UK Health Security Agency

Impact evaluation of a temporary raise in the wage eligibility threshold for the Test and Trace Support Payment in Bradford

Final report

Contents

Introduction

This report presents the findings from the evaluation of the impact of a temporary raise in the wage eligibility threshold for the Test and Trace Support Payment (TTSP) in Bradford. The impact analysis draws on individual-level data, provided by the Department of Health and Social Care, and other area-level statistics to explore the impact of this policy change (hereafter, the 'Bradford intervention') on outcomes relating to testing, contact-sharing behaviour, compliance with self-isolation requirements and TTSP applications. The impact of the Bradford intervention on these outcomes is estimated using 2 quasi-experimental approaches, namely difference-in-differences (DiD) and synthetic control (SC).

Background and context

The TTSP is a £500 support payment aimed at providing an incentive to self-isolate (as stipulated by the Test and Trace self-isolation requirements for those who test positive to coronavirus (COVID-19) or have been in contact with someone who did) for people who earn up to £350 a week (low-income workers) and cannot work from home due to the nature of their work. The foregone income resulting from staying at home means that low-income workers are at serious risk of not complying with the Test and Trace self-isolation requirements.

Between 10 April and 19 May 2021, the wage eligibility threshold for the TTSP was raised in Bradford from £350 to £500 (people within this income range, defined 'newly eligible' individuals, were the main target of the intervention). It was hoped that the intervention would help increase the proportions of individuals claiming and getting TTSP. Considered the higher income security deriving from getting a support payment, a higher proportion of successful TTSP claimants was expected to also increase self-isolation rates, which would in turn reduce the COVID-19 transmission rate.

In addition to the aforementioned (direct) effects, which concern newly eligible individuals, the intervention could have potentially resulted in indirect effects for other subsets of the population. For example, the positive perception of the Test and Trace work reflected in the intervention might have affected the behaviour of the Bradford population more broadly, including 'always-eligible' (earning a weekly wage of up to £350) and 'never-eligible' (above £500) individuals. Like the newly eligible group, some of the people in these 2 categories might have been encouraged by the prospect of the TTSP to come forward for testing and, for those who tested positive, to share the names of those they have been in contact with. They might have also been more likely to comply with self-isolation requirements.

This study investigates whether (and, if so, the extent to which) the Bradford intervention increased compliance with self-isolation requirements, improved contact-sharing behaviour and intensified the TTSP application process for COVID-19 cases or contacts residing in Bradford. It

also explored whether and to what extent the intervention increased testing rates (measured as the proportion who took a COVID-19 test among the population) in Bradford.

Aims of the evaluation

The impact evaluation aims to produce quantitative evidence of whether and to what extent the Bradford intervention positively affected:

- individuals' behaviour reflecting willingness to engage with Test and Trace (testing and sharing contacts).
- individuals' behaviour directly affecting COVID-19 transmission (adherence with Test and Trace self-isolation requirements)
- intervention outputs related to TTSP applications (amount of TTSP claims, including successful applications)

Methodology

We use counterfactual-based impact evaluation approaches (namely, the difference-in-differences and the synthetic control econometric methods) to estimate the impact (causal effect) of the Bradford intervention on outcomes related to testing, contact-sharing behaviour, compliance with self-isolation requirements and TTSP applications.

The findings of this report are based on the analysis of all recorded COVID-19 cases and contacts aged 18 to 67 (working age population) who reside in Bradford or other LADs. In addition to including cases or contacts who are unemployed/inactive (and some who retired before having reached state pension age), this sample suffers from the inclusion of never-eligible and always-eligible cases/contacts. Unfortunately, information about individual-level income or employment status is not available to us and this meant that these subjects cannot be excluded from the analysis. Consequently, the analysis can only explore the impact of the intervention on the Bradford population more broadly. In the attempt to increase the likelihood that the individuals used in the calculation of impact estimates are low-income workers (that is to try and exclude never-eligible individuals), we replicate the analysis using alternative samples which include only individuals who reside in the most income-deprived areas of Bradford/other LADs. For ease of exposition, this report presents and discusses impact estimates obtained based on the full-size sample (all residents of Bradford or other LADs). However, results obtained using the 2 alternative samples of individuals residing in the most deprived areas which differ noticeably from the results based on the full-size sample will be highlighted.

Structure of the report

This report is structured as follows:

- Chapter 2 briefly described the data sources, and profiles Bradford and the other LADs not exposed to the intervention in terms of key demographics and the outcomes of interest
- Chapter 3 illustrates the empirical methodologies used to estimate the impact of the Bradford intervention, namely the differences-in-differences (DiD) and the synthetic control (SC) approaches
- Chapter 4 reports and discusses the impact estimates
- Chapter 5 provides some conclusions

Data

This chapter briefly describes the data sources, explains how the samples used for impact analysis are achieved, and provides some descriptive statistics which summarise the composition of these samples in terms of relevant individual/area level characteristics.

Data sources

The sources of data used for the analysis include:

The Contact Tracing and Advice Service (CTAS) database

This contains information about all cases (individuals who tested positive to COVID-19, either PCR or LFT) and their associated contacts (people whom cases reported they have been in contact with), as shown in the contact-tracing (Test and Trace) system. An individual can have more than one record as they can appear as a case first and a contact afterwards (or vice versa), be re-infected with COVID-19 (recorded again as a case) or be reported as a contact by different cases. A person is only recorded as a contact if the case can provide their details, or if their details can be found in another way (for example from the passenger lists for international arrivals to the UK).[1]

Testing data from the National Pathology Exchange (NPEX) and Second-Generation Surveillance system (SGSS)

A database with aggregate test results from the NPEX and SGSS systems. The SGSS contains information on test-level data and individual-level tests results (non-deduplicated test results from Pillars 1, 2, and 4).[2] All polymerase chain reaction (PCR) swab tests for the wider population and lateral flow tests (LFTs) are reported by Public Health England (PHE) and Arden & GEM CSU (A&G) to Environment for Data Gathering and Engineering, who consolidate all data for the NHS Test and Trace programme for analysts to access securely.

Vaccinations database

This comes from Public Health England, who collect vaccination data through the National Immunisation Management System. This data includes vaccinations carried out on individuals, including first and second doses.

Indices of Deprivation 2019 data[3]

These include the income deprivation rank and decile of each Lower-layer Super Output Areas (LSOAs), and the average rank of income deprivation at the LAD level (this is based on the ranks of the LSOAs within in each LAD; the measure is weighted to take into account the

[1] Lists of school bubbles are not a source of information because schools do not report details to CTAS when they ask bubbles to isolate.
[2] See COVID-19 testing data: methodology note.
[3] English indices of deprivation 2019.

different populations within the LSOAs). This data is published by the Ministry of Housing, Communities and Local Government.

Population counts by age, gender, and ethnic group

Different releases from the Office for National Statistics (ONS).

Selection of the analysis samples

Five different samples are used to produce the estimates of the impact of the Bradford intervention on the 5 outcomes relating to compliance with Test and Trace self-isolation requirements, contact-sharing behaviour and TTSP applications. These 5 impact estimates (obtained by implementing the DiD estimation approach) rely data on individuals living in Bradford or another English LAD. A sixth sample (which uses the LAD instead of the individual as the unit of analysis) is used for estimation of the impact of the intervention on testing rates. As individual-level data on LAD residents who do not take a COVID-19 test are not available for analysis, estimation relies on a different estimation approach, the SC method, which uses aggregated-level data (counts on individuals who took a COVID-19 test within each LAD) for a limited number of English LADs. The 6 samples used for analysis are described below.

Five samples used for the analysis of impacts on compliance with Test and Trace self-isolation requirements, contact-sharing behaviour and TTSP applications

The 5 samples used to produce estimates of the impact of the Bradford intervention on the 5 outcomes relating to compliance with Test and Trace self-isolation requirements, contact-sharing behaviour and TTSP applications are as follows:

1. Residents of Bradford or other LADs (cases or contacts) who started self-isolating in the pre- or post-intervention period and for whom the self-isolation full compliance outcome is observed (this is the reason that this sample is smaller than the next sample). This sample is used to estimate the impact of the Bradford intervention on the outcomes ‘proportion who fully complied with self-isolation requirements.
2. Residents of Bradford or other LADs (cases or contacts) who started self-isolating in the pre- or post-intervention period (regardless of whether their self-isolation compliance outcome is observed). This sample is used to estimate the impact of the Bradford intervention on the outcomes ‘proportion who made a TTSP application’.
3. Residents of Bradford/other LADs (cases only) who were reached by Test and Trace via phone in the pre- or post-intervention period. This sample is used to estimate the impact on the proportion who shared contacts.
4. Residents of Bradford or other LADs (cases) who shared the names of one or more contacts in the pre- or post-intervention period. This sample is a subset of the

previous sample and is used to estimate the impact on the number of contacts shared.

5. Residents of Bradford or other LADs (cases or contacts) who made a TTSP application in the pre- or post-intervention period. This sample is used to estimate the impact on the proportion who made a successful TTSP application.

The 40-day period over which the intervention is in place in Bradford (10 April to 19 May 2021) is referred to as the 'post-intervention period', while the 40 days preceding the intervention (1 March to 9 April 2021) define the 'pre-intervention period'. Only individuals aged between 18 and 67 (working-age population) and who reside in Bradford or one among the other 303 English LADs are included in the analysis.[4]

In defining each sample, when multiple records are observed for an individual within the pre- or post-intervention period we retain only the first (earliest) record.[5] As an illustration, before proceeding to the exclusion of individuals with missing values on the variables of interest (individual characteristics and outcomes), the sample of individuals who started self-isolating includes 725,505 people. Of these, 608,809 (83.92%) have only one self-isolation record between the 1 March and the 20 May, 86,695 (11.95%) have 2 records (that is, 2 different self-isolation dates), 23,802 (3.28%) have 3 records, 5,320 (0.73%) have 4 records, 763 (0.11%) have 5 records, and the remaining 116 (0.01%) have 6 to 8 records.

Removing individuals with missing information on the variables considered resulted in the following sample sizes:

- 236,972 individuals who started a self-isolation period in the pre- and/or post-intervention period
- 54,536 individuals who started a self-isolation period (and for whom a self-isolation compliance outcome was observed) in the pre- and/or post-intervention period
- 81,872 individuals who were reached by Test and Trace in the pre- and/or post-intervention period
- 69,550 individuals who were reached by Test and Trace in the pre- and/or post-intervention period and shared the names of one/more contacts
- 22,246 individuals who made a TTSP application in the pre- and/or post-intervention period

[4] The 303 LADs are those resulting after excluding from the entire list of English LADs those where Test and Trace pilots were implemented in the period overlapping with the pre- or post-intervention periods (Newham, Wandsworth, Lambeth, Cannock Chase, Lichfield, East Staffordshire, South Staffordshire, Newcastle-under-Lyme, Stafford, Staffordshire Moorlands and Tamworth).

[5] Results did not change substantially when using, for individuals with multiple records before and after the intervention, their last record in the pre-intervention period and their first record in the post-intervention period. While this approach to handle multiple records is more suited to capture behavioural changes caused by the Bradford intervention (because the 2 records selected would be closer to the intervention period compared to the records chosen in the first-record approach), it cannot be used for the event study. Therefore, a first-record approach is used to implement the entire analysis.

The sample sizes given above include all individuals who reside in any of the 303 LADs used for analysis (including Bradford) at the time they become at risk (in scope for analysis, this is explain better in the next chapter) either in the pre- or post-intervention period. When the analysis uses more time periods (the event study includes up to 5 additional time periods) or uses a subset of these individuals (the 'restricted' DiD analysis uses only individuals who reside in one or some of the untreated LADs, and sensitivity checks on the definition of treated or untreated areas involve considering only those who live in the most deprived areas) sample sizes are smaller.

Sample used for the analysis of the impact on testing

The sample initially considered for estimation of the impact of the Bradford intervention on testing rates using the SC approach includes the same 303 LADs used for estimation of the DiD impacts. However, 76 LADs are excluded from the analysis because of the excessive number of missing values on at least one of the variables considered (the outcome predictors). For identification of the synthetic control unit 227 LADs are used but only 6 are retained to produce the synthetic unit (positive weights are generated only for these 6 LADs).

Descriptive statistics

Descriptive statistics aimed at illustrating the 6 samples used for analysis are presented and discussed below.

Sample of individuals who started a self-isolation period and for whom a compliance outcome is observed

Table 1.1 illustrates the characteristics of the sample of people who started self-isolating during the study period (and for whom the full compliance outcome could be established), separately for the subsets who started self-isolation in the pre- and post-intervention periods. Each subset is further broken down by individuals' residence (Bradford and other LAD). The table reports the statistical significance of the differences between Bradford and other LADs in terms of each characteristic.

Table 1.1 Characteristics of the sample of individuals who started self-isolating in the pre- or post-intervention period and with a self-isolation compliance outcome, by residence

	Pre-intervention: Bradford	Pre-intervention: other local authorities		Post-intervention: Bradford	Post-intervention: other local authorities	
Outcome						
Proportion who fully complied with self-isolation requirements	59.3	64.7	***	63.9	61.0	

	Pre-intervention: Bradford	Pre-intervention: other local authorities		Post-intervention: Bradford	Post-intervention: other local authorities	
Characteristics						
Aged 18 to 24 (%)	16.2	15.8		17.8	18.6	
Aged 25 to 34 (%)	29.0	28.2		28.4	30.9	
Aged 35 to 49 (%)	37.2	33.7	**	36.7	33.2	
Aged 50 to 59 (%)	12.5	16.1	***	11.8	12.3	
Aged 60 to 67 (%)	5.2	6.2		5.3	5.1	
Women (%)	55.3	52.4	*	53.0	49.5	
Asian/Asian British ethnicity (%)	45.3	17.5	***	36.7	26.1	***
Black/Black British ethnicity (%)	1.3	3.8	***	2.1	4.2	*
Mixed/Multiple ethnicity (%)	2.5	2.5		3.8	2.7	
Other ethnicity (%)	1.1	2.2	**	2.4	2.6	
White ethnicity (%)	49.7	74.0	***	55.0	64.3	***
Income deprivation decile 1 (%)	35.5	15.6	***	35.2	14.0	***
Income deprivation decile 2 (%)	18.3	13.1	***	15.1	12.7	
Income deprivation decile 3 (%)	14.5	12.0	**	16.0	12.1	**
Income deprivation decile 4 (%)	5.1	11.2	***	3.8	10.9	***
Income deprivation decile 5 (%)	6.4	10.0	***	6.2	10.7	***
Income deprivation decile 6 (%)	7.4	8.8		6.8	9.5	*
Income deprivation decile 7 (%)	4.1	8.2	***	5.3	7.9	*
Income deprivation decile 8 (%)	3.0	7.8	***	3.6	7.7	***
Income deprivation decile 9 (%)	2.5	6.9	***	3.3	7.0	***
Income deprivation decile 10 (%)	3.2	6.5	***	4.7	7.6	*
Positivity rate (median)	1.4	1.3	***	1.4	1.3	*
Sample size	977	38,943		338	14,278	

***, ** and *: difference in means, medians or proportions statistically significant at the 1, 5 and 10% level, respectively.

In the pre-intervention period, a lower proportion of people complied with self-isolation requirements in Bradford (59.3%) compared to other local authorities (64.7%). While the opposite is observed in the post-intervention period, the difference between the 2 proportions is not statistically significant.

Important compositional differences are also observed. For example, there appear to be a higher proportion of individuals who identify as belonging to the Asian/Asian British ethnicity group in Bradford than in other local authorities in both the pre- and post-intervention periods, the difference between the 2 proportions being more marked for the former period. The proportions of individuals residing in LSOAs in the first and third income deprivation deciles are higher for Braford than other LADs in both periods (noticeably, the proportion in the first decile is more than twice larger for the former than the latter), suggesting that the typical Bradford resident lives in a poorer area, and is therefore more likely to have a lower income, than the resident of another LAD. Therefore, we would expect Bradford to include a higher proportion of people eligible for TTSP (both before and after the introduction of the increase in the weekly wage threshold) than other LADs. This may explain the higher proportion of people in Bradford who made a TTSP application compared to other local authorities (see next Table 1.2). A higher positivity rate is observed among Bradford residents than residents of other LADs (evidence in this sense is stronger for the pre-intervention period).

Sample of individuals who started a self-isolation period

Table 1.2 profiles the sample of individuals who started self-isolating during the study period (regardless of whether a compliance outcome was observed or not for them). The proportion who made a TTSP application is much higher among residents of Bradford than people living in other LADs both in the pre- and post-intervention periods. A higher proportion from the Asian/Asian British ethnic group (and a lower proportion from the Black/Black British ethnicity group) is observed among Bradford residents compared to residents of other LADs. The proportions living in LSOAs within income deprivation deciles 1 and 2 are much higher for former group than the latter. The positivity rate is found to be higher for Bradford than other LADs.

