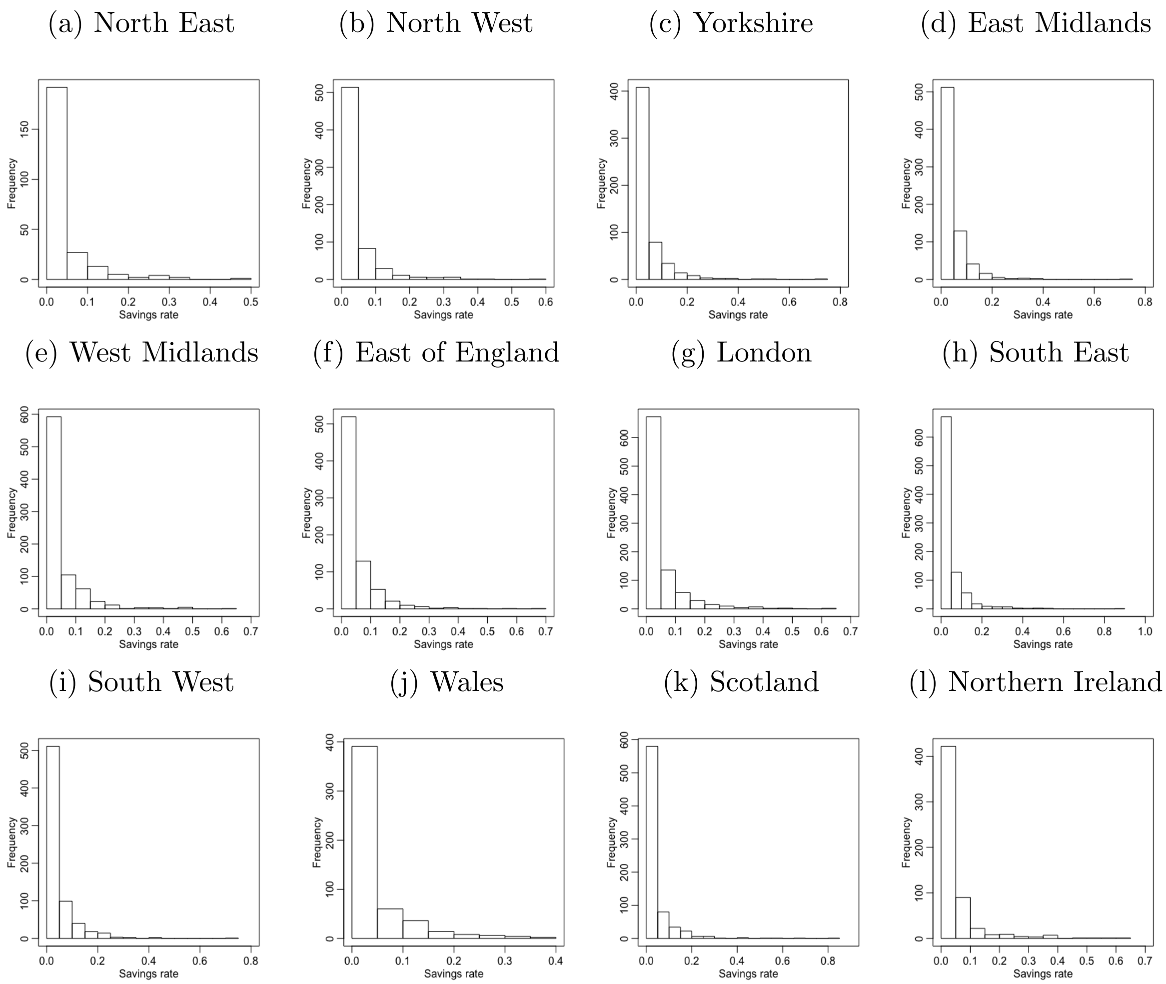
Table 3: Savings descriptive statistics by region

	(1) Proportion of people who save	(2) Mean savings for those who save (£ per month)	(3) Mean savings rate	(4) Median savings rate	(5) Standard deviation of savings rate	(6) Skewness of savings rate
All	0.5223	254.26	0.03908	0.007142	0.07097	3.726
North East	0.5487	164.42	0.03792	0.01204	0.06538	2.997
North West	0.5266	207.97	0.03468	0.007142	0.06258	3.394
Yorkshire and the Humber	0.4466	252.26	0.03760	0	0.07180	3.904
East Midlands	0.5527	218.83	0.03575	0.01136	0.05904	4.032
West Midlands	0.5074	262.32	0.04050	0.004849	0.07326	3.380
East of England	0.5601	264.47	0.04271	0.01276	0.07109	3.422
London	0.5053	392.97	0.04400	0.001630	0.07957	3.170
South East	0.5424	257.51	0.04019	0.009495	0.07593	4.182
South West	0.5782	229.10	0.03878	0.01534	0.06428	3.852
Wales	0.4932	225.65	0.03757	0	0.06465	2.437
Scotland	0.5088	228.05	0.03512	0.005017	0.07223	5.012
Northern Ireland	0.4850	237.82	0.04054	0	0.07958	3.535

NOTES: All averages in (2) and (3) are calculated using data from 2010 to 2020. In (3) the savings rate is defined as reported monthly savings as a proportion of monthly net labour income. Note that the data used to calculate (3) includes households that report 0 monthly savings.

SOURCE: Understanding Society survey waves 1 – 10.

Figure 1: Histograms of savings rate by region



NOTES: The savings ratio is defined as reported monthly savings as a proportion of monthly net labour income. Note that the data used to calculate this variable includes households that report 0 monthly savings.

SOURCE: Understanding Society survey waves 1 – 10.

3.3 Treatment period

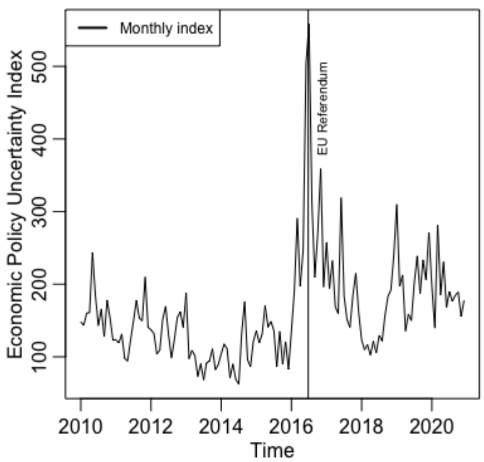
The treatment period spans the duration of the shock in economic policy uncertainty that the result of the EU referendum caused. Figure 2 consists of two plots of the monthly and daily economic policy uncertainty index across the sample period. This index tracks the frequency with which terms related to economic and policy uncertainty appear in 11 high circulation UK newspapers for the monthly index and 650 UK newspapers for the daily index (Baker, Bloom and Davis, 2016).

It is clear from Figure 2 that the initial impact of the shock starts on 24th June 2016, the day the result of the EU referendum was announced. The point, at which the shock ends, however, is less clear. The index shows how the initial shock dissipates and settles around 29th March 2017 when the UK Government invokes Article 50 of the Treaty on European Union, formally notifying the European Council of its intention to leave (Walker, 2021). The daily index settles to its pre-referendum level around the time when the Withdrawal Agreement (the treaty setting out the terms of UK's withdrawal from the EU) is published. On the basis that the duration of the shock caused by the result of the EU referendum is from its impact to the point at which it dissipates, the treatment period in this dissertation is defined between the day the result of EU referendum was announced (24th June 2016) and the day the UK Government invoked Article 50 (29th March 2017).

The uncertainty caused by the Brexit vote is still present until the announcement of policies that remove it, or the implementation of policies that remove it. It follows that the end of the shock could also be defined as the date the Withdrawal Agreement was agreed and published or the date the UK left the EU. As such, two further treatment periods are defined: from the announcement of the result of the referendum to the date the Withdrawal Agreement was published (14th November 2018) and the end of the sample period (31st January 2020), which coincides with the day the UK left the EU.

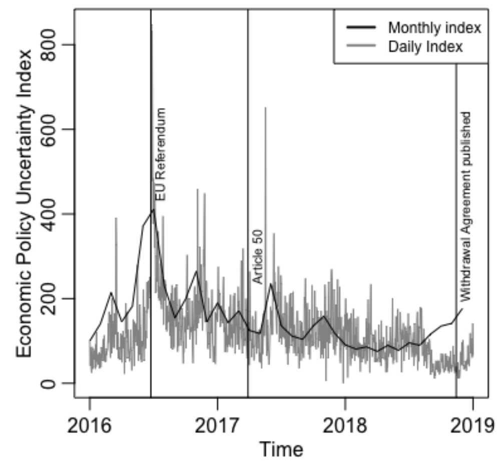
Figure 2: Economic policy uncertainty index in the sample period

(a) Monthly index



Source: Economic Policy Uncertainty Index (Baker, Bloom and Davis, 2016).