Table 1.2 Characteristics of the sample of individuals who started self-isolating in the pre- or post-intervention period, by residence

	Pre-intervention: Bradford	Pre-intervention: other local authorities		Post-intervention: Bradford	Post-intervention: other local authorities	
Outcome						
Proportion who made a TTSP application	11.0	6.4	***	10.9	4.2	***
Characteristics						
Aged 18 to 24 (%)	14.9	15.3		16.8	17.1	
Aged 25 to 34 (%)	25.2	27.6	***	28.0	28.8	
Aged 35 to 49 (%)	38.3	34.0	***	36.4	33.9	*
Aged 50 to 59 (%)	14.3	16.0	***	13.3	14.0	

	Pre-intervention: Bradford	Pre-intervention: other local authorities		Post-intervention: Bradford	Post-intervention: other local authorities	
Aged 60 to 67 (%)	7.3	7.1		5.5	6.3	
Women (%)	49.9	49.9		51.0	48.5	*
Asian/Asian British ethnicity (%)	60.3	29.5	***	47.7	31.6	***
Black/Black British ethnicity (%)	1.3	4.8	***	2.0	5.9	***
Mixed/Multiple ethnicity (%)	2.3	2.6		2.8	3.2	
Other ethnicity (%)	1.1	2.9	***	1.9	3.7	***
White ethnicity (%)	35.0	60.1	***	45.6	55.7	***
Income deprivation decile 1 (%)	40.3	15.2	***	37.2	12.1	***
Income deprivation decile 2 (%)	21.4	13.4	***	17.4	11.9	***
Income deprivation decile 3 (%)	12.7	12.5		14.9	12.2	***
Income deprivation decile 4 (%)	4.2	11.7	***	3.9	11.5	***
Income deprivation decile 5 (%)	6.1	10.5	***	6.2	11.0	***
Income deprivation decile 6 (%)	5.4	8.7	***	7.2	9.6	***
Income deprivation decile 7 (%)	3.4	7.6	***	4.7	8.0	***
Income deprivation decile 8 (%)	1.9	7.2	***	2.7	7.5	***
Income deprivation decile 9 (%)	2.4	6.4	***	2.4	7.1	***
Income deprivation decile 10 (%)	2.0	6.9	***	3.4	9.0	***
Positivity rate (median)	1.4	1.3	***	1.4	1.3	***
Sample size	3,765	150,524		1,312	81,371	

*** and *: difference in means, medians or proportions statistically significant at the 1 and 10% level, respectively.

Sample of individuals who were reached by Test and Trace

As reported in Table 1.3, in the pre-intervention period a higher proportion of people shared contacts in Bradford when reached by Test and Trace to share contacts (87.9%) than in other local authorities (85.4%). However, the difference between the proportions who shared their contacts in Bradford and other local authorities is not found to be statistically significant in the post-intervention period.

Similarly to the samples who started a self-isolation period, the proportion who identified as belonging to the Asian/Asian British (Black/Black British) ethnicity was higher (lower) in Bradford than in other local authorities, and a much higher proportion living in poorer areas was found in Bradford compared to other LADs (in the post intervention period, 56.1% of Bradford residents

lived in an LSOA in the first 2 income deprivation deciles, compared to only 29.3% in other local authorities).

Table 1.3 Characteristics of the sample of individuals who were reached by Test and Trace to share contacts in the pre- or post-intervention period, by residence

	Pre to intervention: Bradford	Pre to intervention: other local authorities		Post to intervention: Bradford	Post to intervention: other local authorities	
Outcome						
Proportion who shared contacts	87.9	85.4	***	83.9	83.5	
Characteristics						
Aged 18 to 24 (%)	16.9	14.4	***	17.7	18.3	
Aged 25 to 34 (%)	26.4	26.4		28.9	29.4	
Aged 35 to 49 (%)	37.7	34.3	***	37.1	34.3	
Aged 50 to 59 (%)	13.2	17.7	***	11.9	12.8	
Aged 60 to 67 (%)	5.8	7.2	**	4.3	5.2	
Women (%)	55.9	53.3	**	53.4	50.2	
Asian/Asian British ethnicity (%)	43.5	13.9	***	42.1	21.7	***
Black/Black British ethnicity (%)	0.9	3.7	***	1.9	4.1	***
Mixed/Multiple ethnicity (%)	2.4	2.5		3.2	2.9	
Other ethnicity (%)	1.2	2.0	**	2.6	2.4	
White ethnicity (%)	51.9	77.9	***	50.2	68.8	***
Income deprivation decile 1 (%)	37.8	16.1	***	37.6	15.7	***
Income deprivation decile 2 (%)	17.8	13.5	***	18.5	13.6	***
Income deprivation decile 3 (%)	13.0	12.0		15.6	12.3	**
Income deprivation decile 4 (%)	5.1	11.0	***	2.6	10.6	***
Income deprivation decile 5 (%)	6.5	9.9	***	7.1	9.9	**
Income deprivation decile 6 (%)	6.6	8.7	***	5.5	8.8	***
Income deprivation decile 7 (%)	4.6	8.1	***	4.0	7.8	***
Income deprivation decile 8 (%)	3.2	7.8	***	2.6	7.6	***
Income deprivation decile 9 (%)	3.0	6.9	***	2.7	6.8	***
Income deprivation decile 10 (%)	2.4	6.1	***	3.9	6.9	***

	Pre to intervention: Bradford	Pre to intervention: other local authorities		Post to intervention: Bradford	Post to intervention: other local authorities	
Positivity rate (median)	1.4	1.3	***	1.4	1.3	
Sample size	1,612	58,326		622	21,312	

*** and **: difference in means, medians or proportions statistically significant at the 1 and 5% level, respectively.

Sample of individuals who were reached by Test and Trace and shared contacts

Table 1.4 shows the characteristics of the subset of individuals who were contacted by Test and Trace in the pre- or post-intervention period and shared one or more contacts.

Table 1.4 Characteristics of the sample of individuals who were contacted by Test and Trace in the pre- or post-intervention period and shared contacts, by residence

	Pre to intervention: Bradford	Pre to intervention: other local authorities		Post to intervention: Bradford	Post to intervention: other local authorities	
Outcome						
Number of contacts shared (mean)	3.0	2.0	***	3.0	3.0	**
Characteristics						
Aged 18 to 24 (%)	17.7	14.2	***	18.8	18.1	
Aged 25 to 34 (%)	25.8	26.4		28.7	29.1	
Aged 35 to 49 (%)	38.2	35.1	**	37.0	35.1	
Aged 50 to 59 (%)	13.0	17.5	***	11.7	12.6	
Aged 60 to 67 (%)	5.4	6.8	**	3.8	5.0	
Women (%)	57.3	54.7	*	55.4	51.9	
Asian/Asian British ethnicity (%)	43.9	13.9	***	42.3	21.7	***
Black/Black British ethnicity (%)	0.8	3.3	***	1.7	3.7	**
Mixed/Multiple ethnicity (%)	2.5	2.5		3.4	2.8	
Other ethnicity (%)	1.4	1.9		2.9	2.2	
White ethnicity (%)	51.3	78.4	***	49.6	69.7	***
Income deprivation decile 1 (%)	37.9	16.0	***	37.9	37.9	***
Income deprivation decile 2 (%)	17.8	13.3	***	18.6	13.4	***

	Pre to intervention: Bradford	Pre to intervention: other local authorities		Post to intervention: Bradford	Post to intervention: other local authorities	
Income deprivation decile 3 (%)	13.3	11.8	*	14.6	12.3	
Income deprivation decile 4 (%)	5.4	10.9	***	2.7	10.4	***
Income deprivation decile 5 (%)	6.1	9.8	***	7.1	9.6	*
Income deprivation decile 6 (%)	5.9	8.7	***	5.0	8.9	***
Income deprivation decile 7 (%)	4.6	8.2	***	3.6	7.9	***
Income deprivation decile 8 (%)	3.3	8.0	***	2.7	7.8	***
Income deprivation decile 9 (%)	3.2	7.1	***	3.3	7.0	***
Income deprivation decile 10 (%)	2.4	6.2	***	4.6	6.8	**
Positivity rate (median)	1.4	1.3	***	1.4	1.3	
Sample size	1,417	49,815		522	17,796	

***, ** and *: difference in means, medians or proportions statistically significant at the 1, 5 and 10% level, respectively.

In the pre-intervention period, a typical Bradford resident shared a higher number of contacts compared to a resident of another local authority (3 and 2 contacts, respectively). An outcome difference is detected also in the post-intervention period, although it is very small (close to 0).

Overall, in terms of the characteristics considered, the individuals who were reached by Test and Trace and shared contacts appear to be similar to the individuals included in the other samples. No strong evidence of differences in terms of gender between Bradford and other local authorities are found either in the pre- or post-intervention period, and some age differences were detected in the pre-intervention period. The proportion of people who identify as being part of the Asian/Asian British ethnic group is much higher in Bradford compared to other local authorities (at the same time, Bradford shows a much lower proportion who identifies as belonging to the Black/Black British ethnic group). Bradford is also found to have a higher proportion of individuals living in poorer areas (first 2 income deprivation deciles) compared to other local authorities in both periods.

Sample of individuals who made a TTSP application

Table 1.5 illustrates the characteristics of the sample of people who made a TTSP application before and/or after the introduction of the Bradford intervention, by residence.

Table 1.5 Characteristics of the sample who made a TTSP application in the pre- or post-intervention period, by residence

	Pre to intervention: Bradford	Pre to intervention: other local authorities		Post to intervention: Bradford	Post to intervention: other local authorities	
Outcome						
Proportion who made a successful TTSP application	57.7	46.3	***	64.3	49.9	***
Characteristics						
Aged 18 to 24 (%)	15.8	15.1		19.3	15.5	*
Aged 25 to 34 (%)	28.0	31.2	*	26.7	31.8	*
Aged 35 to 49 (%)	44.7	38.6	***	41.3	39.3	
Aged 50 to 59 (%)	9.4	12.1	**	9.0	10.8	
Aged 60 to 67 (%)	2.1	3.0		3.7	2.6	
Women (%)	38.8	46.5	***	38.2	43.1	*
Asian/Asian British ethnicity (%)	57.5	22.3	***	54.0	29.9	***
Black/Black British ethnicity (%)	0.8	5.4	***	0.9	5.0	***
Mixed/Multiple ethnicity (%)	2.9	2.9		2.2	2.7	
Other ethnicity (%)	1.0	2.6	**	1.2	2.9	*
White ethnicity (%)	37.9	66.8	***	41.6	59.6	***
Income deprivation decile 1 (%)	41.7	22.4	***	51.9	22.9	***
Income deprivation decile 2 (%)	26.2	16.9	***	20.2	18.6	
Income deprivation decile 3 (%)	13.3	14.7		9.3	14.2	**
Income deprivation decile 4 (%)	3.8	11.8	***	3.4	11.3	***
Income deprivation decile 5 (%)	5.6	9.5	***	5.3	9.4	**
Income deprivation decile 6 (%)	4.0	7.5	***	0.1	7.5	***
Income deprivation decile 7 (%)	2.2	6.1	***	1.2	5.3	***
Income deprivation decile 8 (%)	0.8	4.8	***	2.5	4.9	**
Income deprivation decile 9 (%)	1.8	3.8	***	1.6	3.4	*
Income deprivation decile 10 (%)	0.6	2.7	***	1.2	2.5	
Positivity rate (median)	1.4	1.3	***	1.3	1.3	
Sample size	626	15,356		322	5,942	

***, ** and *: difference in means, medians or proportions statistically significant at the 1, 5 and 10% level, respectively.

In the post-intervention period, a higher proportion is found to have made a successful TTSP application in Bradford (64.3%) compared to other local authorities (49.9%). A similar result is observed in the pre-intervention period, although the outcome difference is smaller than in the post-intervention period.

Overall, the composition of the sample of individuals who made a TTSP application is similar to that of the other samples (for example, higher proportions of people of Asian/Asian British ethnicity and living in poorer areas in Bradford compared to other LADs). However, a difference is that a lower proportion of women is observed in Bradford than in other areas.

Sample of LADs used for the estimation of the impact on testing

The rationale for creating a synthetic unit by weighting some of the LADs where the intervention did not take place to estimate the impact of the Bradford intervention is shown in Figure 1.1, which compares the evolutions of the testing rate for Bradford and of the (average) testing rate for other LADs. The vertical line in the graph indicates week 59, at the start of which the intervention was introduced in Bradford. It is clear from the figure that, at each time point considered, a simple average of the testing rates across all LADs other than Bradford is not representative of the testing rate in Bradford. Testing rates evolved in a different way for different LADs, and it is possible that during particular time periods/at specific time points testing rates in some LADs are closer to testing rates in Bradford.

Figure 1.1 Testing rates in Bradford and other LADs

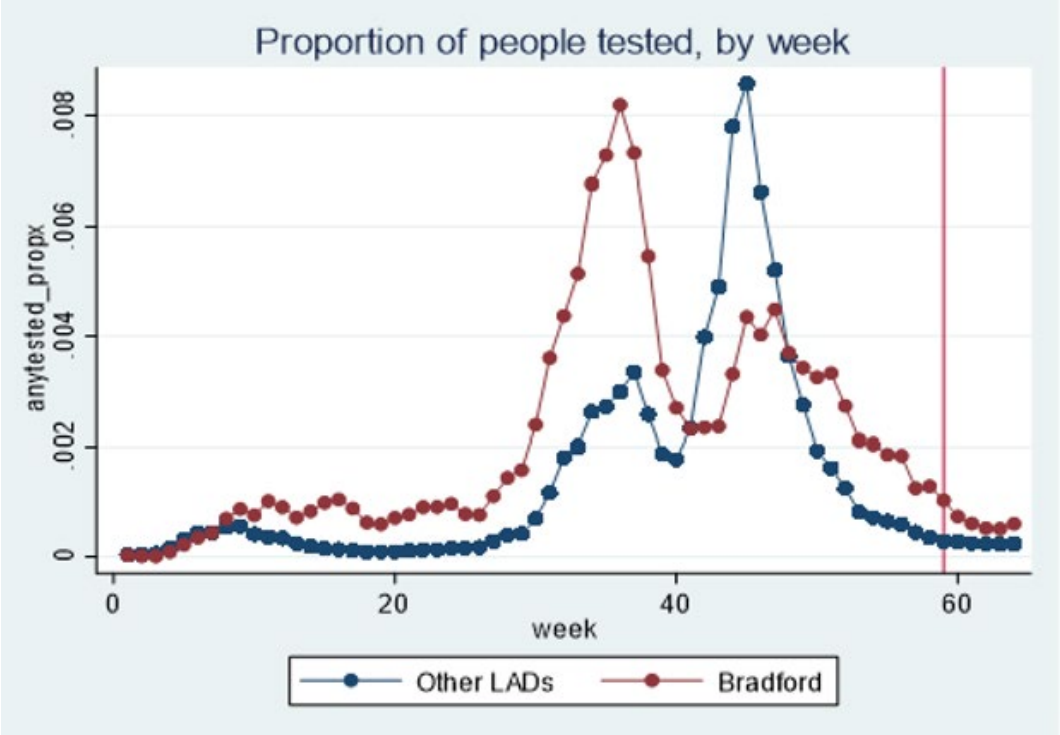
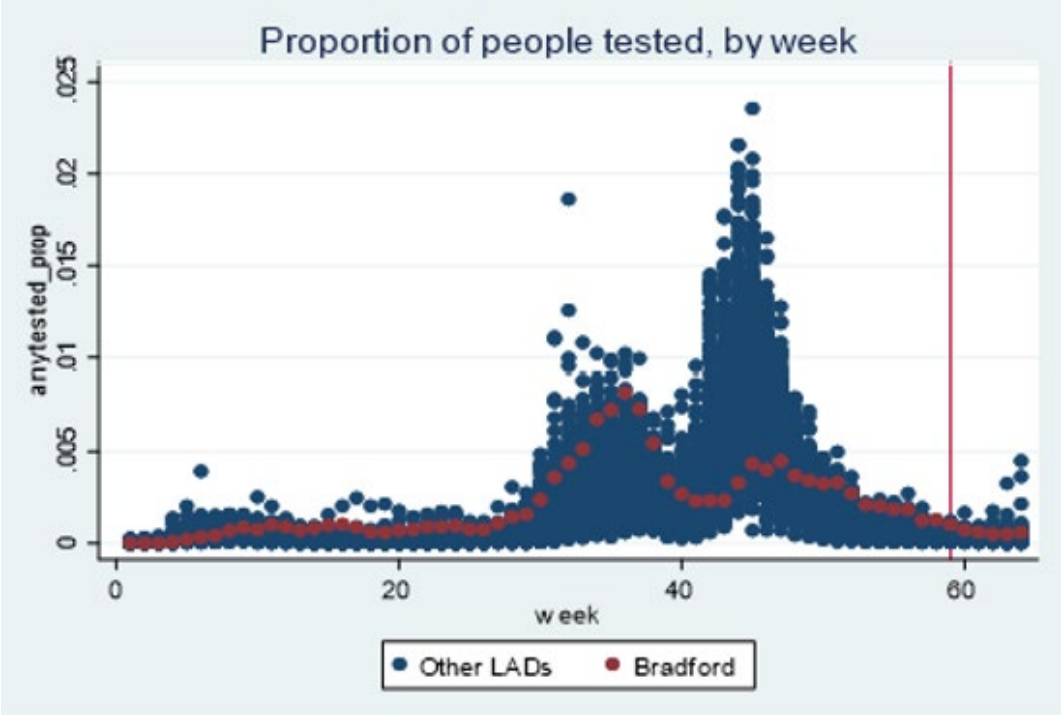


Figure 1.2, which compares the evolutions of testing rates in Bradford and each of the other LADs (there are too many LADs for single evolutions to be distinguishable), shows that the testing rate corridor formed by testing rates for other LADs includes the evolution of the testing

rate for Bradford. The fact that Bradford's trend does not lie outside the corridor is reassuring in that it should be possible to obtain a weighted combination of testing rates from other LADs to form a 'synthetic Bradford' that acts as Bradford in the absence of the intervention.