(b) Monthly and daily index



Notes: Daily and monthly series are transformed to start at 100 on 1st January 2016. The vertical line labelled 'Article 50' is the date the UK Government formally notifies the European Union (EU) of its intention to leave. The line labelled 'Withdrawal Agreement published' is the date the Withdrawal Treaty, setting out the terms of the UK's withdrawal from the EU in the period where the terms of their long term relationship are being negotiated, is published.

Source: Economic Policy Uncertainty Index (Baker, Bloom and Davis, 2016).

3.4 Characteristics of the sample in the treatment period

If a treatment period dummy can explain the variation in household characteristics, then it is possible that this could bias the estimate of the treatment effect (measuring the effect of Brexit on household savings). There is no reason to suppose that the result of the EU referendum could cause either an increase or decrease in family size, for example. Given that households with more children save less (Espenshade, 1975), if households exposed to the shock in uncertainty have more children this would bias the treatment effect downwards. In addition to the number of children and household size, the other variables such as the number in employment in the household and the respondent's assessment of their job security could bias the treatment effect if their variation is explained by a treatment period dummy. The parameters in the following equations are estimated:

$$nkids_{it} = \alpha + (shock_{it} * region_{it})'\beta + region'_{it}\gamma + shock'_{it}\delta + \epsilon_{it} \tag{6}$$

$$nemp_{it} = \alpha + (shock_{it} * region_{it})'\beta + region'_{it}\gamma + shock'_{it}\delta + \epsilon_{it} \tag{7}$$

$$hhsize_{it} = \alpha + (shock_{it} * region_{it})'\beta + region'_{it}\gamma + shock'_{it}\delta + \epsilon_{it} \tag{8}$$

$$jbsec_{i} = \alpha + (shock_{i} * region_{i})'\beta + region'_{i}\gamma + shock'_{i}\delta + \epsilon_{i} \tag{9}$$

where $nkids_{it}$ is the number of children in household i at time t, $nemp_{it}$ is the number in employment in the household, $hhsize_{it}$ is the number of people living in the household, $jbsec_i$ is the respondent's assessment of their job security, $shock_{it}$ is a dummy for the treatment period that is 1 if the respondent was interviewed between 24th June 2016 and 29th March 2017 and is 0 otherwise, and $region_{it}$ is vector of dummies for each region, and ϵ_{it} is an error term.

Data on the number of children, number in employment, and household size are linear. Data on job security are ordered such that higher values represent more job security (Table 4). Respondents report that it is very likely (1 in the data), likely (2), unlikely (3) and very unlikely (4) that they will lose their job in the next 12 months.

Table 4: Job security variable

Question: I would like you to think about your employment prospects over the next 12 months. Thinking about losing your job by being sacked, laid-off, made redundant or not having your contract renewed, how likely do you think it is that you will lose your job during the next 12 months? Is it...

Value	
1	Very likely
2	Likely
3	Unlikely
4	Very unlikely

SOURCE: Understanding Society survey

The number of children in the household, and the number of people in the household, in the treatment period are not significantly different to the average across the sample (Table 5). Households in the West Midlands and the East of England have fewer people in employment compared to the average across the sample. Households in the South East have more people in employment compared to the average. Respondents in Northern Ireland are more likely to report that it is unlikely that they will lose their job in the next 12 months. These results will not bias the estimate of the treatment effect given that the number in employment in the household in the treatment period is not consistently higher (or lower) across all regions. The same is true for the respondent's assessment of their job security. Respondent's jobs are not consistently more (or less) secure in the treatment period across all regions. As such, that respondents in Northern Ireland are more likely to report more job security will not bias the estimate of the treatment effect.

Table 5: Regressions of household characteristics on a treatment period dummy

	Pooled OLS			Ordered logit
	(1)	(2)	(3)	(4)
	$nkids_{it}$	$nemp_{it}$	$hhsize_{it}$	$jbsec_{it}$
Interaction with treatment period				
North East	-0.06153	-0.01503	-0.01713	0.5936
	(-0.2992)	(-0.0924)	(-0.0621)	(1.40)
North West	-0.03045	-0.02665	-0.01450	-0.2179
	(-0.2233)	(-0.2470)	(-0.0792)	(-0.82)
Yorkshire and the Humber	0.1482	-0.1072	0.02430	0.0368
	(1.093)	(-0.9996)	(0.1335)	(0.13)
East Midlands	-0.06289	-0.09647	-0.1357	0.0651
	(-0.5193)	(-1.007)	(-0.8353)	(0.27)
West Midlands	-0.08321	-0.1818*	-0.2849	-0.0635
	(-0.7124)	(-1.968)	(-1.817)	(-0.27)
East of England	-0.05727	-0.2342*	-0.3085	0.2755
	(-0.4354)	(-2.251)	(-1.747)	(1.02)
London	-0.01684	-0.02641	0.09710	-0.0172
	(-0.1375)	(-0.2728)	(0.5909)	(-0.07)
South East	-0.09290	0.2532**	0.04594	-0.1516
	(-0.8307)	(2.862)	(0.3061)	(-0.70)
South West	-0.05734	-0.08749	-0.03174	-0.0022
	(-0.4374)	(-0.8437)	(-0.1804)	(-0.01)
Wales	-0.1631	0.1301	-0.1304	-0.0261
	(-1.207)	(1.217)	(-0.7190)	(-0.10)
Scotland	-0.05634	-0.02132	-0.08820	0.0958
	(-0.4848)	(-0.2320)	(-0.5655)	(0.41)
Northern Ireland	-0.1523	-0.04421	-0.2642	0.9844***
	(-1.360)	(-0.4991)	(-1.758)	(3.78)
$jbsec_i \geq 2$				3.735***
				(4.54)
$jbsec_i \geq 3$				2.278**
				(2.78)
$jbsec_i \geq 4$				-0.1774
				(-0.22)
N	8093	8093	8093	7895
R^2	0.01080	0.006140	0.01765	-
Adj. R^2	0.007864	0.003184	0.01473	-
F-statistic/Chisq	3.672***	2.077**	6.042***	62.43***

Significance codes: p<0.001***; p<0.01**; p<0.05*

NOTES: The dependent variable in column (1), $nkids_{it}$, is the number of children in household i at time t. In column (2), $nemp_{it}$ is the number of people that are employed in the household. In column (3), $hhsize_{it}$ is the number of people living in the household. In column (4), $jbsec_i$ is an ordered dependent variable capturing the respondent's assessment of their job security. Respondents report that it is very likely (1 in the data), likely (2), unlikely (3), or very unlikely (4) that they will lose their job in the next 12 months. This table reports parameter estimates of the following specifications:

$nkids_{it} = \alpha + (shock_{it} * region_{it})\beta + region_{it}\gamma + shock_{it}\delta + \epsilon_{it}$; $nemp_{it} = \alpha + (shock_{it} * region_{it})\beta + region_{it}\gamma + shock_{it}\delta + \epsilon_{it}$

$hhsize_{it} = \alpha + (shock_{it} * region_{it})\beta + region_{it}\gamma + shock_{it}\delta + \epsilon_{it}$; $jbsec_i = \alpha + (shock_i * region_i)\beta + region_i\gamma + shock_i\delta + \epsilon_i$

where $shock_{it}$ is a dummy for the treatment period that is 1 if the respondent was interviewed between 24th June 2016 and 29th March 2017 and is 0 otherwise, and $region_{it}$ is vector of dummies for each region, and ϵ_{it} is an error term.

SOURCE: Understanding Society survey waves 1 - 10.

3.5 Trends in savings behaviour

The claim that trends in savings would have continued in absence of the treatment can be made providing that trends in savings across regions are parallel prior to the EU referendum (Khan-Lang and Lang, 2020). If the trends are parallel, the estimated treatment effect will measure the impact of the shock in uncertainty caused by the EU referendum on household savings. Figure 3 reports plots of the proportion of people that save by region and the average savings rate by region over the sample period. In the plot of the proportion reporting whether they save (Figure 3 (a)), the series exhibit wide variation in sample values. As such, it is not possible to discern a common trend in the period before the announcement of the EU referendum. In the plot of average savings rates (Figure 3 (b)) the series appear correlated before the EU referendum but it is not possible to discern any divergence after the referendum.