Figure 1.2 Testing rates in Bradford and other LADs



Two important facts are highlighted by the graphs. The first, shown by Figure 1.1, is that Bradford's testing rate started to converge towards the general trend (average testing rate across all LADs) since week 51 (around 2 months before the introduction of the intervention): testing rates in Bradford reduced over time like in all other LADs. Therefore, the prima facie evidence is that the Bradford intervention had no positive effect of (that is, it did not cause an increase in) testing rates. The second is that, contrary to Bradford, some LADs did experience an increase in testing rates in the period after the introduction of the intervention in Bradford (see Figure 1.2). This consideration has implications for the analysis and will be discussed in the Impact estimates section.

In addition to differences in terms of past testing rates, it is important to explore whether Bradford and other LADs differ in other important respects. As illustrated in Table 1.6, in a typical week prior to the intervention, a lower proportion of the population was vaccinated in Bradford compared to other LADs (this may possibly reflect the lower positivity rate observed for the former compared to the latter).[6] A higher LSOA income deprivation rank means (due to the way this variable has been constructed) that Bradford residents lived in more income-deprived

[6] For each LAD, the positivity rate is calculated as the ratio of the number of people found positive to COVID-19 at a given week to the number of people who were tested in the same week. By construction, the positivity rate varies on a weekly basis for all LADs (week 59 is the week the intervention started, week 58 is the week before and so on). For each individual, we used the weekly rate observed immediately before (to 7 days before, the number of days varies for each individual depending on when) they become at risk of experiencing the outcome considered.

LSOAs compared to other LADs. Bradford also had higher proportions from Asian, mixed, and other ethnicities. There are no noticeable differences between Bradford and other LADs in terms of gender and age composition.

Table 1.6 Characteristics of Bradford and other LADs

	Bradford	All LADs
Female (%)	50.2	50.3
Aged 18 to 24 (%)	13.9	12.6
Aged 25 to 34 (%)	21.2	20.4
Aged 35 to 49 (%)	32.3	30.9
Aged 50 to 59 (%)	19.8	22.1
Aged 60 to 67 (%)	12.8	14.1
White ethnicity (%)	65.1	86.5
Black ethnicity (%)	2.1	3.0
Asian ethnicity (%)	28.7	7.2
Mixed ethnicity (%)	2.4	2.0
Other ethnicity (%)	1.7	1.0
Has received the first dose of vaccine (average % over weeks 41 to 58)	18.0	19.0
Average LSOA income deprivation rank	21,639.97	15,341.23
Positivity rate (average rate over weeks 13 to 58)	1.162	1.239

Empirical methodology

This chapter illustrates the 2 econometric approaches used to estimate the impact of the temporary raise in the TTSP wage eligibility threshold in Bradford (referred to as the 'intervention'), namely, the difference-in-differences (DiD) and synthetic control (SC) approaches. Each approach estimates the impact of the intervention on a specific outcome or set of outcomes.

Difference-in-differences approach

Overview of the approach

The DiD approach is used to estimate the impact of the Bradford intervention on the following 5 outcomes relating to compliance with self-isolation requirements, contact-sharing behaviour and TTSP applications:

1. Proportion who complied with self-isolation requirements: This is the proportion, among individuals who start self-isolating (and had a self-isolation compliance outcome reported), who stayed at home during the 10 days after contracting COVID-19 or having been in contact with a COVID-19 case. An individual is considered as having complied with self-isolation requirements if successful outcomes are reported for them in relation to the 3 Test and Trace calls on self-isolation days 4, 7 and 10.[7]
2. Proportion who shared contacts: This is the proportion, among individuals reached by Test and Trace to share contacts (that is, provide the names of those whom they have been in contact with after contracting COVID-19), who provided details of one or more contacts.[8]
3. Number of contacts shared: The number of contacts shared by an individual (calculated among the subset who shares contacts).
4. Proportion who made a TTPS application: The proportion, among all individuals (cases or contacts) who self-isolated, who made a TTSP application.[9]
5. Proportion who made a successful TTPS application: The proportion, among all individuals (cases or contacts) who made a TTSP application, who get a TTSP payment.

The impact of the Bradford intervention is estimated by comparing the outcome of interest for a cohort of individuals who become at risk of experiencing that outcome between 10 April and 19 May 2021 (the 40-day period over which the intervention is in place in Bradford) with the

[7] The analysis of the impact of the intervention on the self-isolation compliance outcome includes COVID-19 cases and contacts. It does not include those who self-isolate after experiencing COVID-19 symptoms, unless they are subsequently classified as COVID-19 cases (that is, it is ascertained they contracted COVID-19). Individuals who were reported to have been non-compliant on any of the 3 calls were coded as non-compliant while individuals for whom calls are not recorded are excluded from the analysis.
[8] The estimation of impacts on contact-sharing outcomes (whether the individual shares contacts and, if they do, the number of contacts shared) relies only on COVID-19 cases. In general, contacts are not reached by Test and Trace to provide names of contacts.
[9] We considered only applications made within 42 days after self-isolation start date as this is in line with the TTSP application requirements.

outcome observed for a cohort of individuals who become at risk of experiencing the same outcome between 1 March and 9 April 2021 (the 40 days preceding the pilot). These 2 cohorts are referred to as the post- and pre-intervention cohorts, respectively. Impact estimation also relies on observing, separately for each cohort, outcomes for 2 subsets: individuals who reside in Bradford (the 'treated' area) and those who live in other LADs ('untreated' areas).

Essentially, the DiD approach calculates the impact of the Bradford intervention as the difference between the (average) outcome change experienced among Bradford residents in the period before and after the introduction of the intervention and the correspondent before-after outcome change observed among residents of other LADs (where no similar interventions took place).[10] The DiD estimation requires observing outcomes for 4 groups of individuals defined by the cohort to which they belong (that is, whether they become at risk of experiencing the outcome in the post- or pre-pilot period) and whether they reside in Bradford or other LAD. Figure 1.3 provides an illustration of how the DiD approach estimates the impact of the intervention on outcome 1, 2, 4 or 5.

Figure 1.3 An illustration of the DiD estimator

	Pre-intervention period (1 March to 9 April 2021)	**Post-intervention period (10 April to 19 May 2021)**
Bradford (treated area)	Outcome A: Pre-intervention cohort (Bradford)	Outcome B: Post-intervention cohort (Bradford)
Other LADs (untreated areas)	Outcome C: Pre-intervention cohort (other LADs)	Outcome D: Post-intervention cohort (other LADs)

For example, the impact of the intervention on the proportion, among Bradford residents who start a 10-day self-isolation period and for whom the compliance outcome is observed (the 'at risk' population), who fully complied with self-isolation requirements (the outcome) is estimated as the double difference (B-D)-(A-C), where:

- B is the proportion, among Bradford residents who started self-isolating in the post-intervention period, who fully complied with self-isolation requirements
- D is the proportion, among residents of other LADs who started self-isolating in the post-intervention period, who fully complied with self-isolation requirements
- A is the proportion, among Bradford residents who started self-isolating in the pre-intervention period, who fully complied with self-isolation requirements
- C is the proportion, among residents of other LADs who started self-isolating in the pre-intervention period, who fully complied with self-isolation requirements

[10] It is important to note that the individuals who form the post-intervention cohort are not the same as those included in the pre-intervention cohort, for example, Bradford residents observed before the introduction of the raise in the TTSP wage eligibility threshold are not the same Bradford residents observed after the policy change is introduced. This means that DiD relies on repeated cross-sections rather than panel data.

The DiD approach is used in the same way for estimation of the impacts on the proportions who shared contacts, made a TTSP application and made a successful TTSP application, in which case the at-risk populations include all those who were reached by Test and Trace to share contacts, those who started a self-isolation period and those who made a TTSP application, respectively, either in the pre- or post-intervention period. When the outcome considered is the number of contacts shared, the average number of contacts observed for each of the 4 groups (instead of a proportion) is used to implement DiD. The analysis of the impact of the Bradford intervention on the number of contacts shared relies on a subset of the cohort used for the assessment of the impact of the intervention on the proportion sharing contacts (this cohort includes people who shared contacts and people who did not share contacts).

A naive DiD estimate of the impact of the Bradford intervention can be obtained using the figures reported in Table 2.1. For example, the impact on the proportion who fully complied with self-isolation requirements can be calculated as (63.9-61) -(59.3-64.7) =8.3ppts. However, this estimate would not account for the fact that in the period before and after the introduction of the intervention the individuals used for estimation vary in terms of some of the characteristics considered. The DiD estimation approach is therefore implemented within a regression framework, as this approach allows for differences among individuals in terms of relevant characteristics (their age, gender, ethnicity, income deprivation decile of the LSOA where they reside and positivity rate of their LAD) to be accounted.[11]

Testing the parallel trend assumption

The validity of the DiD approach crucially relies on the 'parallel trend' assumption. This assumption stipulates that, in the absence of the Bradford intervention, the post-intervention outcomes for Bradford and other LADs would have evolved in parallel. While this assumption is untestable, historical data can be used to explore the extent to which it is plausible. Essentially, if a parallel trend is observed in the past (before the introduction of the Bradford intervention) it is reasonable to assume that the same trend would have continued after the introduction of the intervention. The existence of a parallel trend in the past is explored using an 'event study' approach, which involves implementing the following regression model:[12]

$$Y_{its} = \gamma_s + \lambda_t + \sum_{\tau=-6}^{-1} \gamma_\tau D_{i\tau s} + \delta_{\tau=0} D_{i\tau s(\tau=0)} + x_{its} + \varepsilon_{its}$$

[11] A typical 2-period (one pre-intervention period and one post-intervention period) DiD regression involves using the individual outcome (for example, whether someone complied with self-isolation requirements or the number of contacts they shared) as the dependent variable, and regressing it on the following independent variables: a binary variable indicating whether the individual is observed (that is, becomes at risk of experiencing the outcome) in the post-intervention period as opposed to the pre-intervention period, a binary variable denoting whether they live in Bradford as opposed to other LADs, and an interaction term which results from multiplying the post-intervention and the area binary variables. The coefficient of the interaction term provides a measure of the impact of the Bradford intervention.

[12] See section 9.4.3 of The Mixtape (Cunningham, 2021).

where *Y* denotes the outcome of interest (proportion who complied with self-isolation requirements, proportion who made a TTSP application, and so on) for individual *i* who resides in LAD *s* in time period *t* (where *t*=0 indicates the 40 days after the introduction of the Bradford intervention, and *t*=-1, -2,…,-6 indicate the 40-day period before the introduction of the Bradford intervention, the 40-day period between 40 and 80 days before the introduction of the intervention,…, and the 40-day period between 200 and 240 days before the introduction of the intervention), γ_s and λ_t denote LAD- and time period-specific effects, respectively, γ_τ represents a set of coefficients indicating the anticipatory effects of the Bradford intervention and δ_τ is the post-intervention effect. Importantly, δ_τ is the DiD estimate calculated using time periods 0 and -1 as the post- and pre-intervention periods, respectively.

As this estimate can differ from the 2-period DiD estimate (described in Footnote 9) both estimates will be reported. $D_{i\tau s}$ indicates a set of treatment dummy variables, one for each lagged time period τ $(\text{where } \tau = -1, -2, \ldots, -6)$ and one for the post-intervention period $\tau = 0$. These variables are coded as 1 if the individual resides in Bradford in time period τ or 0 if they live in another LAD. The coefficient of each lag (-1, -2, …, -6) denotes the DiD impact (or anticipatory effect) over a specific pre-intervention time period. In practice, one lag must be omitted (we have chosen lag -1) so that the coefficients for all other lags can be interpreted as impacts relative to lag -1. For example, $\gamma_{\tau=-2}$ is a DiD estimate which uses -1 as the post-intervention and -2 as the pre-intervention time periods (or vice versa, the order does not change one's conclusions in terms of evidence of an anticipation effect, in the example between time periods -2 and -1).

A lack of evidence of anticipatory effects (no statistically significant coefficients for all lags -1 to -6) would reflect very compelling evidence of a parallel trend between the outcomes of Bradford and other LADs prior before the introduction of the Bradford intervention. However, we will also consider evidence of a parallel trend in the period immediately before the introduction of the Bradford intervention (reflected by a small and/or not statistically significant coefficient for lag -2) as evidence (albeit not very strong) which justifies the use of the DiD estimation approach.

The results of the event study, reported in Figure 1.4, suggest the following:

Proportion who fully complied with self-isolation requirements

A parallel trend existed (that is the difference between the proportions observed in Bradford and other LADs was constant) over the pre-intervention time span between time periods -2 and -1 (this is denoted by a very small coefficient for lag -2, close to zero, which is also not statistically significant). Non-parallel trends were detected for earlier periods (the coefficients for lags -3, -4 and -5 are quite large and all statistically significant).

Proportion who made a TTPS application

The proportions for Bradford and other LADs initially developed in a parallel fashion (as suggested by the coefficients for lags -3 and -4, which are small and/or not statistically significant) but in the period immediately before the introduction of the intervention there is no

evidence of a parallel trend (the coefficient for lag -2 is positive and statistically significant). This is the opposite result to the self-isolation compliance outcome.

Proportion who shared contacts

We find no evidence of a parallel trend prior to the introduction of the Bradford intervention (as indicated by the negative and relatively large coefficients for lags -2 and -3, which are found to be statistically significant).

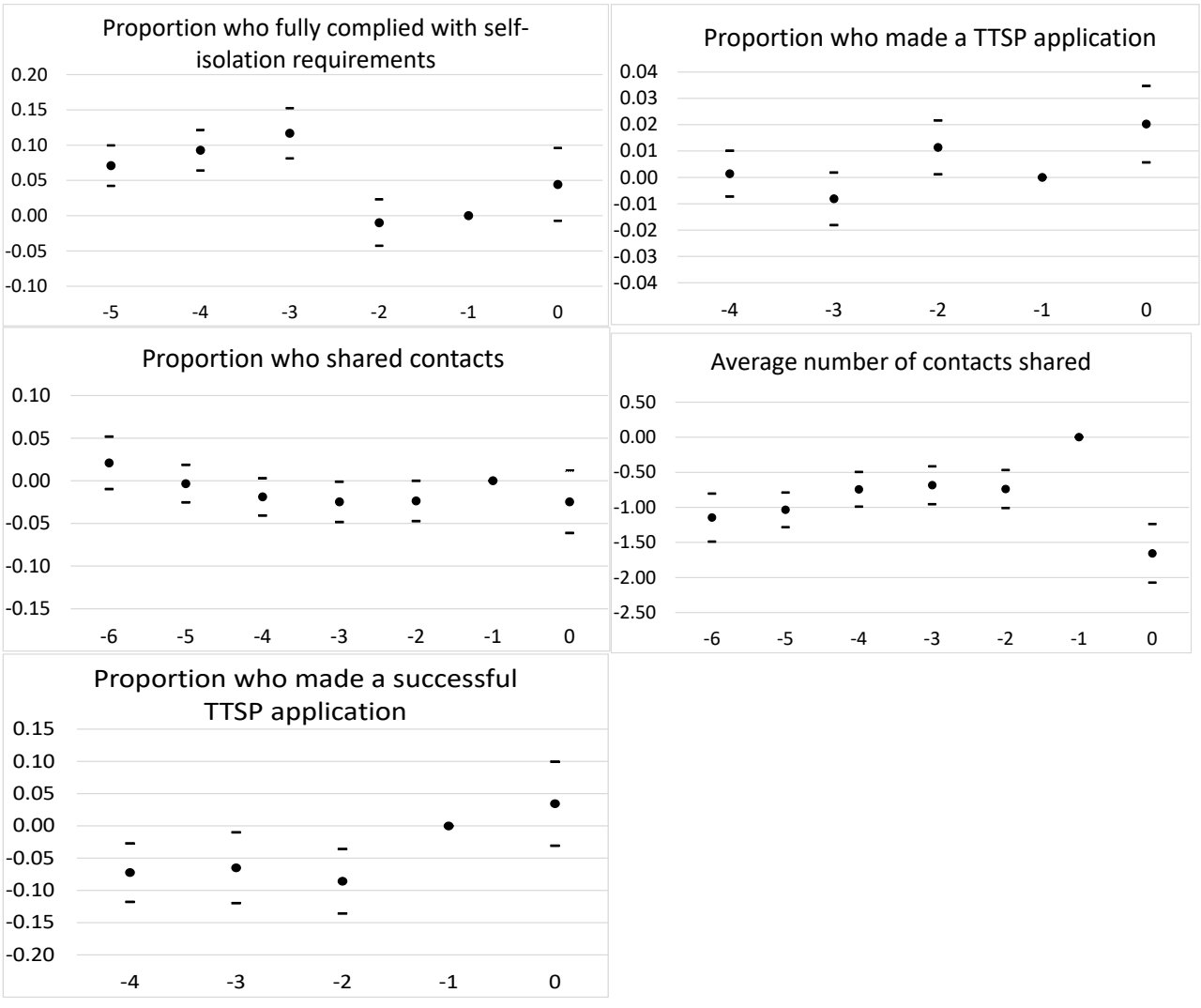
Number of contacts shared

There is very strong evidence against a parallel trend between Bradford and other LADs over the entire pre-intervention period (the coefficients for all lags from -6 to -2, which are negative in sign, are statistically significant).