An assumption of the research design used in this dissertation is the existence of a common trend across regions before the EU referendum. To test this assumption, the parameters in equations (10) and (11) are estimated. The parameters in equation (12) are estimated to understand how savings trajectories vary across regions.

$$\begin{aligned} saves_{it} &= \lambda_i + \delta_t + (shock_{i,-t} * region_{it})'\beta_{-1} + (shock_{it} * region_{it})'\beta_1 \\ &\quad + region'_{it}\phi + \alpha shock_{i,-t} + \gamma shock_{it} + \epsilon_{it} \end{aligned} \tag{10}$$

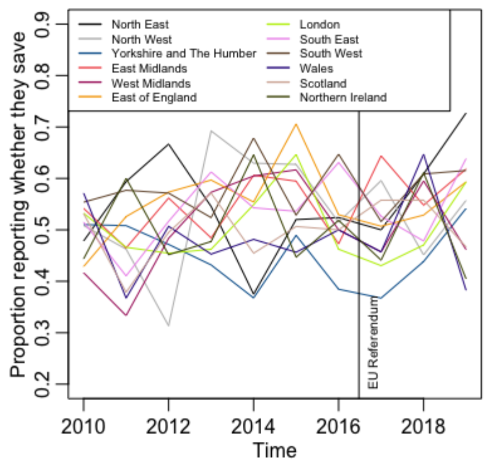
$$\begin{aligned} \frac{saved_{it}}{income_{it}} &= \lambda_i + \delta_t + (shock_{i,-t} * region_{it})'\beta_{-1} + (shock_{it} * region_{it})'\beta_1 \\ &\quad + region'_{it}\phi + \alpha shock_{i,-t} + \gamma shock_{it} + \epsilon_{it} \end{aligned} \tag{11}$$

$$\begin{aligned} \Delta\frac{saved_{it}}{income_{it}} &= \lambda_i + \delta_t + (shock_{i,-t} * region_{it})'\beta_{-1} + (shock_{it} * region_{it})'\beta_1 \\ &\quad + region'_{it}\phi + \alpha shock_{i,-t} + \gamma shock_{it} + \epsilon_{it} \end{aligned} \tag{12}$$

In the equations above, $saves_{it}$ is a binary variable that is 1 if the respondent reports saving and 0 if they do not save for household i at time t ; $\frac{saved_{it}}{income_{it}}$ is the ratio of reported monthly savings as a proportion of monthly total net household labour income (the savings rate); $\Delta\frac{saved_{it}}{income_{it}}$ is a first difference of the savings rate; λ_i and δ_t are household and time-fixed effects, $shock_{i,-t}$ is a pre-treatment dummy that is 1 before 24th June 2016 and is 0 otherwise, $shock_{it}$ is a treatment dummy that is 1 between 24th June 2016 and 29th March 2017 and is 0 otherwise, $region_{it}$ is a vector of dummies for each region.

Figure 3: Savings profiles by region

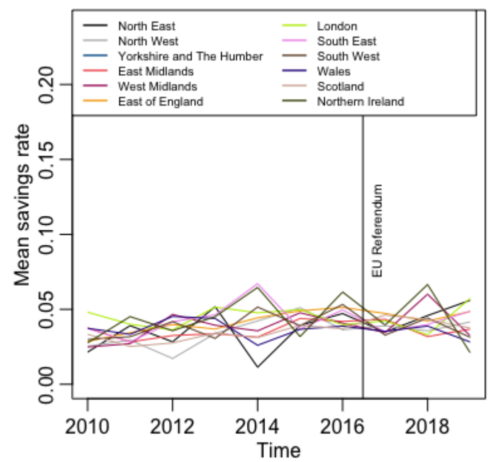
(a) Proportion reporting whether they save



NOTES: The series ends in 2019 because there are too few observations in 2020 in the sample to produce good mean estimates.

SOURCE: : Understanding Society survey waves 1 – 10.

(b) Monthly and daily index



NOTES: The savings rate is defined as reported monthly savings as a proportion of monthly net labour income. Note that the data used to calculate this variable includes households that report 0 monthly savings. The savings rate is computed for every household and an average is taken across households in the same region interviewed in the same year. The series ends in 2019 because there are too few observations in 2020 in the sample to produce good mean estimates.

SOURCE: : Understanding Society survey waves 1 – 10.

Table 6: Trends in savings behaviour and savings trajectories by region

	Two-way Fixed Effects		
	(1)	(2)	(3)
	$saves_{it}$	$\frac{saved_{it}}{income_{it}}$	$\Delta\frac{saved_{it}}{income_{it}}$
Interaction with pre-treatment period			
North East	-0.2075	-0.08545	-0.0007715
	(-0.4762)	(-1.487)	(-0.0413)
North West	-0.1002	-0.07743	0.02673
	(-0.2320)	(-1.359)	(1.857)
Yorkshire and the Humber	-0.1268	-0.07557	0.02578
	(-0.2932)	(-1.325)	(1.697)
East Midlands	-0.1065	-0.07125	0.007765
	(-0.2465)	(-1.249)	(0.5468)
West Midlands	-0.08419	-0.08215	0.01804
	(-0.1956)	(-1.443)	(1.351)
East of England	-0.1101	-0.07760	0.03884**
	(-0.2551)	(-1.362)	(2.880)
London	-0.04841	-0.06610	0.02572
	(-0.1122)	(-1.162)	(1.944)
South East	-0.08720	-0.07940	0.01608
	(-0.2021)	(-1.395)	(1.210)
South West	-0.1126	-0.07910	0.01340
	(-0.2609)	(-1.389)	(0.9673)
Wales	-0.1177	-0.06252	0.02081
	(-0.2712)	(-1.092)	(1.310)
Scotland	-0.07377	-0.07613	0.008151
	(-0.1708)	(-1.337)	(0.5594)
Northern Ireland	-0.07838	-0.08236	0.03524*
	(-0.1812)	(-1.444)	(2.236)
Interaction with treatment period			
North East		-0.03082*	
		(-2.149)	
n	2557	2557	2239
N	8093	8093	5536
T	1-5	1-5	1-4
R^2	0.01137	0.009322	0.01020
Adj. R^2	-0.4574	-0.4604	-0.6841
F-statistic	1.706**	1.396	0.9317

Significance codes: p<0.001***; p<0.01**; p<0.05*

NOTES: T-statistics are reported in parentheses.

The dependent variable in (1), $saves_{it}$, is a dummy variable that is 1 if the respondent saves and is 0 if they do not save. The dependent variable in column (2), $\frac{saved_{it}}{income_{it}}$, is the ratio of monthly savings to net labour income. Note that for households that report not saving, their value for $\frac{saved_{it}}{income_{it}}$ is 0. The dependent variable in column (3), $\Delta\frac{saved_{it}}{income_{it}}$ is the first difference of the ratio of net labour income saved for household i in period t. This table reports parameter estimates of the following specifications:

$saves_{it} = \lambda_i + \delta_t + (shock_{i,-t} * region_{it})'\beta_{-1} + (shock_{it} * region_{it})'\beta_1 + region'_{it}\phi + \alpha shock_{i,-t} + \gamma shock_{it} + \epsilon_{it}$; $\frac{saved_{it}}{income_{it}} = \lambda_i + \delta_t + (shock_{i,-t} * region_{it})'\beta_{-1} + (shock_{it} * region_{it})'\beta_1 + region'_{it}\phi + \alpha shock_{i,-t} + \gamma shock_{it} + \epsilon_{it}$; $\Delta\frac{saved_{it}}{income_{it}} = \lambda_i + \delta_t + (shock_{i,-t} * region_{it})'\beta_{-1} + (shock_{it} * region_{it})'\beta_1 + region'_{it}\phi + \alpha shock_{i,-t} + \gamma shock_{it} + \epsilon_{it}$

where λ_i and δ_t are household and time-fixed effects, $shock_{i,-t}$ is a pre-treatment dummy that is 1 before 24th June 2016 and is 0 otherwise, $shock_{it}$ is a treatment dummy that is 1 between 24th June 2016 and 29th March 2017 and is 0 otherwise, $region_{it}$ is vector of dummies for each region. The pre-treatment period is defined as the respondents that are interviewed before the result of the EU referendum was announced, 24th June 2016. The treatment period is defined as respondents that are interviewed between 24th June 2016 and 29th March 2017, the day the UK Government formally notified the EU of its intention to leave.

SOURCE: Understanding Society survey waves 1 – 10.

The coefficients of the pre-treatment period interaction with region dummies for models where $saves_{it}$ and $\frac{saved_{it}}{income_{it}}$ are the dependent variable are not significantly different from zero (Table 6). As such, this provides evidence that the assumption of a common pre-treatment trend holds. There is evidence that savings rates in the North East diverge in the treatment period and decrease relative to other regions. This is unexpected given that the North East is one of the most exposed regions to Brexit (exposure is measured by regional EU export concentration – see **section 4** below for further explanation). Income, age, and the likelihood of having been in education past the age of 16 are not significantly different in the North East compared to the average across the sample. Households in the treatment period in the North East are less likely to live in privately rented and furnished accommodation and more likely to live in privately rented and unfurnished accommodation. The latter of these results explains some of the divergence of savings rates in the treatment period given that households that rent their accommodation privately have consistently had the lowest savings rates compared to other housing tenures since 1975 (Crossley and O'Dea, 2010). That savings rates decrease in the North East after the EU referendum could bias the estimate of the treatment effect down.

The variation in savings rates across regions can be explained by variation in age, household characteristics, and where individuals lie in the distribution of income. Those in the lowest quintile of income, for example, have consistently had the lowest savings rates compared to those in higher quintiles since 1975. Those that own their homes outright have consistently saved more compared to other housing tenures in the same period. Those who are older have tended to have higher savings rates in this period also (Crossley and O'Dea, 2010). There is no reason to suppose that the result of the referendum will have altered either the composition of the dwelling stock by tenure, the distribution of age, or the distribution of income in a given region in the short-run. As such, I contend that the patterns in savings behaviour in UK regions would have continued in the absence of the EU referendum.

Households in the East of England and Northern Ireland have higher savings trajectories. It is not clear why this is the case. One would expect regions with a younger population to have higher savings trajectories. Respondents in Northern Ireland, however, are trivially younger on average compared to the average across the sample (43.79 years against a sample average of 43.87 years) and respondents in the East of England are older than the average in the sample (45.15 years against a sample average of 43.87 years).

4 Statistical model

I use the shift-share instrumental variables research design proposed by Borusyak, Jaravel, and Hull (2020) to analyse the data. This research design defines the treatment period across the unit interval, where its value is the respondent's exposure to a shock. The parameters in the following specifications are estimated:

$$saves_{it} = \lambda_i + \delta_t + \beta treatment_{it} + w'_{it}\gamma + jbsec'_{it}\phi + \epsilon_{it} \tag{13}$$

$$\frac{saved_{it}}{income_{it}} = \lambda_i + \delta_t + \beta treatment_{it} + w'_{it}\gamma + jbsec'_{it}\phi + \epsilon_{it} \tag{14}$$

where $saves_{it}$ is a binary variable that is 1 if the respondent reports saving and 0 if they do not save for household i at time t ; $\frac{saved_{it}}{income_{it}}$ is the ratio of reported monthly savings as a proportion of monthly total net household labour income (the savings rate); λ_i and δ_t are household and time-fixed effects; w_{it} is a vector of household characteristics (including age, number of children, number of people in the household, number in employment in the household, housing tenure, and the respondents highest qualification); and $jbsec_{it}$ is a vector of dummies capturing the respondent's assessment if their job security. The parameters in these equations are estimated using fixed effects instrumental variables. The motivations for this choice of estimator are set out in **section 4.3**.

The treatment is defined as follows:

$$treatment_{it} = exc_{irt} * shock_{it} \tag{15}$$

where exc_{irt} is the EU export concentration in region r in the third quarter of 2016; and $shock_{it}$ is a treatment dummy that is 1 between 24th June 2016 and 29th March 2017 and is 0 otherwise. EU export concentration is defined as the ratio of the value of exports from region r to EU member states to the value of exports to all countries.

EU export concentration is used to define a household's exposure to Brexit. An increase in policy uncertainty after the EU referendum decreases the number of firms that enter into exporting to the EU and increases the number of firms exiting exporting to the EU (Crowley, Exton and Han, 2020). A decrease in exports decreases wages of all skill types (Hummels, Jorgensen, Munch and Xiang, 2014). I would expect that households more exposed to Brexit decrease their expected lifetime income by more (compared to households that are less exposed) and save more in response to the result of the EU referendum.

Table 7: Exposure to Brexit

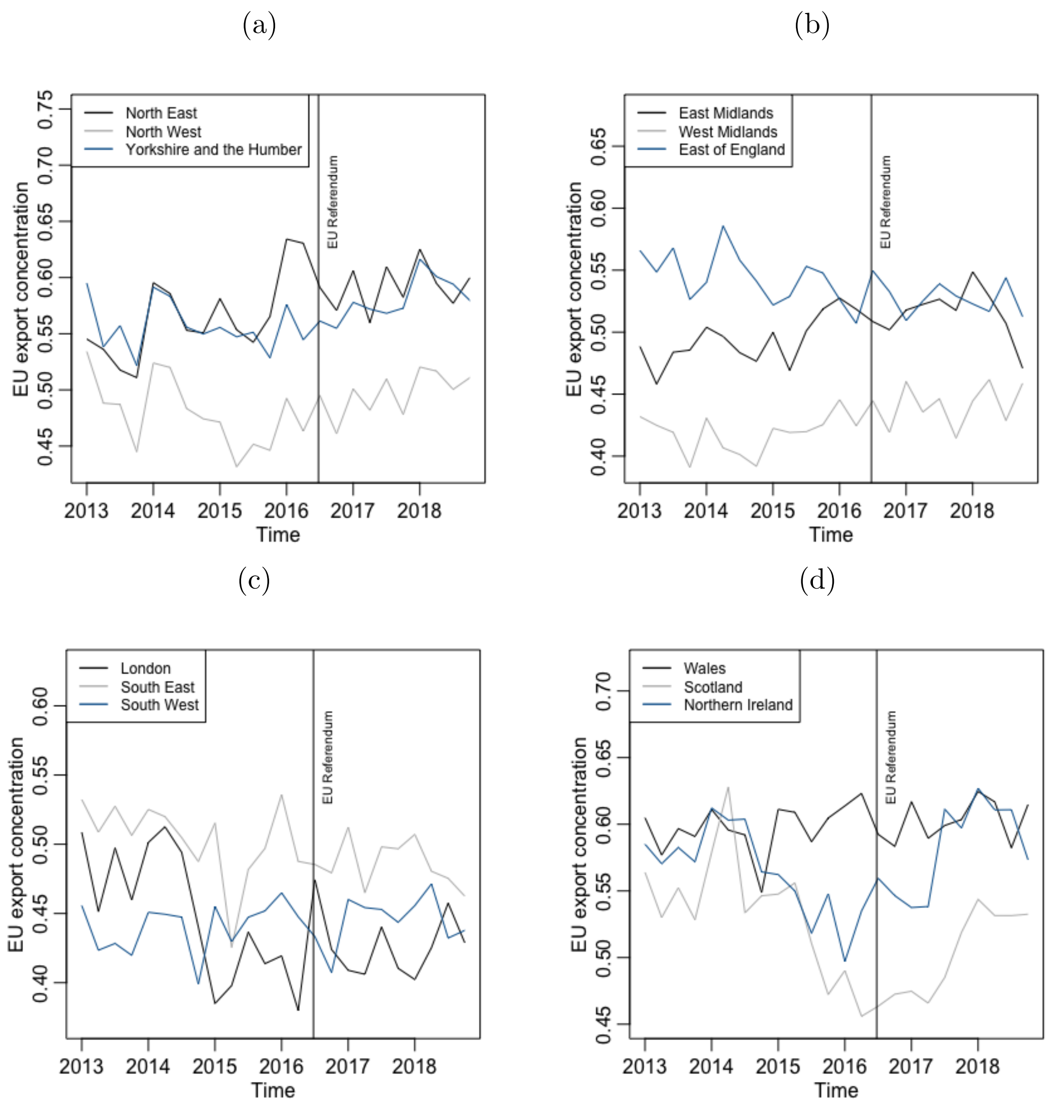
Region	EU export concentration Q3 2016	Region	EU export concentration Q3 2016
North East	0.5911	London	0.4743
North West	0.4949	South East	0.4853
Yorkshire and the Humber	0.5612	South West	0.4332
East Midlands	0.5085	Wales	0.5924
West Midlands	0.4446	Scotland	0.4635
East of England	0.5494	Northern Ireland	0.5594

NOTES: EU export concentration is defined as the ratio of the value of exports to European Union member states as a proportion of the value of exports to all countries.

SOURCE: HM Revenue and Customs.

The region with the most exposure to Brexit in the third quarter of 2016 is Wales, where 59.2% of the value of exports are to EU member states, and the region with the least exposure is the South West, where 43.3% of the value of exports are to EU member states (Table 7). EU export concentration in Wales from 2013 to the EU referendum appears to fluctuate around 60% (Figure 4 (d)). In other regions, particularly Scotland, Northern Ireland and Wales, EU export concentration before the referendum is volatile.

Figure 4: Quarterly export concentration by region



NOTES: Vertical line is the day the result of the EU referendum is announced (24th June 2016). Regional EU export concentration is defined as the value of exports to EU member states as a proportion of the value of exports to all countries.

SOURCE: HM Revenue and Customs.

4.1 Identification strategy

The treatment is potentially endogenous. To find an instrument, the parameters in the following equations are estimated:

$$saves_{it} = \lambda_i + \delta_t + exc_{i,r,t-j}\beta + \epsilon_{it} \tag{16}$$

$$\frac{saved_{it}}{income_{it}} = \lambda_i + \delta_t + exc_{i,r,t-j}\beta + \epsilon_{it} \tag{17}$$

$$j = 0, ..., 11$$

where $saves_{it}$ is a binary variable that is 1 if the respondent reports saving and 0 if they do not save for household i at time t ; $\frac{saved_{it}}{income_{it}}$ is the ratio of reported monthly savings as a proportion of monthly total net household labour income; λ_i and δ_t are household and time-fixed effects; $exc_{i,r,t-j}$ are quarterly lags of EU export concentration in region r.

When the dependent variable is $saves_{it}$, the only significant coefficient is for EU export concentration in Q3 2014 (Table 8). When the dependent variable is the savings rate, $\frac{saved_{it}}{income_{it}}$, none of the coefficients are significant. As such, EU export concentration in Q3 2015, a year before the EU referendum, is used to instrument the treatment because it does not explain the variation in whether the respondent chooses to save and the savings rate they choose. Regional EU export concentration in Q3 2015 is also correlated with the treatment, as can be seen in Figure 5.