Proportion who made a successful TTPS application

The findings are strongly suggestive of a non-parallel trend before the introduction of the intervention in Bradford (the negative coefficients for lags -2 to -4 are all statistically significant).

Figure 1.4 Testing the existence of a parallel trend between Bradford and other LADs prior to the Bradford intervention



To sum up, the parallel trend assumption is untenable (there is no, or no convincing, empirical evidence of a parallel trend before the introduction of the Bradford intervention) for 4 of the 5 outcomes considered, namely, the proportions who shared contacts, made a TTSP application and made a successful application, and the number of contacts shared). This means that the DiD approach using all LADs would not provide a reliable approach to estimate the impact of the Bradford intervention. Therefore, for these outcomes we rely on alternative estimation strategies to estimate impacts, namely, a 'restricted' DiD which uses only one or some untreated LADs to estimate impacts and a synthetic control approach.

There is evidence of a parallel trend immediately prior to the introduction of the Bradford intervention for the outcome 'proportion who fully complied with self-isolation requirements.' Therefore, for this outcome, a DiD approach which relies on all LADs (to reflect the approach used for the event study, which provided evidence in support of a parallel trend) could be used to estimate impacts. However, as evidence of a parallel trend is not very strong, the DiD estimate should be considered with some caution. To improve on the reliability of the results, we will rely on alternative estimation strategies also for this outcome.

Note that the above results are based on samples which include all residents of Bradford or other LADs (we call them 'full-size' samples). We explored the sensitivity of the results to this sample definition by replicating the event study using 2 alternative samples: the subset who reside in LSOAs included in income deprivation deciles 1 and 2, and the subset who reside in the most income-deprived LSOAs.[13] This is because these 2 alternative samples may be better suited to capture low-income individuals, which are those most likely to be affected by the intervention (direct and indirect impacts).

The results of these sensitivity tests are reported in Annexe A2. While, in the main, they confirm the findings of the event study based on the full sample (results for the sample 'individuals who live in LSOAs in income deprivation deciles 1 and 2' are the same as those for the full sample), it is interesting to note that for the 'most income-deprived LSOAs' sample (including only the subset of individuals who reside in the most deprived LSOAs within income deprivation decile 1) an anticipatory effect is detected in the immediate pre-intervention period for the outcome 'proportion who fully complied with self-isolation requirements', which denies support to the parallel trend assumption (albeit the coefficient for lag -2 is statistically significant only at the 10% level), and no anticipatory effect (lag -2) is found for the outcomes 'proportion who made a successful TTSP application' and 'proportion who shared contacts' which suggests that the parallel trend assumption is a plausible one when the impact of the Bradford intervention on these 2 outcomes for individuals who live in areas with the highest income deprivation.

[13] Annexe A1 explains how the subset of individuals who reside in the most income-deprived LSOAs is defined.

Synthetic control approach

Overview of the approach

The SC method is used to estimate the impact of the Bradford intervention on testing rates. The testing rate is defined as the proportion, among the Bradford population aged 18 to 67, who took any COVID-19 test (a PCR test or an MLT test, or both) within a given week.[14]
The SC approach estimates the impact of the Bradford intervention by comparing the evolution of the testing rate for Bradford to the evolution of the testing rate for a 'synthetic control' unit over the period following the introduction of the intervention (the post-intervention period starts on 10 April and ends on 19 May 2021, almost 6 weeks). The synthetic control unit is constructed by using a weighted combination of some LADs which (jointly) resemble Bradford in terms of the testing rate predictors. The predictors include the proportion of the LAD population who is of female gender, the proportions aged 18 to 24, 25 to 34, 35 to 49, 50 to 59 and 60 to 67, the proportions who are of white, black, Asian, mixed and other ethnicity, the proportion who has been vaccinated up to that week (first dose), the positivity rate (calculated as the proportion, among those who had a PCR test during the week, who turned out to be positive to COVID-19) and the lagged (past) values of the outcome variable (testing rate).

Finding a good synthetic control unit means finding a weighted combination of some LADs for which, prior to the introduction of the intervention, testing rate evolved in a similar fashion to Bradford (ideally, the past trends in testing rates for Bradford and the synthetic control unit should overlap). This would provide reassurance that the evolution of the testing rate observed after the 9 April 2021 for such a synthetic unit provides a reliable estimate of the counterfactual, that is, the testing rate that would have been observed in Bradford in the absence of the intervention.

Using the SC approach to identify comparator LADs for DiD estimates

The SC method is employed also to explore the existence of suitable comparator LADs that can be used to implement 'restricted' DiD estimates for each of the 4 outcomes for which a parallel trend prior to the introduction of the intervention was not detected (and also for the outcome 'full compliance with self-isolation requirements', as evidence of a parallel trend is not very strong).

For each outcome, the synthetic control (SC) approach is implemented to identify those LADs which resemble Bradford in terms of lagged (pre-intervention) outcome and other outcome predictors (for these LADs positive weights are produced). We then plot the pre-intervention outcome trends for Bradford and the LADs with the highest weights (we limit the number of LADs explored because in some instances all/most LADs are assigned positive weights), and visually inspect these trends to ascertain whether the pre-intervention outcome trend of any

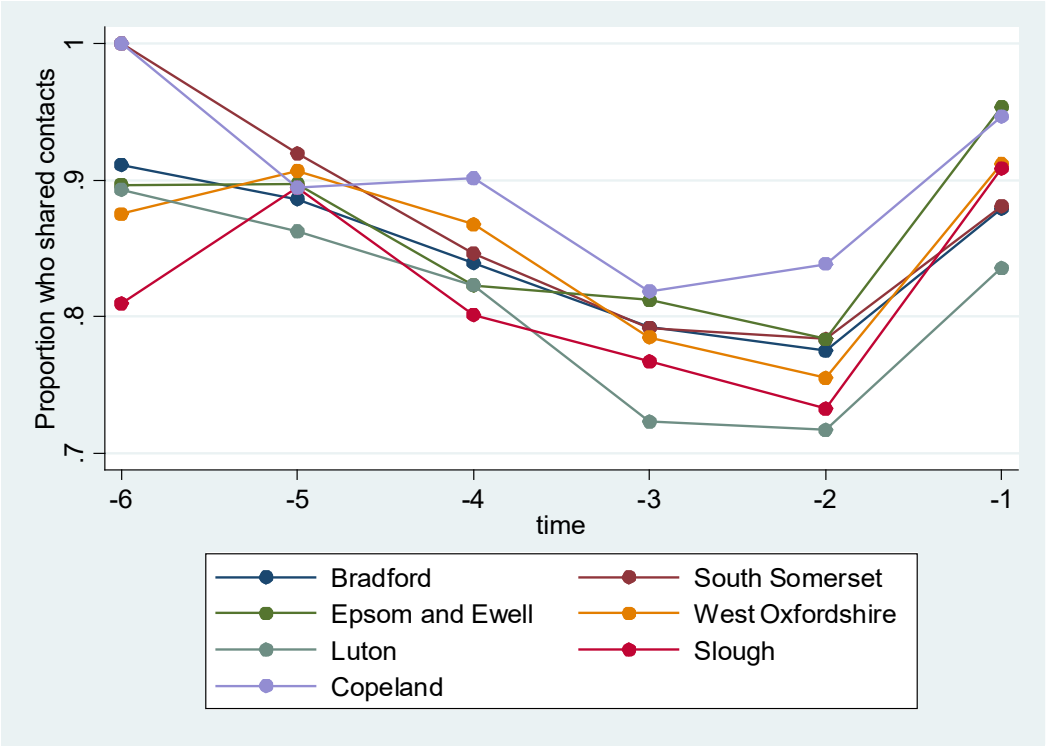
[14] Week 59 starts on the first day of the intervention (10 April 2021) and marks the start of the post-intervention period over which impacts are explored. Considering only PCR tests in the derivation of testing rates is unlikely to change the results of the analysis as the distribution of the proportion who took a PCR test over time overlaps with the distribution of the proportion who took any test.

LAD is either overlapping or parallel to the outcome trend for Bradford. The comparator LAD which satisfies this criterion more closely is identified (we will call it the 'best comparator') and an event study is implemented using only individuals from Bradford and individuals from the best comparator LAD. If the event study provides evidence of a parallel trend, a 'restricted' DiD (including only individuals from Bradford or the selected comparator LAD) is considered as more reliable than the DiD estimate based on the full sample. We also conduct event studies using (instead of the best comparator) the LAD with the highest SC weight, and all (or some of the) LADs with positive weights.

For example, for the outcome 'proportion who shared contacts' we implement the SC method using the proportions who shared contacts in time periods -1, -2, -3, -4, -5 and -6 (lagged values of the outcome) and the following outcome predictors: the proportions of the LAD population who were (averages across the 6 lagged periods) women, of white, black, Asian, mixed and other ethnicity, and average values (across the same 6 time periods) of the individuals' age at the time they were reached by Test and Trace to share contacts and of the positivity rate in the week before being reached by Test and Trace.[15] These are the same variables capturing the impact confounders controlled for in the DiD analysis. The LADs with the 6 highest SC weights are South Somerset (with weight 0.282), Epsom and Ewell (0.118), West Oxfordshire (0.040), Luton (0.031), Slough (0.017) and Copeland (0.012). Comparing the pre-intervention outcome trends of these LADs with the correspondent outcome trend for Bradford (see Figure 1.5) suggests that, overall, South Somerset is the area which resembles Bradford closest in terms of the proportion who shared contacts over the pre-intervention period (outcomes for Bradford and South Somerset show a reasonable overlap between time periods -1 and -4).

[15] For the outcome 'proportion who made a TTSP application' we used 4, rather than 6, time periods (-1, -2, -3 and -4) as applications could be made only starting from some time in time period 5 (therefore, no applications were observed in time period -6 and the number of applications made in time period -5 was much smaller, and therefore not comparable, to the numbers made in other periods). For the outcome 'proportion who fully complied with self-isolation requirements' we used 5 time periods (-1, -2, -3, -4 and -5) as during time period -6 an operational issue resulted in unreliable data entries on Test and Trace calls to explore compliance.

Figure 1.5 Selecting a comparator for Bradford using the synthetic control method (outcome: proportion who shared contacts)

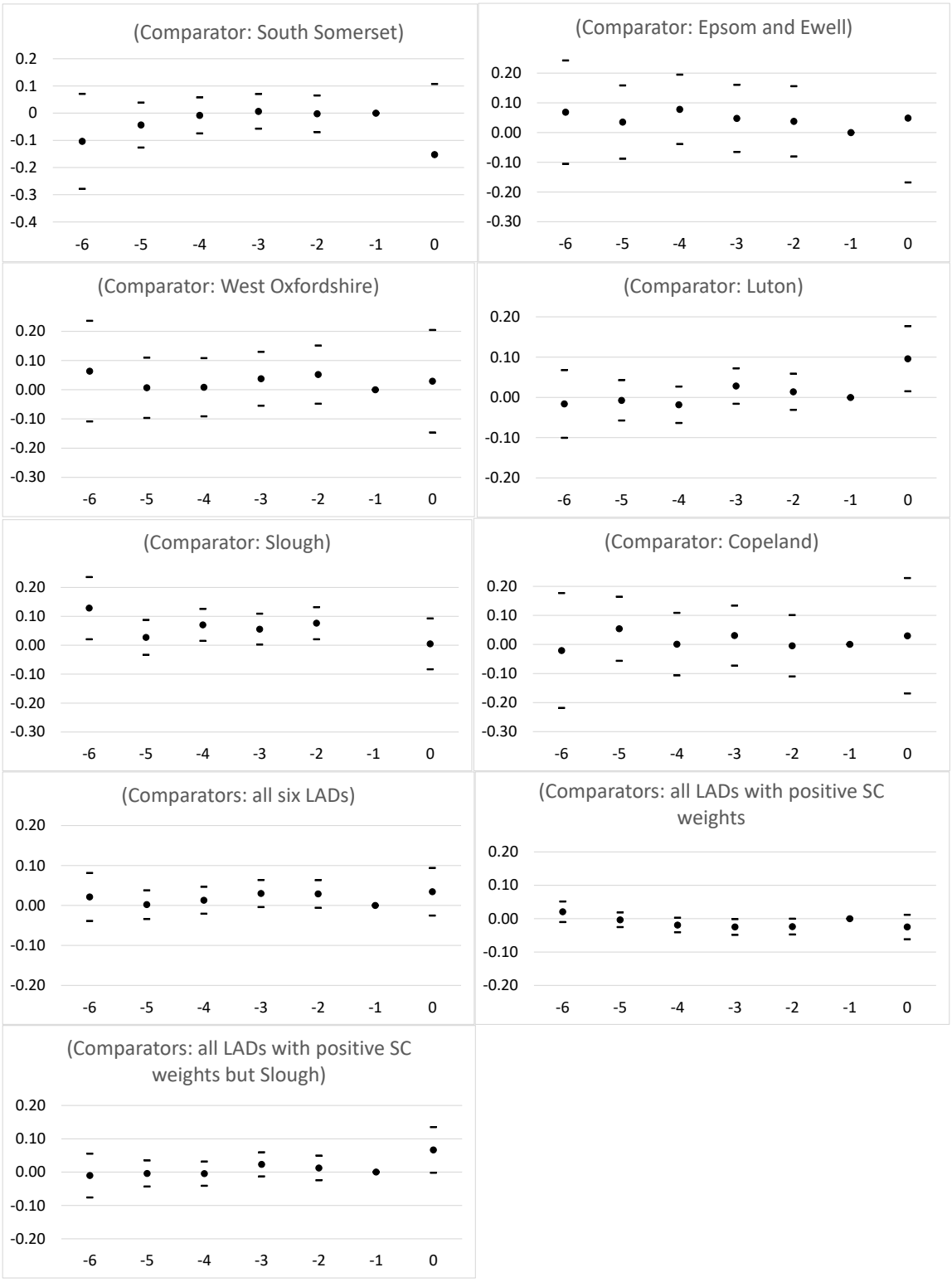


South Somerset is then used as the comparison area for Bradford in an event study where all individuals residing in Bradford or South Somerset are included, with the aim of assessing whether the parallel trend assumption holds for this 'restricted' sample (this would justify a DiD estimate for the sample in question). However, for some outcomes choosing the closest comparator is not as easy as in this case as some LADs showed better resemblance with Bradford over certain time spans but other LADs were preferred when looking at different (or showed a better trend over longer) time spans. For this reason, we run a series of event studies on alternative samples which use either a different LAD (the one with the highest SC weight) or a group of LADs (all/some of those with positive SC weights).

The first graph in Figure 1.6 illustrates the findings from the event study which used all individuals who resided in Bradford or South Somerset. The coefficients of all lags are close to zero and not statistically significant, which provides strong evidence of a parallel trend. It is therefore plausible that the proportion who shared contacts Bradford or South Somerset would have continue to develop in parallel also after the introduction of the intervention (which justifies the use of a DiD estimation approach which relies on individuals who reside in South Somerset as the comparators for Bradford residents). However, the other graphs show evidence of the parallel trend also when LADs other than South Somerset are used in the event study (the graphs are presented in ascending order of SC weights so Epsom and Ewell has a SC weight smaller than South Somerset, West Oxfordshire has a SC weight smaller than Epsom and Ewell and so on). With the only exception of Slough, using any LAD results in the parallel trend being met for the entire pre-intervention period. The parallel trend assumption is not met neither when all LADs with positive SC weights are used nor when we rely on the 6 LADs with the highest

weights. However, it is met when Slough is removed from the group of the 6 LADs with the highest weights. In the choice of our preferred DiD estimate, we favour the use of a comparator group with multiple LADs to the single LAD specification due to larger sample sizes, which result in more precise estimates and higher power.

Figure 1.6 Event study: Proportion who shared contacts (different comparator LADs and clusters of LADs)



The results of the event studies for the other outcomes (full compliance with self-isolation requirements is also included as the evidence found for the parallel trend is not very strong) can be summarised as follows:[16]

Proportion who fully complied with self-isolation requirements

The best (and fully satisfactory) evidence of a parallel trend prior to the intervention is found when all 5 LADs with positive SC weights (Harlow, Preston, City of London, Camden, and South Northamptonshire) are included in the event study. For this reason, our best DiD estimate of the impact of the Bradford intervention on this outcome will rely on all individuals who reside in any of these 5 LADs as the comparators for Bradford residents.

Proportion who made a TTSP application

The parallel trend assumption is considered as fully met when either Hyndburn or Torbay is included in the analysis. However, the same result is achieved when using the 5 LADs with the highest SC weights (Hyndburn, Torbay, Forest of Dean, Malvern Hills, and Folkestone and Hythe) in the even study. Therefore, our preferred DiD estimate for this outcome will rely on comparator individuals from any of these 5 LADs.

Proportion who shared contacts

As previously illustrated, while the best individual comparator is South Somerset, there is evidence of a parallel trend also when using a wider set, which includes 4 other LADs, namely, West Oxfordshire, Epsom and Ewell, Luton, and Copeland. Therefore, all 5 LADs are used to implement the DiD estimates for this outcome.

Average number of contacts shared

The strongest evidence of a parallel trend is found when Leicester is chosen as the comparator area. Adding any of the other 4 LADs among the 5 with highest weights is not conducive to better results. Therefore, our best specification for the DiD estimate of the impact of the Bradford intervention on this outcome will use Leicester residents as comparators for Bradford residents.