Table 8: Regression of savings on quarterly regional EU export concentration

	Two-way Fixed Effects	
	(1)	(2)
	$saves_{it}$	$\frac{saved_{it}}{income_{it}}$
EU regional export concentration		
Q3 2016	-8.359	-0.4641
	(-0.7742)	(-0.3261)
Q2 2016	4.417	-0.01562
	(0.6368)	(-0.0171)
Q1 2016	-1.140	0.3834
	(-0.1480)	(0.3774)
Q4 2015	-6.482	-0.9575
	(-0.4287)	(-0.4803)
Q3 2015	12.05	1.220
	(1.296)	(0.9962)
Q2 2015	-4.852	-0.1805
	(-0.9051)	(-0.2555)
Q1 2015	-1.880	-0.2717
	(-0.1817)	(-0.1990)
Q4 2014	7.813	0.8329
	(1.153)	(0.9328)
Q3 2014	20.21**	1.439
	(2.812)	(1.518)
Q2 2014	-12.02	-1.277
	(-1.723)	(-1.388)
Q1 2014	-0.05878	0.09945
	(-0.0051)	(0.0655)
Q4 2013	-9.297	-0.7759
	(-1.288)	(-0.8159)
n	2557	2557
N	8093	8093
T	1-5	1-5
R^2	0.005126	0.003043
Adj. R^2	-0.4600	-0.4630
F-statistic	2.367**	1.402

Significance codes: p<0.001***; p<0.01**; p<0.05*

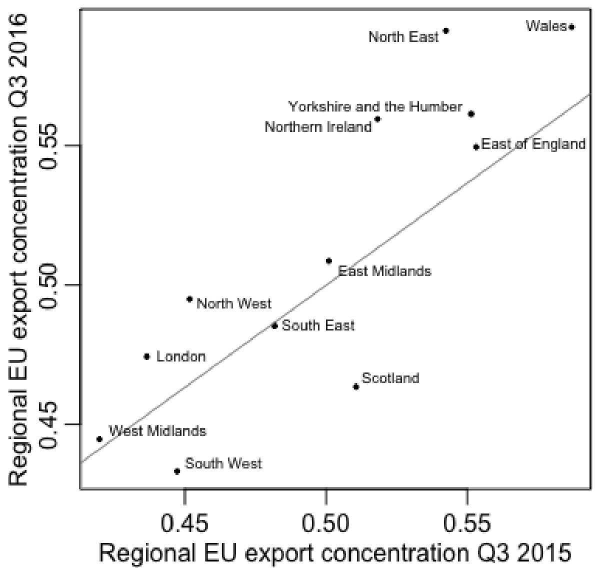
NOTES: T-statistics are reported in parentheses.

The dependent variable in (1), $saves_{it}$, is a dummy variable that is 1 if the respondent saves and is 0 if they do not save. The dependent variable in column (2), $\frac{saved_{it}}{income_{it}}$, is the ratio of monthly savings to net labour income. Note that for households that report not saving, their value for $\frac{saved_{it}}{income_{it}}$ is 0. This tables reports parameter estimates of the following specifications: $saves_{it} = \lambda_i + \delta_t + exc_{i,r,t-j}\beta + \epsilon_{it}$; $\frac{saved_{it}}{income_{it}} = \lambda_i + \delta_t + exc_{i,r,t-j}\beta + \epsilon_{it}$; for $j = 0, ..., 11$

where λ_i and δ_t are household and time-fixed effects;$exc_{i,r,t-j}$ are quarterly lags of EU export concentration in region r. Regional EU export concentration is defined as the value of exports to EU member states in period t and region r as a proportion of the value of exports to all countries at the same time and region.

SOURCE: Understanding Society survey waves 1 – 10; HM Revenue and Customs.

Figure 5: Regional EU export concentration in Q3 2015 and Q3 2016



Notes: Regional EU export concentration is defined as the value of exports to EU member states as a proportion of the value of exports to all countries.

Source: HM Revenue and Customs.

4.2 Changes in fixed characteristics and the instrument

If the instrument is picking up changes in household characteristics and job security, it is possible that this could bias the estimate of the treatment effect. To understand how changes in fixed characteristics affect the instrument, the parameters in the following equation are estimated:

$$\begin{aligned}\Delta instrument_{it} = {} & \lambda_i + \delta_t + \beta_1 \Delta nkids_{it} + \beta_2 \Delta hhsize_{it} + \beta_3 \Delta nemp_{it} \\ & + \beta_4 \Delta log(income_{it}) + \beta_5 \Delta tenure_{it} + \beta_6 \Delta hiqual_{it} + \beta_7 \Delta jbsec'_{it} \phi + \epsilon_{it}\end{aligned} \tag{18}$$

where $\Delta instrument_{it}$ is the difference between EU export concentration in Q3 2015 and Q4 2014, λ_i and δ_t are household and time-fixed effects, $\Delta nkids_{it}$ is the change in the number of children in the household from period $t-1$ to period t, $\Delta hhsize_{it}$ is the change in the number of people in the household, $\Delta nemp_{it}$ is the change in the number employed in the household, $\Delta log(income_{it})$ is the change in the logarithm of net household labour income, $\Delta tenure_{it}$ is a dummy variable that is 1 if the respondents housing tenure has changed from their previous interview and is 0 otherwise, $\Delta hiqual_{it}$ is a dummy variable that is 1 if the respondent's highest qualification has change since their last interview and is 0 otherwise. $\Delta jbsec_{it}$ is a vector of two dummy variables: one that is 1 when the respondent reports greater job security compared to their previous interview and is 0 otherwise; the other is 1 when the respondent reports greater job insecurity compared to their previous interview and is 0 otherwise.

Coefficients for the changes in the number of children, household size, the number employed in the household, income, and job security are not significant (Table 9). Changes in household tenure and the highest qualification are significant. The dummy capturing changes in household tenure is noisy, given that it is not picking up changes from, for example, renting from a private landlord to renting from a local authority (or any other possible combination of changes in housing tenure) but just a change. As such, it is not possible to determine which changes in household tenure affect the instrument and which do not. The positive coefficient on the dummy, however, does indicate that given the instrument is picking up changes in household tenure it could bias the treatment effect up. Households in which one member has stayed in education past the age of 16 have lower savings rates on average (Crossley and O'Dea, 2010). That the instrument is picking up increases in the highest qualification of the respondent, could bias the estimate of the treatment effect down.

Table 9: Regression of changes in the instrument on changes in household characteristics

	Two-way Fixed Effects
	(1)
	$\Delta instrument_{it}$
Δ Number of children	-0.0001445
	(-0.2711)
Δ Household size	0.0004153
	(1.0123)
Δ Number in employment in household	-0.0004428
	(-1.0432)
$\Delta log(income_{it})$	0.0001526
	(0.2392)
Household tenure changed from previous interview	0.001966**
	(2.627)
Highest qualification changed from previous interview	-0.003646*
	(-2.215)
Job is more secure compared to last interview	-0.001522
	(-1.103)
Job is less secure compared to last interview	0.0003285
	(0.5978)
n	2203
N	5296
T	1-4
R^2	0.004818
Adj. R^2	-0.7125
F-statistic	1.862

Significance codes: p<0.001***; p<0.01**; p<0.05*

NOTES: T-statistics are reported in parentheses.

The dependent variable is the EU export concentration in the region in which respondent i lives at time t in Q3 2015 less the EU export concentration in Q3 2014. This table reports parameter estimates for the following specification:

$$\Delta instrument_{it} = \lambda_i + \delta_t + \beta_1 \Delta nkids_{it} + \beta_2 \Delta hhsize_{it} + \beta_3 \Delta nemp_{it} + \beta_4 \Delta log(income_{it}) + \beta_5 \Delta tenure_{it} + \beta_6 \Delta hiqual_{it} + \beta_7 \Delta jbsec'_{it} \phi + \epsilon_{it}$$

where λ_i and δ_t are household and time-fixed effects, $\Delta nkids_{it}$ is the change in the number of children in the household from period $t-1$ to period t, $\Delta hhsize_{it}$ is the change in the number of people in the household, $\Delta nemp_{it}$ is the change in the number employed in the household, $\Delta log(income_{it})$ is the change in the logarithm of net household labour income, $\Delta tenure_{it}$ is a dummy variable that is 1 if the respondents housing tenure has changed from their previous interview and is 0 otherwise, $\Delta hiqual_{it}$ is a dummy variable that is 1 if the respondent's highest qualification has change since their last interview and is 0 otherwise, $\Delta jbsec_{it}$ is a vector of two dummy variables: one that is 1 when the respondent reports greater job security compared to their previous interview and is 0 otherwise, the other is 1 when the respondent reports greater job insecurity compared to their previous interview and is 0 otherwise.

SOURCE: Understanding Society survey waves 1 – 10.