Proportion who made a successful TTSP application

A parallel trend is confirmed for the entire pre-intervention period when North Somerset (the LAD with the highest weigh) is the only comparator LAD included in the event study. The same result is achieved when both North Somerset and South Norfolk (second highest weight) are included (including more LADs among those with the highest weights does not lead to detection of the parallel trend). Therefore, the DiD estimate of the impact of the Bradford intervention on this outcome will rely on all individuals from both comparator LADs.

[16] The pre-intervention outcome trends for Bradford and the LADs with the highest SC weights are shown in Annexe C. The complete set of results (event study estimates) is available upon request.

Empirical findings

This chapter presents and discusses the estimates of the impact of the Bradford intervention on the 6 outcomes considered.

Impacts on compliance with self-isolation requirements, contact-sharing behaviour and TTSP applications

DiD impact estimates

This section reports and briefly discuss the estimates of the impact of the Bradford intervention on the 5 outcomes related to compliance with self-isolation requirements, contact-sharing behaviour and TTSP applications obtained by means of the DiD estimation approach.[17] For each outcome, we illustrate the DiD estimates obtained using 5 different specifications:

1. Individuals from Bradford and all other LADs.
2. Individuals from Bradford and the preferred LAD selected based on visual inspection of the pre-intervention outcome trend for the LADs with a positive SC weight.
3. Individuals from Bradford and the LAD with highest SC weight.
4. Individuals from Bradford and all LADs with positive SC weights.
5. Individuals from Bradford and all LADs with the 5 highest SC weights (or a lower number of LADs if this resulted in convincing evidence of the parallel trend prior to the intervention).

Furthermore, we report both the DiD impact estimates obtained after implementing an event study (where all lags from -1 to -6 are included) and the DiD impact estimates produced by means of a simpler regression using only the pre- and post-intervention time periods (only the lag -1 is used). As researchers may use one model or the other to implement the DiD estimates it is interesting to see whether (and, if so, to what extent) these 2 estimates diverge. Evidence of the parallel trend assumption resulting from implementing the event study corresponding to each specification is also reported.

Table 1.7 shows the results for the outcome ‘Proportion who fully complied with self-isolation requirements.’ As discussed before, when using all LADs as comparator areas evidence of a parallel trend is limited to the time span between time periods -1 and -2, while no evidence of a parallel trend was found for earlier time spans. Therefore, the DiD estimate resulting from this specification (which varies between 4.4 and 3.8ppts depending on whether it is produced by means of an event study or a simpler 2-time period regression, the former being significant only

[17] We follow Mackinnon and Webb (2017) who suggest not to cluster standard errors in the presence of a strong group cluster imbalance or, more generally, when only one treated cluster is used. This is our case as we have one treated vs over 300 untreated LADs (full-size estimates) and one treated area vs one/few untreated all LAD/s (restricted estimates)

at the 10% level and the latter not significant) should be considered with caution. Slightly stronger evidence of a parallel trend is obtained when using only Harlow (the area, among those with positive SC weights, that we considered closer to Bradford in terms of the pre-intervention outcome trajectory) as the comparator LAD because a parallel trend is detected also for the time span between time periods -1 and -4. Nevertheless, the DiD estimates associated with this specification are not statistically significant. No evidence of a parallel trend is detected when using Preston (the area with the highest SC weight) and therefore the DiD estimates are not considered reliable. When all LADs with positive SC weights (Harlow, Preston, Camden, City of London, and South Northamptonshire) are used, there is compelling evidence of a parallel trend and therefore we consider the DiD impact estimates (11 and 12.7ppts, depending on which DiD method was used to produce them, both statistically significant at the 5% level) as our most reliable ones. These estimates indicate that the Bradford intervention has increased the proportion who fully complied with self-isolation requirements among those who started a self-isolation period by between 11 and 12.7ppts. The fourth and fifth columns report the same figures because, in total, the LADs with positive SC weights are only 5.

Table 1.7 Estimates of the impact of the Bradford intervention on the proportion who fully complied with self-isolation requirements (difference-in-differences method)

	All other LADs than Bradford		LAD with most similar pre-intervention outcome trend to Bradford		LAD with highest synthetic control weight		All LADs with positive synthetic control weights		LADs with the 5 highest synthetic control weights	
DiD impact estimate (event study)	0.044	*	0.210		-0.276	***	0.127	***	0.127	***
DiD impact estimate (pre-post regression)	0.038		0.108		0.057		0.110	**	0.110	**
Event study: Parallel trend assumption observed between time period -1 and:										
time period -2	Yes		Yes		No		Yes		Yes	
time period -3	No		No		No		Yes		Yes	
time period -4	No		Yes		No		Yes		Yes	
time period -5	No		No		No		Yes		Yes	
time period -6	-		-		-		-		-	

***, ** and * denote statistical significance at the 1, 5 and 10% level, respectively; impacts in percentage points are obtained by multiplying the figures in the table by 100; the best comparator LAD chosen based on visual inspection of the pre-intervention outcome trends among LADs with positive synthetic control weights is Harlow; the LAD with highest synthetic control weight is Preston. The other 3 LADs with positive weights are Camden, City of London and South Northamptonshire.

The estimates of the impact of the Bradford intervention on the outcome ‘Proportion who made a TTSP application’ are illustrated by means of Table 1.8. As when we include all LADs in the event study no evidence of a parallel trend is found in the time span between time periods -1 and -2, we do not consider the DiD estimates associated with this specification as reliable. On the other hand, for the specification which includes the LAD which best resembles Bradford in terms of pre-intervention outcome trend as the only comparator (Hyndburn) evidence of a

parallel trend is convincing. However, both DiD estimates associated with this specification (1.8 and 3.6ppts, depending on whether an event study or simpler pre-post DiD regression approach is used to calculate impacts) are not statistically significant. A similar result is obtained when using Torbay (the LAD with the highest SC weight) as the only comparator for Bradford: although there is strong evidence supporting the parallel trend assumption the impact estimates are not statistically significant. We note that some of these estimates are very small, and therefore it is possible that statistical power is not sufficient to detect the impacts. Whereas using all LADs with positive SC weights as comparators for Bradford produces a positive impact estimate of between 2.1 to 2.7ppts, these estimates are not considered sufficiently reliable as they are not supported by evidence of a parallel trend in the immediate pre-intervention period. When the 5 LADs with the highest SC weights (Hyndburn, Torbay, Forest of Dean, Malvern Hills, and Folkestone and Hythe) are considered, there is strong evidence of a parallel trend. However, the DiD impacts (3.2ppts) are not statistically significant.

Table 1.8 Estimates of the impact of the Bradford intervention on the proportion who made a TTSP application (difference-in-differences method)

	All other LADs than Bradford		LAD with most similar pre-intervention outcome trend to Bradford		LAD with highest synthetic control weigh		All LADs with positive synthetic control weights		LADs with the 5 highest synthetic control weights	
DiD impact estimate (event study)	0.020	***	0.018		0.008		0.027	***	0.032	
DiD impact estimate (pre-post regression)	0.014	*	0.036		-0.006		0.021	**	0.032	
Event study: Parallel trend assumption observed between time period -1 and:										
time period -2	No		Yes		Yes		No		Yes	
time period -3	Yes		Yes		Yes		Yes		Yes	
time period -4	Yes		Yes		Yes		Yes		Yes	
time period -5	-		-		-		-		-	
time period -6	-		-		-		-		-	

***, ** and * denote statistical significance at the 1, 5 and 10% level, respectively; impacts in percentage points are obtained by multiplying the figures in the table by 100; the best comparator LAD chosen based on visual inspection of the pre-intervention outcome trends among LADs with positive synthetic control weights is Hyndburn; the LAD with highest synthetic control weight is Torbay; the other 56 LADs with positive weights are Adur, Blackburn with Darwen, Blackpool, Bolton, City of Bristol, Burnley, Colchester, Corby, Darlington, Derby, Doncaster, Dudley, East Riding of Yorkshire, Folkestone and Hythe, Forest of Dean, Great Yarmouth, Halton, Hartlepool, Lancaster, Leicester, Lincoln, Liverpool, Luton, Malvern Hills, Manchester, Newark and Sherwood, North East Lincolnshire, Northumberland, Norwich, Nottingham, Oadby and Wigston, Peterborough, Portsmouth, Preston, Redditch, Sandwell, Sefton, Shropshire, South Kesteven, South Somerset, Southampton, Southend-on-Sea, St. Helens, Stevenage, Sunderland, Swindon, Tameside, Thanet, Torridge, Wakefield, Warrington, West Lindsey, West Suffolk, Wolverhampton, Worcester and Wychavon; the 5 LADs with the highest weights are Hyndburn, Torbay, Forest of Dean, Malvern Hills, and Folkestone and Hythe.

Table 1.9 shows the estimates of the impact of the Bradford intervention on the outcome ‘Proportion who shared contacts.’ Most of the DiD estimates are negative and not statistically significant, including those supported by strong evidence of a parallel trend, which use South Somerset as a single comparator for Bradford (note that these estimates are around 6 times larger than the estimates obtained using multiple comparators). Note that South Somerset is also the LAD with highest SC weight, and this is the reason that the same figures are reported in the second and third columns. When the 5 LADs with the highest SC weights (South Somerset, Copeland, Luton, West Oxfordshire, and Epsom and Ewell) are included in the event study, there is strong evidence of a parallel trend, and a positive impact (6.6ppts) is detected. This is considered as the best estimate of the impact of the Bradford intervention on the proportion who shared contacts, although it is statistically significant only at the 10% level. A smaller (and not significant) impact of 5.2ppts is found when the 2-period DiD is used instead of the event study approach.

Table 1.9 Estimates of the impact of the Bradford intervention on the proportion who shared contacts (difference-in-differences method)

	All other LADs than Bradford		LAD with most similar pre-intervention outcome trend to Bradford		LAD with highest synthetic control weigh		All LADs with positive synthetic control weights		Five LADs among the 6 with the highest synthetic control weights	
DiD impact estimate (event study)	-0.025		-0.152		-0.152		-0.025		0.066	*
DiD impact estimate (pre-post regression)	-0.025		-0.170		-0.170		-0.025		0.052	
Event study: Parallel trend assumption observed between time period -1 and:										
time period -2	No		Yes		Yes		No		Yes	
time period -3	No		Yes		Yes		No		Yes	
time period -4	No		Yes		Yes		No		Yes	
time period -5	Yes		Yes		Yes		Yes		Yes	
time period -6	Yes		Yes		Yes		Yes		Yes	

Impacts in percentage points are obtained by multiplying the figures in the table by 100; the best comparator LAD chosen based on visual inspection of the pre-intervention outcome trends among LADs with positive synthetic control weights is South Somerset; South Somerset is also the LAD with highest synthetic control weight; with the only exception of Mid Devon and City of London, all other 301 LADs have positive SC weights; the 5 LADs used (among the 6 with the highest SC weights) are South Somerset, Copeland, Luton, West Oxfordshire, and Epsom and Ewell.

As illustrated in Table 1.10, for the outcome ‘number of contacts shared’, the only specification which is found reliable (that is, supported by evidence of a parallel trend over the pre-intervention period) is the DiD estimate obtained using a single comparator LAD (Leicester, which is

both the LAD with the most similar pre-intervention outcome trend to Bradford and the LAD with the highest SC weight). For this specification, the impact detected using the event study approach suggests that the intervention reduced the (average) number of contacts shared by COVID-19 cases in Bradford by almost 3 units (statistically significant impact). A smaller (around 2 units) and not statistically significant impact is detected when using the 2-period DiD regression model. No parallel trend is detected if all 5 (or a lower number of) LADs with the highest weights are used.

Table 1.10 Estimates of the impact of the Bradford intervention on the number of contacts shared (difference-in-differences method)

	All other LADs than Bradford		LAD with most similar pre-intervention outcome trend to Bradford		LAD with highest synthetic control weight		All LADs with positive synthetic control weights		LADs with the 5 highest synthetic control weights	
DiD impact estimate (event study)	-1.657	***	-2.733	***	-2.733	***	-2.191	***	-3.271	***
DiD impact estimate (pre-post regression)	-1.270	*	-2.158		-2.158		-1.388		-2.568	*
Event study: Parallel trend assumption observed between time period -1 and:										
time period -2	No		Yes		Yes		No		Yes	
time period -3	No		Yes		Yes		No		No	
time period -4	No		Yes		Yes		No		No	
time period -5	No		Yes		Yes		No		No	
time period -6	No		Yes		Yes		No		No	

*** and * denote statistical significance at the 1 and 10% level, respectively; the best comparator LAD chosen based on visual inspection of the pre-intervention outcome trends among LADs with positive synthetic control weights is Leicester, which is also the LAD with highest synthetic control weight; the other 21 LADs with positive weights are Adur, Barking and Dagenham, Birmingham, Cambridge, Craven, East Cambridgeshire, Hillingdon, Hounslow, Luton, Malvern Hills, Oldham, Pendle, Redbridge, Rushmoor, Sandwell, Teignbridge, Tower Hamlets,

Walsall, Waltham Forest, Woking and Wolverhampton; the 5 LADs with the highest SC weights are Leicester, Tower Hamlets, Adure, Pendle and Malvern Hills.

Finally, Table 1.11 reports the estimates of the impact of the Bradford intervention on the proportion who made a successful TTSP application. When Uttlesford (which based on our visual inspection of all outcome trends is considered to best comparator for Bradford) is used, both the event study and the 2-period DiD approaches find a very large (around 113ppts) and statistically significant impact. However, this estimate is supported by weaker evidence of a parallel trend and should therefore be considered with caution. A non-statistically significant impact of between 62.9 and 71.2ppts (the estimates produced by the event study and 2-period DiD approaches, respectively) is found when the DiD estimate is obtained using North Somerset (the LAD with the highest SC weight) as a comparator LAD for Bradford. However, evidence of the parallel trend was equally strong when 2 among the 5 LADs with the highest weights (North Somerset and South Norfolk) are used in the event study. This specification uses a larger sample size and is therefore preferred. It produces an impact of almost 60ppts (statistically significant only at the 10% level) when estimated within an event study approach. The 2-period DiD estimate is smaller (38.1ppts) and not statistically significant.

Table 1.11 Estimates of the impact of the Bradford intervention on the proportion who made a successful TTSP application (difference-in-differences method)

	All other LADs than Bradford		LAD with most similar pre-intervention outcome trend to Bradford		LAD with highest synthetic control weight		All LADs with positive synthetic control weights		LADs with the 2 highest synthetic control weights	
DiD impact estimate (event study)	0.034		1.133	***	0.712		0.035		0.592	*
DiD impact estimate (pre-post regression)	0.029		1.128	***	0.629		0.029		0.381	
Event study: Parallel trend assumption observed between time period -1 and:										
time period -2	No		Yes		Yes		No		Yes	
time period -3	No		No		Yes		No		Yes	

	All other LADs than Bradford	LAD with most similar pre-intervention outcome trend to Bradford	LAD with highest synthetic control weight	All LADs with positive synthetic control weights	LADs with the 2 highest synthetic control weights
time period -4	No	No	Yes	No	Yes
time period -5	-	-	-	-	-
time period -6	-	-	-	-	-

*** denote statistical significance at the 1% level; impacts in percentage points are obtained by multiplying the figures in the table by 100; the best comparator LAD chosen based on visual inspection of the pre-intervention outcome trends among LADs with positive synthetic control weights is Uttlesford; the LAD with highest synthetic control weight is North Somerset; the other 274 LADs with positive weights are Adur, Allerdale, Amber Valley, Arun, Ashfield, Ashford, Barking and Dagenham, Barnet, Barnsley, Barrow-in-Furness, Basildon, Basingstoke and Deane, Bedford, Bexley, Birmingham, Blaby, Blackburn with Darwen, Blackpool, Bolsover, Bolton, Boston, Bournemouth, Christchurch and Poole, Bracknell Forest, Braintree, Breckland, Brent, Brentwood, Brighton and Hove, City of Bristol, Broadland, Bromley, Bromsgrove, Broxbourne, Broxtowe, Buckinghamshire, Burnley, Bury, Calderdale, Cambridge, Camden, Canterbury, Castle Point, Central Bedfordshire, Charnwood, Chelmsford, Cheltenham, Cherwell, Cheshire East, Cheshire West and Chester, Chesterfield, Chorley, Colchester, Copeland, Corby, Cornwall, County Durham, Coventry, Craven, Crawley, Croydon, Dacorum, Darlington, Dartford, Daventry, Derby, Derbyshire Dales, Doncaster, Dorset, Dover, Dudley, Ealing, East Devon, East Hampshire, East Hertfordshire, East Lindsey, East Northamptonshire, East Riding of Yorkshire, East Suffolk, Eastleigh, Eden, Elmbridge, Enfield, Epping Forest, Epsom and Ewell, Erewash, Exeter, Fareham, Fenland, Folkestone and Hythe, Forest of Dean, Fylde, Gateshead, Gedling, Gloucester, Gosport, Gravesham, Great Yarmouth, Guildford, Hackney, Halton, Hambleton, Hammersmith and Fulham, Haringey, Harlow, Harrogate, Harrow, Hartlepool, Hastings, Havant, Havering, County of Herefordshire, Hertsmere, High Peak, Horsham, Hounslow, Huntingdonshire, Hyndburn, Ipswich, Isle of Wight, Islington, Kensington and Chelsea, Kettering, King's Lynn and West Norfolk, City of Kingston upon Hull, Kirklees, Knowsley, Lancaster, Leeds, Leicester, Lewes, Lewisham, Lincoln, Liverpool, Luton, Maidstone, Maldon, Malvern Hills, Manchester, Mansfield, Medway, Melton, Mendip, Merton, Mid Devon, Mid Suffolk, Mid Sussex, Middlesbrough, Milton Keynes, Mole Valley, New Forest, Newark and Sherwood, Newcastle upon Tyne, North Devon, North East Derbyshire, North East Lincolnshire, North Hertfordshire, North Kesteven, North Lincolnshire, North Norfolk, North Somerset, North Tyneside, North Warwickshire, North West Leicestershire, Northampton, Northumberland, Norwich, Nottingham, Nuneaton and Bedworth, Oadby and Wigston, Oldham, Oxford, Pendle, Peterborough, Plymouth, Portsmouth, Preston, Reading, Redbridge, Redcar and

Cleveland, Redditch, Reigate and Banstead, Ribble Valley, Richmond upon Thames, Richmondshire, Rochdale, Rochford, Rotherham, Rugby, Runnymede, Rushcliffe, Rushmoor, Ryedale, Salford, Sandwell, Scarborough, Sedgemoor, Sefton, Selby, Sevenoaks, Sheffield, Shropshire, Slough, Solihull, Somerset West and Taunton, South Cambridgeshire, South Derbyshire, South Gloucestershire, South Hams, South Holland, South Kesteven, South Norfolk, South Northamptonshire, South Ribble, South Somerset, South Tyneside, Southampton, Southend-on-Sea, Southwark, Spelthorne, St Albans, St. Helens, Stevenage, Stockport, Stockton-on-Tees, Stoke-on-Trent, Stratford-on-Avon, Stroud, Sunderland, Surrey Heath, Sutton, Swale, Swindon, Tameside, Teignbridge, Telford and Wrekin, Tendring, Test Valley, Tewkesbury, Thanet, Three Rivers, Thurrock, Tonbridge and Malling, Torbay, Tower Hamlets, Trafford, Tunbridge Wells, Uttlesford, Wakefield, Walsall, Waltham Forest, Warrington, Warwick, Watford, Wellingborough, Welwyn Hatfield, West Berkshire, West Lindsey, West Oxfordshire, West Suffolk, Westminster, Wigan, Wiltshire, Winchester, Windsor and Maidenhead, Wirral, Woking, Wokingham, Wolverhampton, Worcester, Worthing, Wychavon, Wyre, Wyre Forest, and York. The 2 LADs with the highest weights are North Somerset and South Norfolk.

Sensitivity checks

The impact of the Bradford intervention on the 5 outcomes related to compliance with self-isolation requirements, contact-sharing behaviour and TTSP applications was estimated also using the SC method, which (differently from the DiD approach) does not require a parallel trend assumption. The SC estimates are particularly important for the outcomes 'average number of contacts shared' and 'proportion who made a successful TTSP application' as our preferred DiD specifications for these outcomes relies only on one or 2 (rather than more) comparator LADs.

The SC impact estimates, alongside the P values resulting from the placebo tests (see next section), are reported in Table 1.12. The figures suggest that the Bradford intervention increased the proportion who made a TTSP application by 10.2ppts and reduced the average number of contacts shared by around 3 units. A positive impact is found for the proportions who fully complied with self-isolation requirements (11ppts) and who made a TTSP application (3.4ppts), while a negative impact (-3.2ppts) is detected for the proportion who shared contacts. However, all impacts are found to be not statistically significant, and therefore we cannot reach the conclusion that the Bradford intervention has had an effect on the outcomes considered. A possible explanation for the inability of the SC method to detect statistically significant results is that the number of pre-intervention periods is too small (up to only 6 lags are observed).

Table 1.12 Estimates of the impact of the Bradford intervention on the 5 outcomes related to full compliance with self-isolation requirements, contact sharing behaviour and TTSP applications (synthetic control method)

	Impact estimate	P value	Standardised P value
Proportion who fully complied with self-isolation requirements	0.110	0.415	0.771
Proportion who made a TTSP application	0.034	0.159	0.248
Proportion who shared contacts	-0.032	0.724	0.505
Average number of contacts shared	-3.067	0.299	0.468
Proportion who made a successful TTSP application	0.102	0.673	0.449

We note that the size of the impacts estimated by means of the DiD is either the same or larger than the size of the impacts estimated by means of the SC approach. For example, the impact on the proportion who fully complied with self-isolation requirements estimated using the SC method is 11ppts, which is the lowest value obtained for the impact estimated by means of DiD (11 to 12.7ppts), and the impact on the proportion who made a TTSP application is 3.2ppts using both methods. The SC-based estimates therefore provide conservative estimates of the magnitude of the impact of the Bradford intervention.

Restricted DiD estimates were also obtained based on different samples, namely, the sample composed of people who live in Bradford/comparator LSOAs in income-deprived deciles 1 and

2, and the sample composed of individuals who live in the most deprived LSOAs of Bradford or comparator LADs. These samples are more likely to identify the population eligible for the intervention (newly eligible individuals) and also always-eligible people (which might have indirectly benefitted from the intervention). However, they are smaller in that they use subsets of the full sample (the size of the 'most deprived' sample is smaller than the 'deciles 1 and 2' sample).

The sensitivity of the results to the use of these 2 alternative samples is illustrated by means of Table 1.13. For each of the 5 outcomes, the table reports what we consider our most reliable DiD estimates, called 'full-size sample' estimates and the DiD estimates obtained for the 2 alternative samples explored here. The extent to which the parallel trend is satisfied is also reported. Differently from the full-size sample estimates, the impact estimates for the outcome 'full compliance with self-isolation requirements' are not significant for either sample. On the other hand, for the proportion who made a TTSP application (not significant when relying on the full-size sample) positive and larger impacts are found for both the 'LSOAs in income-deprived deciles 1 and 2' and 'Most income-deprived LSOAs' samples. Estimates based on the latter sample are twice as large as estimates for the former (around 17ppts and over 8ppts, respectively). The impact on the proportion who shared contacts more than doubles in size, and its statistically significance improves, moving from the full-size estimates to the estimates for the sample 'LSOAs in income-deprived deciles 1 and 2', and the size of the negative impact on the average number of contacts shared also doubles. The impact on the proportion who made a successful application, which is very large (but not strongly significant) for the full-size sample (59.2ppts) is found to be smaller (around 15ppts) for the sample 'Most income-deprived LSOAs.' The most convincing of all estimates is the one found for the proportion who made a TTSP application for the sample 'LSOAs in income-deprived deciles 1 and 2' as 5 comparator LADs are used, the sample size is not too small, the parallel trend assumption is satisfied over the entire pre-intervention period, and is confirmed by both the event study and 2-period DiD estimates.

Table 1.13 Sensitivity of the results to the use of different samples

Full-size sample	Impact estimate (DiD event study)	Significance level	Parallel trend passed?	Impact estimate (2-period DiD)	Significance level
Proportion who fully complied with self-isolation requirements	12.7	***	Yes	11.0	**
Proportion who made a TTSP application	3.2		Yes	3.2	
Proportion who shared contacts	6.6	*	Yes	5.2	
Average number of contacts shared	-2.7	***	Yes	-2.2	
Proportion who made a successful TTSP application	59.2	*	Yes	38.1	
LSOAs in income-deprived deciles 1 and 2					
Proportion who fully complied with self-isolation requirements	-2.3		Yes	16.6	
Proportion who made a TTSP application	8.1	**	Yes	8.8	**
Proportion who shared contacts	15.6	**	Yes (-4)	11.6	*
Average number of contacts shared	-6.4	***	Yes (-2)	-4.8	*
Proportion who made a successful TTSP application	82.1		Yes (-3)	88.6	
Most income-deprived LSOAs					

Full-size sample	Impact estimate (DiD event study)	Significance level	Parallel trend passed?	Impact estimate (2-period DiD)	Significance level
Proportion who fully complied with self-isolation requirements	-3.6		Yes	15.8	
Proportion who made a TTSP application	16.6	***	Yes (-4)	17.1	***
Proportion who shared contacts	9.4		Yes	9.8	
Average number of contacts shared	-4.1	***	Yes	-2.5	
Proportion who made a successful TTSP application	15.4	***	Yes	14.5	***

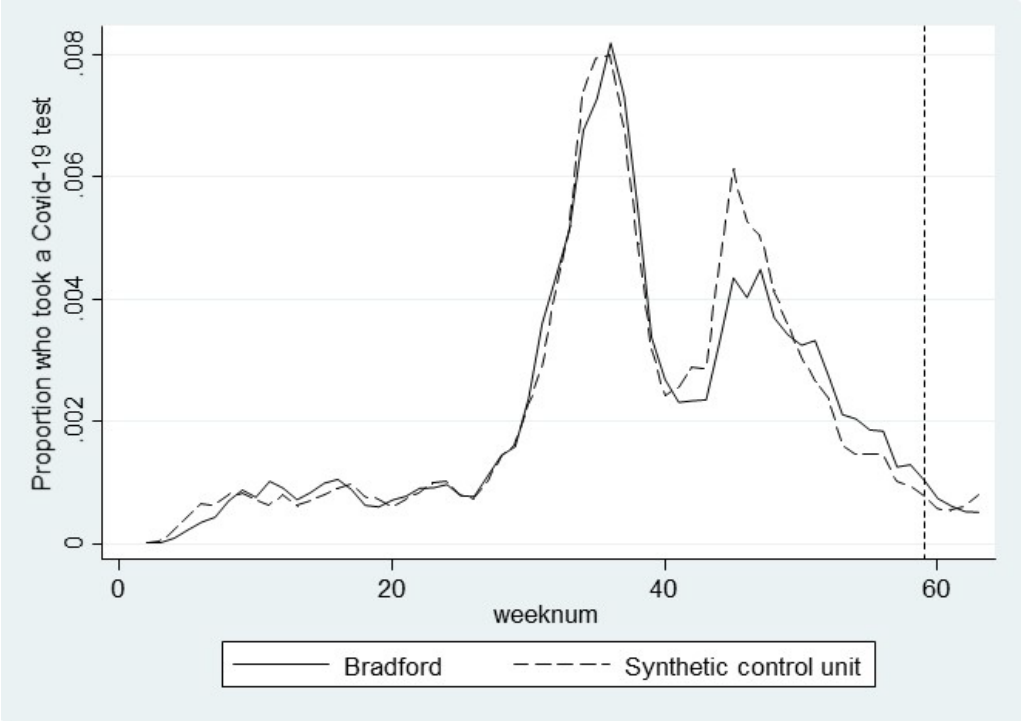
***, ** and *: statistically significant at the 1, 5 and 10% level. Parallel trend satisfied for all lags but those in brackets.

Impact on testing

Credibility of the synthetic control as a comparison unit

As shown in Figure 1.7, the synthetic control unit (or 'synthetic Bradford') constructed as a weighted combination of other LADs shows a pre-intervention outcome (testing rate) trend very similar to that observed for Bradford.

Figure 1.7 Evolution of testing rate for Bradford and the synthetic control unit, which represents Braford in the absence of the intervention



Six LADs were used to produce the synthetic control LAD. These areas (and their estimated weights) are as follows:

- Oldham (0.410)
- Leicester (0.227)
- Bolton (0.135)
- Rotherham (0.128)
- Barnsley (0.063)
- Blackburn with Darwen (0.038)

A higher weight assigned to Oldham compared to other LADs means that, overall, the former resembles Bradford more closely than the latter in terms of the predictors considered (Oldham is therefore given more importance in the construction of the synthetic unit). The predictors include the proportion of the LAD's population who is of female gender, the proportions aged 18 to 24, 25 to 34, 35 to 49, 50 to 59 and 60 to 67, past testing rates (selected weeks), positivity

rate over weeks 13 to 58, and average proportion of the population who has a vaccine (first dose) over weeks 41 to 58).[18]

The extent to which the synthetic control approach provides a more credible comparison group compared to using all LADs indiscriminately in the estimation of impacts can be appreciated by comparing the pre-intervention trends in testing rates across all LADs (the average trajectory shown in Figure 1.1 assigns the same weight to all 227 LADs) and the synthetic unit formed by a weighted combination of only 6 selected LADs (Figure 1.7). Using the weighted combination of the 6 LADs largely reduces the pre-intervention testing rate gap between Bradford and the comparator areas.

For what concerns the other testing rate predictors, Table 1.14 shows that the populations of Bradford and another 'typical' English LAD (among the initial sample of 303) are quite similar in terms of the proportion of female gender and the proportions within different age bands, and the main difference concerns the different proportions of Asian ethnicity.[19] In the main, the synthetic control approach reduced compositional differences between Bradford and a typical LAD taken from the larger pool on non-intervention areas in terms of their ethnic composition, the proportion vaccinated and the positivity rate.

Table 1.14 Other predictors of the weekly testing rate for Bradford and other LADs

	Bradford	Synthetic unit	All LADs
Female (%)	50.2	50.0	50.3
Aged 18 to 24 (%)	13.9	15.1	12.6
Aged 25 to 34 (%)	21.2	22.3	20.4
Aged 35 to 49 (%)	32.3	29.7	30.9
Aged 50 to 59 (%)	19.8	20.2	22.1
Aged 60 to 67 (%)	12.8	12.7	14.1
White ethnicity (%)	65.1	73.2	86.5
Black ethnicity (%)	2.1	2.6	3.0
Asian ethnicity (%)	28.7	21.4	7.2
Mixed ethnicity (%)	2.4	2.0	2.0
Other ethnicity (%)	1.7	1.0	1.0

[18] We implemented the synthetic control methodology using the Stata programme synth developed by Abadie, A., Diamond, A., and J. Hainmueller (2010). Instead of using the average value of the lagged outcome over the entire pre-intervention period for which the outcome is available (that is, the mean of testing rates across weeks 2 to 59) to construct the weights, we requested that a set of time points representative of the outcome distribution were considered. Specifically, we used weeks 9, 13, 16, 19, 24, 26, 29, 36, 41, 43, 50, 53, 56, 57 and 58 as they represent spikes/troughs or delimit temporary linear trends in testing rates.

[19] This finding is consistent with the descriptive statistics for the other outcomes, which use different individual-level samples, and this suggests that the sample of LADs used for estimation of impacts by means of DiD is similar to the sample of LADs used for estimation of impacts using the SC approach.

	Bradford	Synthetic unit	All LADs
Has received the first dose of vaccine (average % over weeks 41 to 58)	18.0	18.7	19.0
Average LSOA income deprivation rank	21,639.97	21,902.61	15,341.23
Positivity rate (average rate over weeks 13 to 58)	1.162	1.162	1.239

Impact on testing rates

Having ascertained that the synthetic control approach has resulted in a reliable comparator area, we now turn to look at the impact of the intervention, which is represented by the difference between the post-intervention testing rates for Bradford and the synthetic control unit at any week from week 59 to week 63.[20] A visual inspection of the impact trend in Figure 1.7 shows that, in the immediate post-intervention period (week 59), the proportion of the population who took a COVID-19 test in Bradford is higher compared to the hypothetical situation (depicted by means of the outcome of the synthetic control unit) in which no intervention had taken place. However, it would be wrong to conclude that this is evidence of a positive impact as the difference between the testing rates of Bradford and the synthetic unit is so small that it may not be different from 0 (that is, no impact at all).

After week 61 a negative (detrimental) impact is observed. However, this negative impact is also close to zero. There is no logical explanation whatsoever for the Bradford intervention to have exerted a detrimental effect on testing rates. As we saw in Figure 1.1, Bradford has caught up with (the average testing rate calculated among) other LADs and is likely to have follow the general testing rate pattern. It is more likely that the (slightly) positive/negative impacts observed after week 59 are simply the result of considering extreme outcome values for the LADs used to generate the synthetic control unit than a reflection of a genuine impact. Therefore, the impacts estimated following implementation of the SC approach should be considered with extreme caution.

In the context of the SC approach statistical inference (statistical significance) can be made by comparing the estimated impact for Bradford with the distribution of ‘placebo impacts’ (obtained by considering each of the untreated LADs as the treated unit; Bradford is removed from the donor set used to create the synthetic controls). If the distribution of these placebo impacts includes a large proportion of the size of the Bradford’s impact estimate, then it is unlikely that the Bradford’s estimate indicates a genuine impact. Essentially, finding similar impacts for other LADs where no intervention was implemented is taken to mean that the impact estimates found for Bradford are not indicative of an impact.

[20] Week 64 has been omitted as the proportion who took a test in that week would also include individuals who tested outside the intervention period. Therefore, the analysis (and the discussion) is limited to weeks 59-63.

Table 1.15 Estimates of the impact of the Bradford intervention on testing rates (synthetic control method)

	Impact estimate	P value	P value (standardised)
1 week after the introduction of the intervention	0.0002	0.0396	0.0617
2 weeks after the introduction of the intervention	0.0002	0.0969	0.1630
3 weeks after the introduction of the intervention	0.0001	0.5683	0.6035
4 weeks after the introduction of the intervention	-0.0001	0.2775	0.3216
5 weeks after the introduction of the intervention	-0.0003	0.0749	0.0881

P values between 0.01 (excluded) and 0.05 and between 0.05 (excluded) and 0.10 denote statistical significance at the 5 and 10% level, respectively.

As illustrated by means of Table 1.15, all impacts are very small (close to zero). Only impacts 1 week and 5 weeks after the introduction of the intervention (0.02 and -0.03ppts, respectively) are statistically significant, albeit only at the 10% significance level. Overall, these results point to the absence of an impact of the Bradford intervention on testing rates, or at the best to an extremely small (and therefore negligible) impact.