4.3 Motivation for the use of fixed effects instrumental variables

4.3.1 Fixed effects instrumental variables over non-linear instrumental variables

The savings rate, $\frac{saved_{it}}{income_{it}}$, is censored at zero because the question about monthly savings in *Understanding Society*, does not allow respondents to report below zero savings. The linear probability model also has a limited dependent variable. The reasons why both models are estimated using fixed effects instrumental variables as opposed to non-linear instrumental variables are twofold. The first is that non-linear instrumental variables estimates requires that the distributional specification of the instruments must be known for the estimates to be asymptotically efficient (Newey, 1990). The distributional specification for the instruments used in this analysis is not known. The second is that non-linear instrumental variables estimation assumes the data are independent and identically distributed (iid). This assumption cannot hold in the shift-share instrumental variable setting given that data are assumed to be non-iid to allow for the observed shock (the EU referendum) to be treated as a random variable, as if arising from a natural experiment (Borusyak, Jaravel and Hull, 2020).

4.3.2 Fixed effects instrumental variables over two stage least squares

I choose to estimate the linear probability model using fixed effects instrumental variables as opposed to two stage least squares because of the possibility that the fixed effects are correlated with the instrument. I test this by regressing two stage least squares (2SLS) residuals on regional EU export concentration in Q3 2015 (the instrument). The coefficient on the instrument is significant at the 10% level and as such this provides evidence that fixed effects, which are in the 2SLS residuals, are correlated with the instrument (Table 10). The same test carried out on the model estimated using fixed effects instrumental variables (Table 13) provides evidence that the estimation method has removed fixed effects that are correlated with the instrument. Validity of the instrument is not an issue for the savings rate model when it is estimated using 2SLS. For both models, fixed effects estimation also has the advantage of controlling for the variation in the respondent's degree of risk aversion across households.

Table 10: Diagnostic tests for models estimated using 2SLS

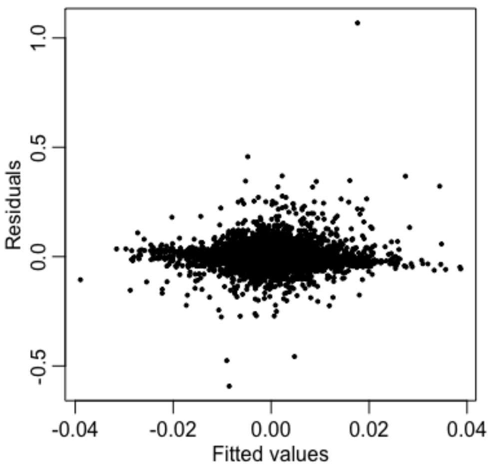
	Linear probability model		Savings rate model	
Test	Null hypothesis	p=value	Null hypothesis	p-value
Test for validity of instruments	Instrument is valid	0.0974	Instrument is valid	0.384

NOTES: The test for the validity of regresses 2SLS residuals for both models on the regional EU export concentration in Q3 2015. The p-value reported is for the hypothesis that the coefficient on the instrument is 0.

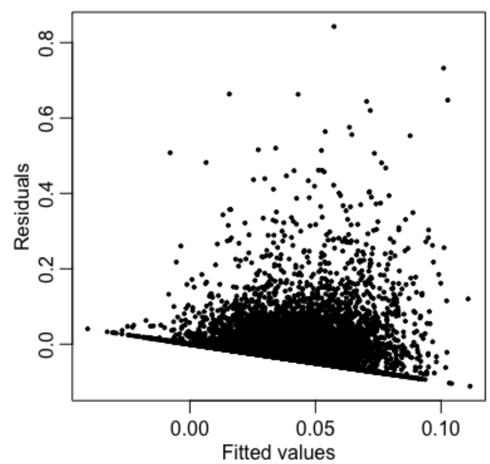
I choose to estimate the savings rate model using fixed effects instrumental variables over 2SLS because the former is a better model for forecasting. In Figure 6, the residuals for the savings rate model estimated by 2SLS are positive for the most part. It is likely that the limited dependent variable is biasing the estimate of the treatment effect up. The 2SLS estimate of the treatment effect is -7.713 $\times 10^{-3}$ (with t-statistic -1.553) compared to the fixed effects instrumental variables estimate of -0.01757 (with t-statistic -2.419). It can therefor be seen that the fitted values are mostly underestimating the observed savings rates. The residuals for the savings rate model estimated by fixed effects instrumental variables are, by contrast, scattered randomly around zero and are more 'well behaved.' This indicates that fixed effects estimation has removed the bias to the estimate of the treatment effect caused by the censored dependent variable.

Figure 6: Residual plots for savings rate model estimated using FE IV and 2SLS

(a) Fixed effects instrumental variables



(b) Two stage least squares



NOTES: These are residuals for the model: $\frac{saved_{it}}{income_{it}} = \lambda_i + \delta_t + \beta treatment_{it} + w'_{it}\gamma + jbsec'_{it}\phi + \epsilon_{it}$. The dependent variable is reported savings as a proportion of net labour income; w_{it} is a vector of household characteristics, $jbsec_{it}$ is the respondent's assessment of their job security, and λ_i and δ_t are household and time-fixed effects. The model is estimated using two-way fixed effects instrumental variables.

NOTES: These are residuals for the model: $\frac{saved_i}{income_i} = \alpha + \beta treatment_i + w'_i\gamma + jbsec'_i\phi + \epsilon_i$. The dependent variable is reported savings as a proportion of net labour income; w_i is a vector of household characteristics, $jbsec_i$ is the respondent's assessment of their job security, α is the intercept. The model is estimated using two stage least squares.

5 Results

For both dependent variables, whether the respondent saves and the savings rate, the coefficient on the treatment is significant and is negative (Table 11). The absolute value of the treatment coefficient decreases as more controls are added in the linear probability model. The treatment coefficient in the savings rate model increases when job security controls are added. The omission of controls for job security in the savings rate model biases the treatment effect down.

A negative treatment coefficient is not consistent with the predictions of theory. An explanation of this result is that regions most exposed have lower savings rates and the treatment effect is picking up that this continues after the result of the referendum is announced. Another explanation is that the treatment effect is zero but the divergence in savings in the North East in the treatment period is biasing the treatment effect down. It is unlikely that the divergence in savings rates in the North East is biasing the treatment effect towards zero. If this were the case, one would expect trends in savings rates in other regions to diverge upwards after the EU referendum. Savings rates in regions other than the North East do not diverge after the EU referendum. These results are not consistent with a short-run impact of Brexit on household savings.

The coefficients of the specifications are estimated with a change of shock definition and results are reported in Table 12. In both cases the duration of the shock increases. In the first case the duration increases to the date the Withdrawal Agreement treaty is agreed and published (14th November 2018) and in the second case to the end of the sample period, which coincides with the date the UK leaves the EU (31st January 2020). The treatment coefficients for both dependent variables are negative and their absolute value increases as the duration of the treatment period increases. This provides further evidence that the treatment is picking up that savings rates continue to decline after the EU referendum.

Table 11: Main Results

	Two-way Fixed Effects IV						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$treatment_{it}$	$saves_{it}$	$saves_{it}$	$saves_{it}$	$\frac{saved_{it}}{income_{it}}$	$\frac{saved_{it}}{income_{it}}$	$\frac{saved_{it}}{income_{it}}$
Instrument	1.018***						
	(537.8)						
Treatment		-0.1609**	-0.1561**	-0.1549**	-0.01643*	-0.01804*	-0.01757*
		(-3.085)	(-3.016)	(-2.990)	(-2.390)	(-2.471)	(-2.419)
Age	0.0002274		0.01328	0.01373		0.002407	0.001742
	(0.9374)		(1.026)	(1.061)		(1.358)	(1.055)
Number of children	-0.0001532		0.03402*	0.03362*		0.002182	0.002385
	(-0.5484)		(2.402)	(2.375)		(1.220)	(1.351)
Household size	-0.0001067		-0.03889**	-0.03839**		-0.004428**	-0.004686*
	(-0.4087)		(-3.171)	(-3.125)		(-2.396)	(-2.558)
Number in employment in household	0.00005687		0.01830	0.01858		-0.00006929	-0.001361
	(0.1839)		(1.286)	(1.306)		(-0.0332)	(-0.8421)
$log(income_{it})$	-0.0003646		0.08292***	0.08144***		-0.01526**	-0.01125***
	(-0.8802)		(4.097)	(4.013)		(-2.866)	(-3.470)
Likelihood of losing job in 12 months: Very likely	0.001679			-0.003737			0.01492*
	(1.468)			(-0.0701)			(2.129)
Likelihood of losing job in 12 months: Likely	0.00009286			0.02392			0.006291
	(0.0951)			(0.5531)			(1.135)
Likelihood of losing job in 12 months: Unlikely	0.0001772			0.02317			0.007989
	(0.1989)			(0.6486)			(1.676)
Likelihood of losing job in 12 months: Very unlikely	0.0005431			0.03415			0.008566
	(0.6164)			(0.9535)			(1.790)
n	2557	2557	2557	2557	2557	2557	2557
N	8093	8093	8093	8093	8093	8093	8093
T	1-5	1-5	1-5	1-5	1-5	1-5	1-5
R^2	0.9924	0.001699	0.008638	0.008995	0.001008	0.02145	0.02178
Adj. R^2	0.9889	-0.4621	-0.4569	-0.4575	-0.4631	-0.4380	-0.4387
F-statistic/Chisq	30239***	9.515**	48.08***	50.04**	5.714*	120.8***	122.6***

Significance codes: p<0.001***; p<0.01**; p<0.05*

NOTES: T-statistics are reported in parentheses and are computed using Arellano standard errors.