Conclusions

The main findings of this report can be summarised as follows:

Full compliance with self-isolation requirements

The Bradford intervention is found to have raised the proportion who fully adhered to the Test and Trace self-isolation requirements among Braford residents (cases or contacts) who self-isolated during the 40 days in which the intervention was in place. Our estimates indicate that this proportion was at least 11ppts higher than it would have been had the intervention not been introduced. However, this result is not confirmed when the population of Bradford residents is restricted to include only individuals who live in the most deprived geographies (2 definitions of deprived LSOAs were used). The 'most deprived' subset is expected to include a larger proportion of low-income (either always- or newly eligible) individuals than the full population set (which should instead include higher proportions of never-eligible people). The findings seem to suggest that the intervention improved self-isolation compliance among the never eligible (who were not the direct targets of the intervention), leaving low-income people unaffected.

TTSP applications

There is no evidence that the Bradford intervention had an impact on the proportion who made a TTSP application among the population of self-isolating Braford residents (cases or contacts) as a whole. However, a positive impact is observed among Bradford residents of the most deprived LSOAs as the proportion who made an application is found to have increased by at least 8ppts as a direct consequence of the intervention. Evidence on the impact of the intervention on the proportion who made a successful TTSP application is not considered reliable due to excessively small sample sizes being used for estimation.

Sharing contacts

We found some evidence suggesting that the intervention raised the proportion who shared contacts among Bradford residents (cases only) reached via phone by Test and Trace, and also reduced the number of contacts shared. These effects were much stronger (that is a larger proportion who shared contacts and a greater reduction in the number of contacts reported were detected) for individuals who reside in the most deprived areas compared to all Bradford residents. However, this evidence is not compelling and should therefore be considered with caution.

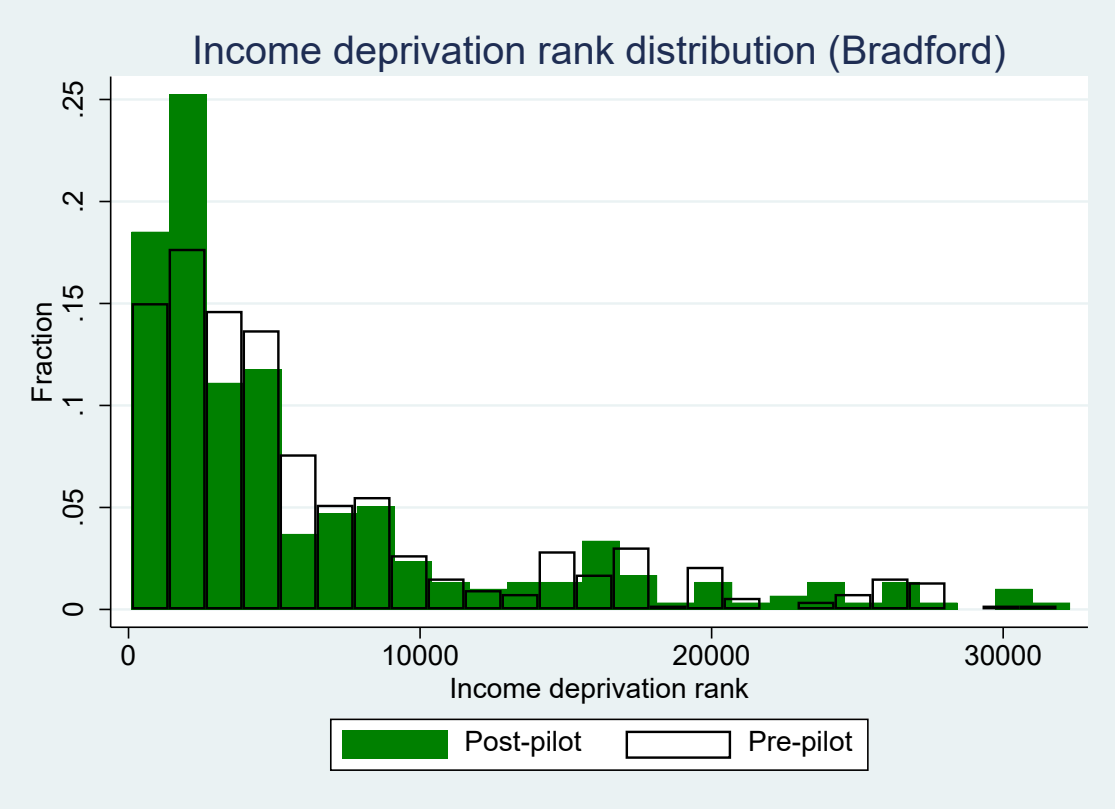
We found no evidence suggesting that the Bradford intervention had an effect on the testing rates of the Bradford population.

Annexe 1. Establishing the LSOA income deprivation rank threshold to define ‘most deprived’ and ‘less derived’ areas

The rationale for identifying ‘most deprived’ LSOAs has to do with the need to understand in which geographical areas always eligible and newly eligible people reside (the TTSP is aimed at supporting low-income individuals, who are concentrated in the most deprived geographical areas). Due to lack of data on individuals’ income, we cannot identify always eligible and newly eligible people, and as a consequence we cannot observe where they live. However, we can attempt to identify the areas where individuals who are most likely to be either always eligible or newly eligible reside.

To this aim, we explored the distributions of TTSP claimants (see Figure A1.1) and of successful claimants (Figure A1.2) across LSOA income deprivation ranks. Lowest income deprivation ranks indicate most deprived areas in terms of income (LSOAs with the highest proportion of the population who does not work or earns a low income).

Figure A1.1. Distribution of successful TTSP claimants across LSOA income deprivation rank



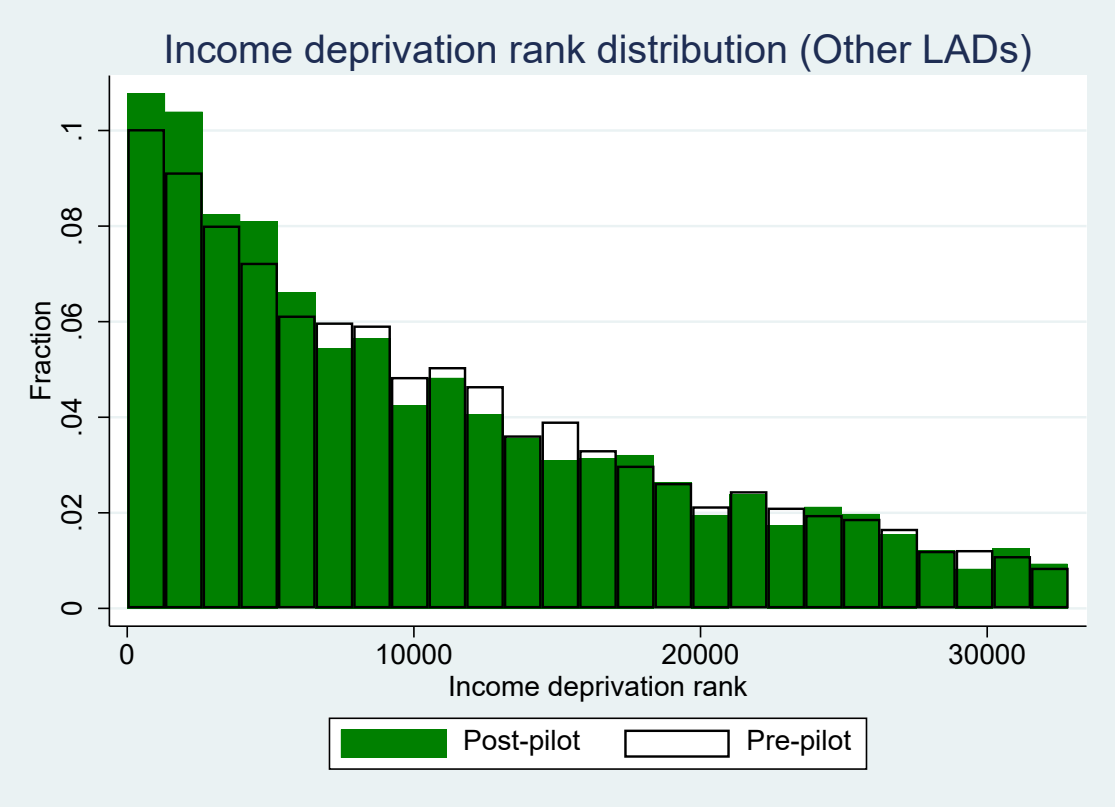
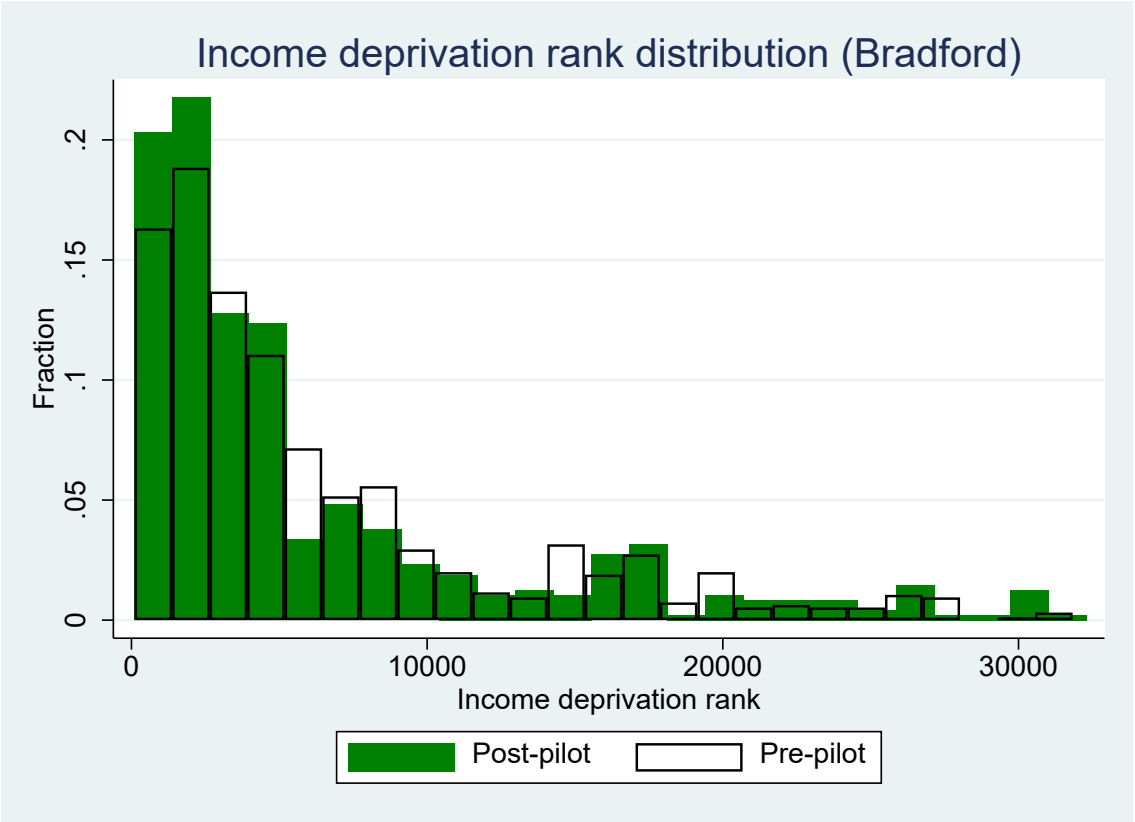
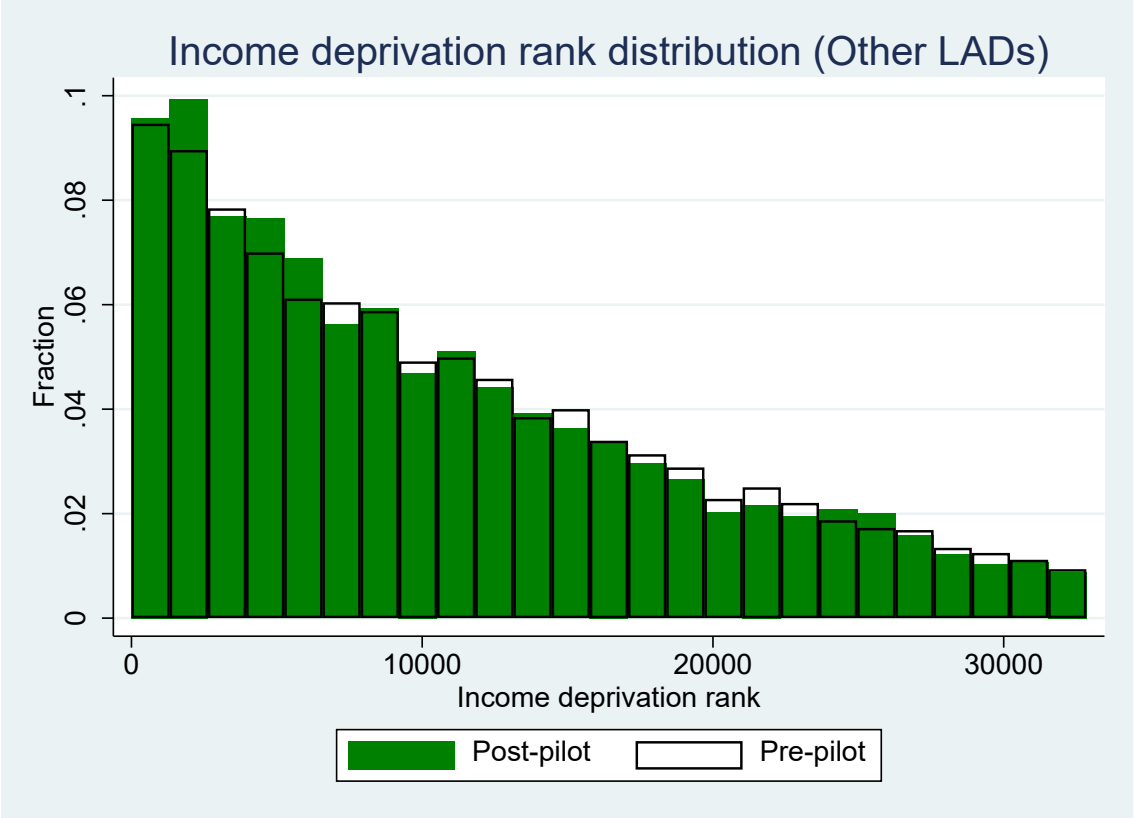


Figure A1.1. Distribution of TTSP claimants (regardless of whether successful or unsuccessful) across LSOA income deprivation rank





The graphs illustrated above indicate that in Bradford or other LADs people applied and made successful apps across a wide range of LSOA deprivation rank values. This is expected as people with different income levels are scattered across LSOAs with different deprivation ranks so there are always eligible and newly eligible people also in less deprived LSOAs. However, looking at concentrations of individuals in Bradford, we can see that the number of people making an application and the number of people making a successful application are concentrated in the first 4 bins (tallest bins). This is true both in the pre- and post-pilot period. If we look at the increase in the proportions making an application and making a successful application (rather than looking at numbers) then we note the action in Bradford is mainly in the first 2 bins (within first 5 bins in Other LADs). This suggests using a threshold of 2,629.36 of the income deprivation rank (the value delimited by the second bin) to identify LSOAs in Bradford where we are more likely to observe always- and newly eligible people. Alternatively, we could have used the threshold 5,256.72 (delimited by the fourth bin) as there is an increase in the proportion applying in Bradford also among people included in the fourth bin, although there is no increase for people in the third bin.