The dependent variable $saves_{it}$ is a dummy variable that is 1 if the respondent saves and is 0 if they do not save. The dependent variable $\frac{saved_{it}}{income_{it}}$ is the ratio of monthly savings to net labour income. Note that for households that report not saving, their value for $\frac{saved_{it}}{income_{it}}$ is 0. The treatment is defined as positive if the household was interviewed between the announcement of the result of the EU referendum (24th June 2016) and the day the UK Government notified the EU of its intention to leave (29th March 2017) and is 0 otherwise. When the treatment is positive, its value is the EU export concentration of the region in which the household is located in Q3 2016. Note that dummies capturing household tenure and the highest qualification of the respondent are included in regressions reported in columns (1), (3), (4), (6), and (7) but their coefficients are not reported.

SOURCE: Understanding Society survey waves 1 – 10; HM Revenue and Customs.

Table 12: Main results with a change in the length of the treatment period

	Two-way Fixed Effects IV					
	(1) $saves_{it}$	(2) $saves_{it}$	(3) $saves_{it}$	(4) $\frac{saved_{it}}{income_{it}}$	(5) $\frac{saved_{it}}{income_{it}}$	(6) $\frac{saved_{it}}{income_{it}}$
Treatment period defined from:						
24th June 2016 – 29th March 2017	-0.1549**			-0.01757*		
	(-2.990)			(-2.419)		
24th June 2016 – 14th November 2018		-0.1787***			-0.02044**	
		(-3.953)			(-2.960)	
24th June 2016 – 31st January 2020			-0.2862***			-0.03263**
			(-4.152)			(-3.273)
Age	0.01373	0.01444	0.02723*	0.001742	0.001826	0.003185
	(1.061)	(1.113)	(2.043)	(1.055)	(1.105)	(1.863)
Number of children	0.03362*	0.03306*	0.03292*	0.002385	0.002320	0.002307
	(2.375)	(2.330)	(2.325)	(1.351)	(1.316)	(1.309)
Household size	-0.03839**	-0.03794**	-0.03819**	-0.004686*	-0.004634*	-0.004667*
	(-3.125)	(-3.082)	(-3.108)	(-2.558)	(-2.524)	(-2.546)
Number in employment in household	0.01858	0.01704	0.01744	-0.001361	-0.001537	-0.0001488
	(1.306)	(1.197)	(1.225)	(-0.8421)	(-0.9500)	(-0.918)
$log(income_{it})$	0.08144***	0.08235***	0.08173***	-0.01125***	-0.01114***	-0.01120***
	(4.013)	(4.063)	(4.032)	(-3.470)	(-3.436)	(-3.457)
Likelihood of losing job in 12 months: Very likely	-0.003737	-0.004425	-0.001669	0.01492	0.01484	0.01513
	(-0.0701)	(-0.0833)	(-0.0313)	(1.898)	(1.882)	(1.920)
Likelihood of losing job in 12 months: Likely	0.02392	0.02426	0.02622	0.006291	0.006330	0.006539
	(0.5531)	(0.5588)	(0.6070)	(1.108)	(1.110)	(1.147)
Likelihood of losing job in 12 months: Unlikely	0.02317	0.02490	0.02637	0.007989	0.008187	0.008330
	(0.6486)	(0.6932)	(0.7382)	(1.557)	(1.587)	(1.616)
Likelihood of losing job in 12 months: Very unlikely	0.03415	0.03570	0.03621	0.008566	0.008743	0.008787
	(0.9535)	(0.9917)	(1.011)	(1.621)	(1.646)	(1.656)
n	2557	2557	2557	2557	2557	2557
N	8093	8093	8093	8093	8093	8093
T	1-5	1-5	1-5	1-5	1-5	1-5
R^2	0.008995	0.009857	0.01027	0.02178	0.02252	0.02249
Adj. R^2	-0.4575	-0.4562	-0.4556	-0.4387	-0.4376	-0.4376
Chisq	50.04**	55.19***	57.11***	122.6***	126.7***	126.8***

Significance codes: p<0.001***; p<0.01**; p<0.05*

NOTES: T-statistics are reported in parentheses and are computed using Arellano standard errors.

The dependent variable $saves_{it}$ is a dummy variable that is 1 if the respondent saves and is 0 if they do not save. The dependent variable $\frac{saved_{it}}{income_{it}}$ is the ratio of monthly savings to net labour income. Note that for households that report not saving, their value for $\frac{saved_{it}}{income_{it}}$ is 0. The treatment is defined as positive if the household was interviewed between the announcement of the result of the EU referendum (24th June 2016) and either: the day the UK Government notified the EU of its intention to leave (29th March 2017); the day the Withdrawal Agreement treaty was published (14th November 2018); and the end of the sample period, which coincides with the day the UK left the EU (31st January 2020). If a household is interviewed outside these periods the treatment is 0. When the treatment is positive, its value is the EU export concentration of the region in which the household is located in Q3 2016. Note that dummies capturing household tenure and the highest qualification of the respondent are included in all regression reported in this table but their coefficients are not reported.

SOURCE: Source: Understanding Society survey waves 1 – 10; HM Revenue and Customs.

5.1 Residual diagnostics

In the linear probability model, the residual contains all household-level shocks that would affect the likelihood of the respondent saving that are not systematically related to the controls. Similarly, in the savings rate model, the residual contains household-level shocks to household savings that are not systematically related to the controls. The residual plot for the linear probability model (Figure 7 (a)) shows how the residuals are clustered in several groups and are downward sloping. A large proportion of the fitted values are less than zero, which indicates that the model is misspecified. The residual plot for the savings rate model (Figure 7 (b)) shows the residuals scattered randomly around zero but their variance does not appear constant. In this case negative fitted values are not an issue because they can be interpreted as predictions of the proportion of monthly household income borrowed.

Diagnostic tests provide evidence of heteroskedasticity in savings rate model (Table 13) and homoskedasticity in the linear probability model. There is also evidence that the dependent variables of both models are stationary and that the instrument is not correlated with the estimated residuals of both models. Tests for exogeneity for both models provide evidence that the treatment is exogenous.

Table 13: Diagnostic tests

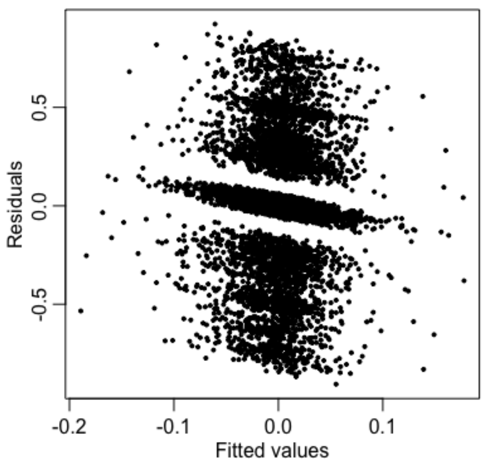
	Linear probability model		Savings rate model	
Test	Null hypothesis	p=value	Null hypothesis	p-value
Breusch-Godfrey/Wooldridge test for serial correlation	No serial correlation	$< 2.2 \times 10^{-16}$***	No serial correlation	$< 2.2 \times 10^{-16}$***
Breusch-Pagan test for heteroskedasticity	Residuals are homoskedastic	0.4848	Residuals are homoskedastic	$< 2.2 \times 10^{-16}$***
Augmented Dickey-Fuller test	$saves_{it}$ is I(1)	<0.01**	$saves_{it}$ is I(1)	<0.01**
Test for validity of instruments	Instrument is valid	0.7165	Instrument is valid	0.691
Test for strict exogeneity	$treatment_{it}$ is exogenous	0.3422	$treatment_{it}$ is exogenous	0.8116

NOTES: Significance codes: p<0.001***; p<0.01**; p<0.05*

The test for the validity of regresses fixed effects IV residuals for both models on the regional EU export concentration in Q3 2015. The p-value reported is for the hypothesis that the coefficient on the instrument is 0. Wooldridge (2012) proposes the test for strict exogeneity. It estimates the reduced form equation using two-way fixed effects: $treatment_{it} = \lambda_i + \delta_t + \alpha_1 instrument_{it} + u_{it}$. The baseline specifications are augmented with the instrument and the estimated residuals from the reduced form equation and estimated using two-way fixed effects: $saves_{it} = \lambda_i + \delta_t + \beta_1 treatment_{it} + \beta_2 instrument_{it} + w'_{it}\gamma + jbsec'_{it}\phi + \rho_1 \hat{u_{it}} + \epsilon_{it}$; $\frac{saved_{it}}{income_{it}} = \lambda_i + \delta_t + \beta_1 treatment_{it} + \beta_2 instrument_{it} + w'_{it}\gamma + jbsec'_{it}\phi + \rho_1 \hat{u}_{it} + \epsilon_{it}$ where w_{it} and $jbsec_{it}$ are covariates and λ_i and δ_t are household and time-fixed effects. P-values reported in the table are for the following hypothesis: $H_0 : \rho_1 = 0$.

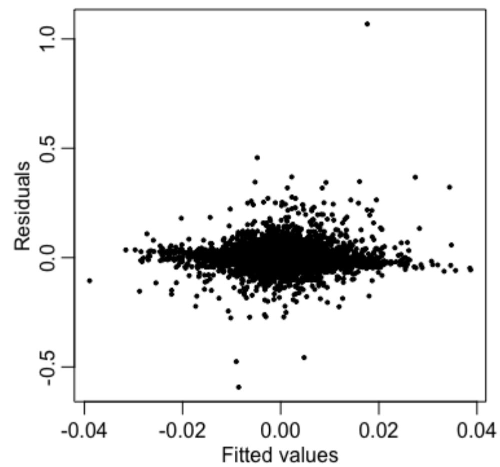
Figure 7: Residual plots

(a) Linear probability model



Notes: These are residuals for the model: $saves_{it} = \lambda_i + \delta_t + \beta treatment_{it} + w_{it}'\gamma + jbsec_{it}'\phi + \epsilon_{it}$. The dependent variable is a dummy variable that is 1 if the respondent saves and is 0 if they do not save; w_{it} is a vector of household characteristics, $jbsec_{it}$ is the respondent's assessment of their job security, and λ_i and δ_t are household and time-fixed effects. The model is estimated using two-way fixed effects instrumental variables.

(b) Savings rate model



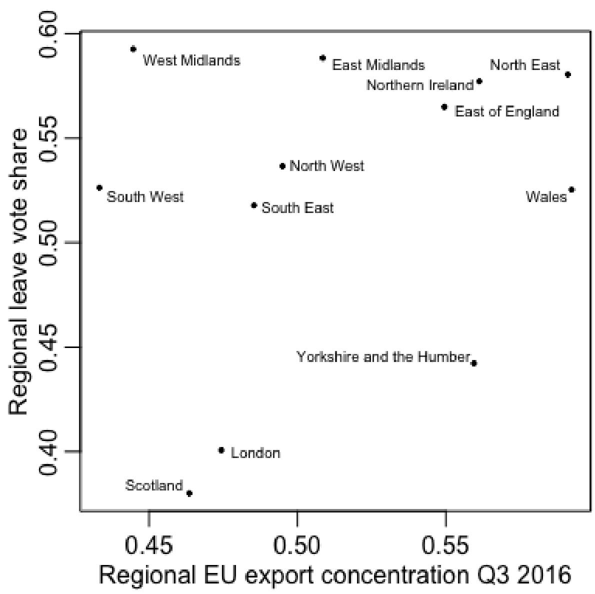
Notes: These are residuals for the model: $\frac{saved_{it}}{income_{it}} = \lambda_i + \delta_t + \beta treatment_{it} + w_{it}'\gamma + jbsec_{it}'\phi + \epsilon_{it}$. The dependent variable is reported savings as a proportion of net labour income; w_{it} is a vector of household characteristics, $jbsec_{it}$ is the respondent's assessment of their job security, and λ_i and δ_t are household and time-fixed effects. The model is estimated using two-way fixed effects instrumental variables.

5.2 Discussion

The results indicate that the result of the EU referendum did not induce a precautionary saving response. A negative treatment coefficient suggests that savings behaviour does not reflect regional exposure to Brexit. It is possible that respondents in regions that are more exposed to Brexit are more optimistic (and choose to not alter saving behaviour) and that those in the least exposed regions are more pessimistic (and choose to save more). To test this, a linear probability is estimated where the dependent variable is 1 when the respondent reported that that voted to leave the EU and 0 if the respondent reports that they voted to remain in the EU. My assumption is that respondents that voted to leave the EU are optimistic about Brexit and those that voted to remain are pessimistic. This binary variable is regressed on regional EU export concentration, a vector of household characteristics and dummies capturing the respondents' assessment of their job security.

The results in Table 14 are consistent with research into the drivers of the leave vote (Goodwin and Heath, 2016). Older respondents are more likely to have voted leave, women less likely, those on lower income more likely, and those with the least job insecurity are less likely to have voted leave. Exposure to Brexit, however, does not predict the respondent's likelihood of voting to leave the EU. Indeed, Figure 8 shows that there is no relationship between the proportion voting leave in a given region and its exposure to Brexit. Leave achieved more that 50% of the vote in the three most exposed regions but there is mixture of leave and remain majorities in the least exposed areas.

Figure 8: Regional leave vote share and regional EU export concentration



NOTES: The proportion voting leave in each region is the number of leave votes as a proportion of valid votes cast in the region. EU export concentration is defined as the value of exports from the UK to EU member states as a proportion of the value of exports to all countries. EU export concentration is used to define the exposure of a region to Brexit.

SOURCE: Electoral Commission; HM Revenue and Customs.

Table 14: Linear probability model for voting leave in the EU referendum

	Pooled OLS
	(1)
	$votedleave_{it}$
Exposure to Brexit	0.2990
	(1.201)
Female	-0.07309**
	(-3.029)
Age	0.002699*
	(2.038)
Number of children	0.02265
	(1.012)
Household size	-0.02986
	(-1.685)
Number in employment in household	0.09412***
	(3.848)
$log(income_{it})$	-0.06412*
	(-2.230)
Likelihood of losing job in 12 months: Very likely	-0.1073
	(-0.9922)
Likelihood of losing job in 12 months: Likely	-0.05524
	(-0.5895)
Likelihood of losing job in 12 months: Unlikely	-0.1229
	(-1.588)
Likelihood of losing job in 12 months: Very unlikely	-0.1729*
	(-2.251)
n	470
N	1618
T	1-5
R^2	0.1298
Adj. R^2	0.1161
F-statistic	9.500***

Significance codes: p<0.001***; p<0.01**; p<0.05*

NOTES: T-statistics are reported in parentheses.

The dependent variable, $votedleave_{it}$, is a dummy variable that is 1 if the respondent reports that they voted to leave the EU in the EU referendum and is 0 if they report voting to remain. Exposure to Brexit is defined as the EU export concentration of the region in which the respondent lives. Note that dummies capturing household tenure and the highest qualification of the respondent are included in all regression reported in this table but their coefficients are not reported.

SOURCE: Understanding Society survey waves 1 – 10; HM Revenue and Customs.

Polling carried out after the referendum paints a complex picture of how the public felt in relation to Brexit and job security. One poll found that the degree to which respondents expressed concern about their job security post EU referendum is negatively correlated with the proportion voting leave in their region (Young, 2016). If these concerns influenced savings decisions, I would expect to see a divergence of trends in savings in remain majority regions like London, Scotland, and Yorkshire and the Humber after the referendum. There is no evidence of this in the *Understanding Society* data. Another found that a plurality of leave voting respondents consider significant damage to the British economy and Brexit causing either themselves or members of their family to lose their job to be a price worth paying for bringing Britain out of the EU (YouGov, 2017). This could indicate divergence in savings trends in leave majority regions post referendum. There is no evidence of this in the data. It is likely that there is a complex interaction between beliefs about Brexit and real factors that are driving saving behaviour. To better understand this relationship would require household level data on economic variables and beliefs about Brexit, which the Understanding Society survey do not provide.

That household savings do not respond to the uncertainty shock caused by the EU referendum is consistent with Saunders' (2017) view that 'Brexit-related uncertainty probably mattered less than expected.' That there was positive growth in consumer spending in the months after the EU referendum is suggestive of no savings response to the uncertainty shock. Indeed, the proxies used to measure the shock in Brexit-related uncertainty might have over stated its magnitude. Forbes (2016) points out that 'a remain voter might believe that leaving the European Union means a lower path for economic growth [but] this lower forecast would be a deterioration in the first moment and not necessarily an increase in uncertainty.' No response in household savings to the EU referendum suggests that households did not believe that the increase in uncertainty they faced after the Brexit vote was an increase the kind of uncertainty that would affect their expected lifetime labour income. Namely, the results suggest households did not believe their jobs were at risk as a result of the Brexit vote.

6 Conclusions

There is no evidence that the result of the European Union referendum induced precautionary saving. Savings rates across UK regions are in decline in the period between 2010 and 2020. Savings are in decline in the years preceding the EU referendum and continue to decline during the period in which the uncertainty shock caused by the result of the referendum takes place. Households in regions that are most exposed to Brexit – those with higher EU export concentration – save less. There is no relationship, however, between regional exposure to Brexit and the likelihood of voting leave in the referendum. It is unlikely, therefor, that optimism about Brexit is driving households' decision to not save more after the referendum. This result is not consistent with the Brexit-vote having a short-term impact on household savings. Indeed, no precautionary saving response indicates that households did not believe that Brexit would adversely affect their job security.

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