Annexe 2. Event studies for 2 alternative samples

Figure A2.1. Proportion who fully complied with self-isolation requirements, by time period (Comparators: All other LADs)

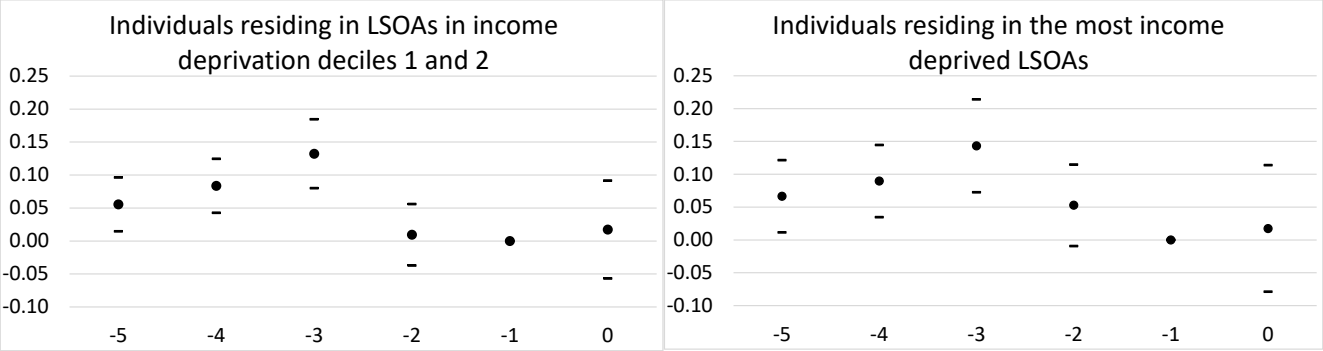


Figure A2.2. Proportion who made a TTSP application, by time period (Comparators: All other LADs)

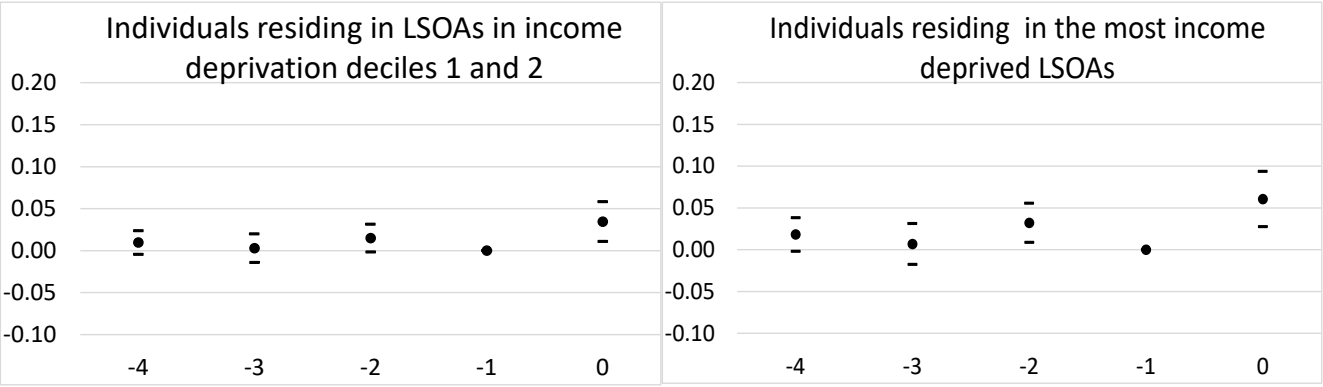


Figure A2.3 Proportion who shared contacts, by time period (Comparators: All other LADs)

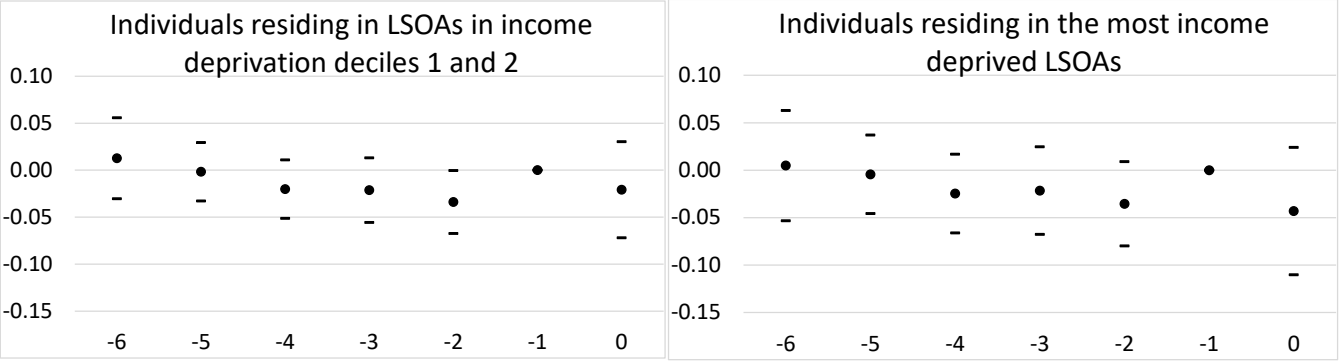


Figure A2.4 Average number of contacts shared, by time period (Comparators: All other LADs; all individuals)

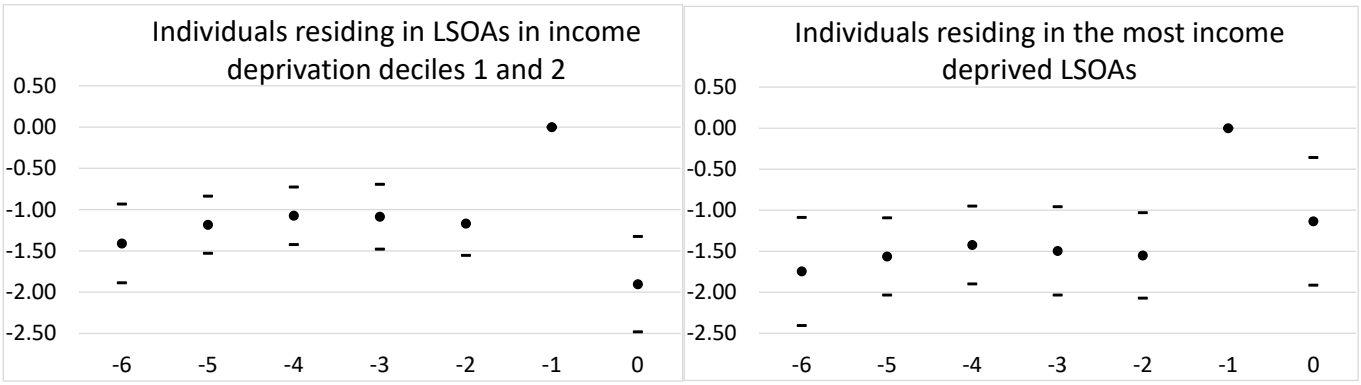
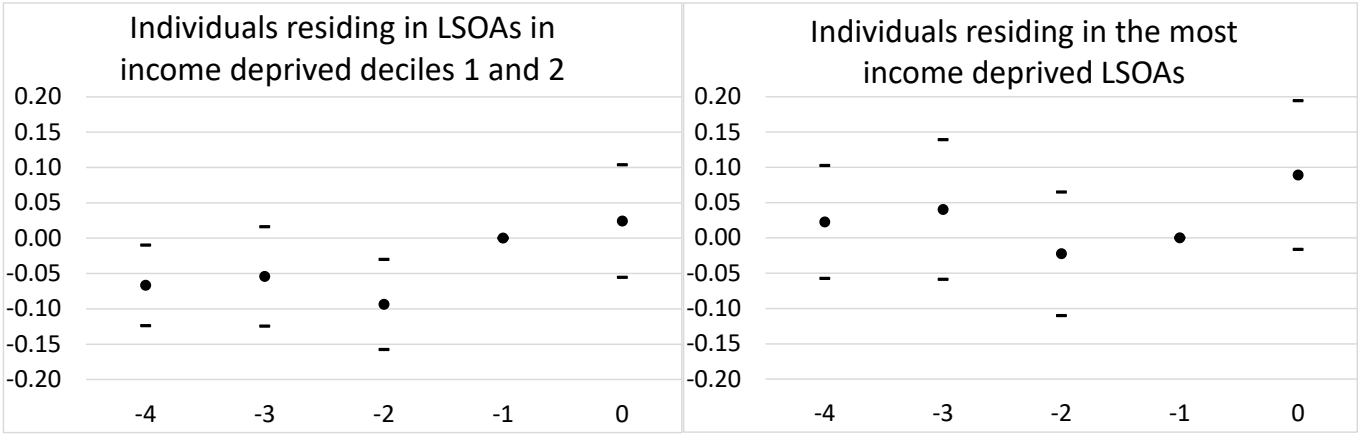


Figure A2.5 Proportion who made a successful TTSP application, by time period (Comparators: All other LADs; all individuals)



Annexe 3. Selection of the comparator LADs for the 'restricted' DiD estimation

Figure A3.1. Proportion who fully complied with self-isolation requirements

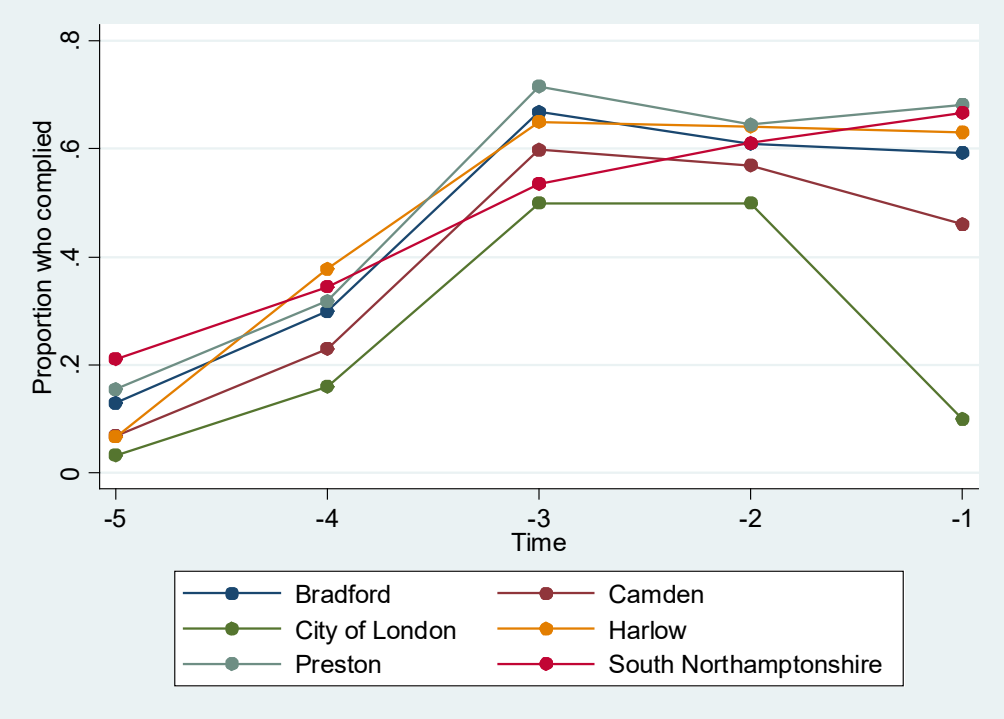


Figure A3.2. Proportion who made a TTSP application

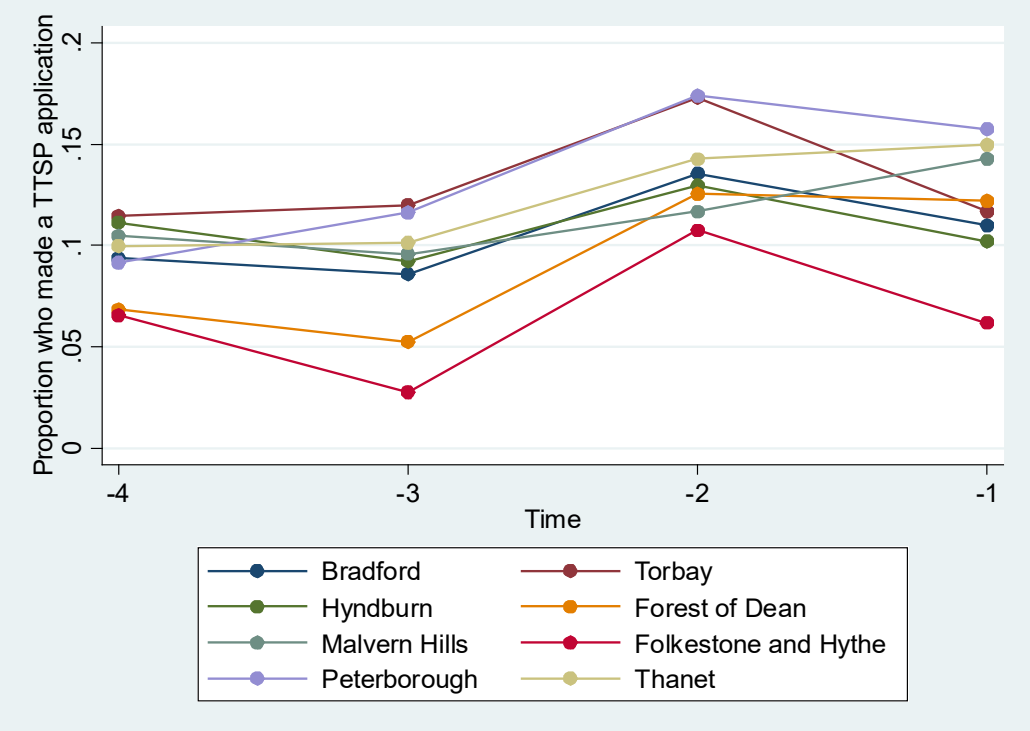


Figure A3.3. Average number of contacts shared

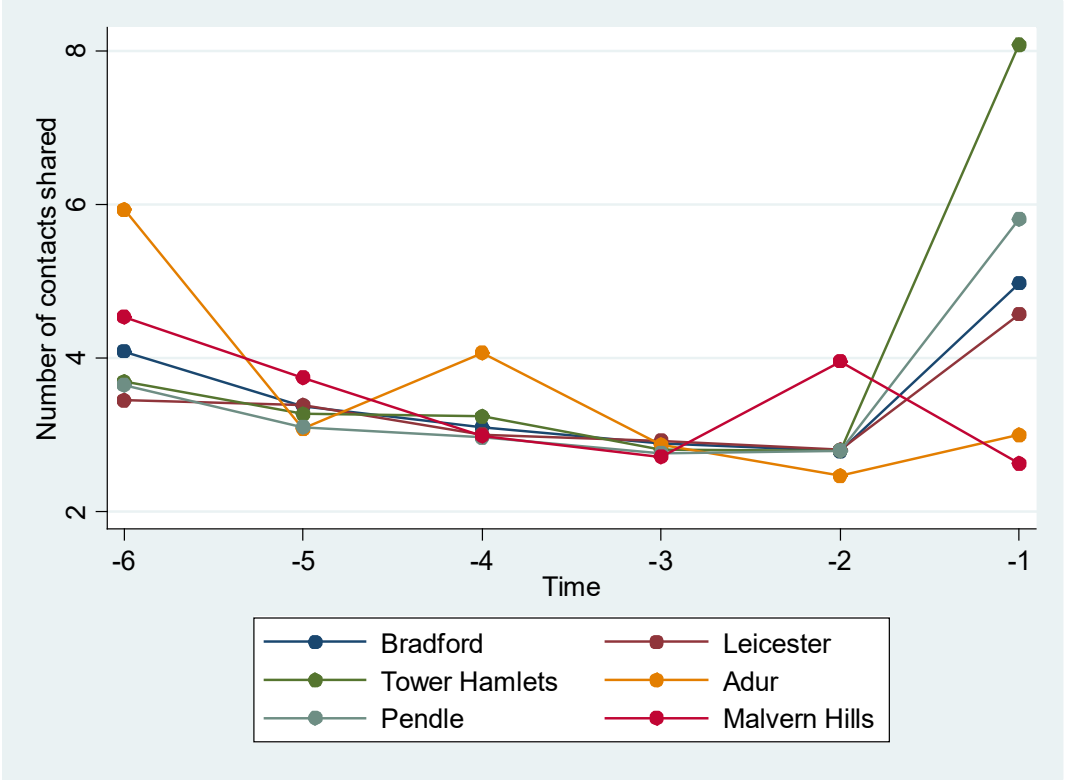
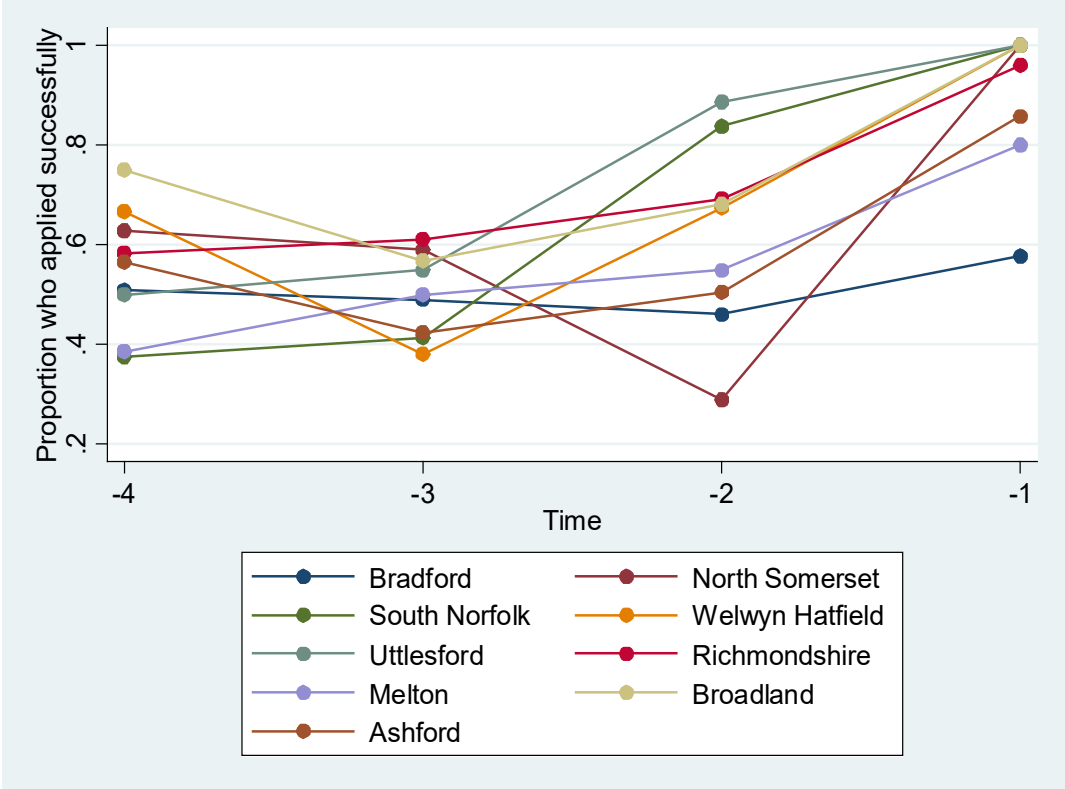


Figure A3.4. Proportion who made a successful TTSP application



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