Covid-19 vaccines as a condition of employment: impact on uptake, staffing, and mortality in elderly care homes

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Abstract

Laws mandating vaccination against Covid-19 as a condition of employment in health and care sectors were commonplace during the pandemic. Using weekly data at the local authority level, we examine the impact of the vaccine mandate for elderly care homes in England on vaccine take-up, staffing levels, and mortality. Our identification strategy involves 1. comparing take-up and staffing in English elderly care homes relative to other social care settings unaffected by the mandate; 2. comparing take-up and staffing in English elderly care homes relative to those in Wales where the mandate also did not apply; 3. comparing Covid-19 mortality among English elderly care home residents relative to mortality in domestic homes in England and to care homes in Wales. Our results suggest that the mandate substantially decreased the proportion of care home workers who remained unvaccinated (equivalent to between 28,000 and 41,000 fewer unvaccinated staff), but this came at the cost of a reduction in staffing levels of between 3 and 4 percent (equivalent to 14,000 to 18,000 staff). We observe this effect most strongly in areas of low unemployment. Our results do not provide evidence that the vaccine mandate was successful in its primary aim of reducing care home deaths. Relatively wide confidence intervals mean inferences regarding mortality are more uncertain than for vaccination uptake and staffing.

Keywords: Covid-19; vaccine mandates; care homes; elderly care; staffing.

JEL codes: I18, J14, J63, J78

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1. Background

A key policy tool of most governments in tackling the Covid-19 pandemic has been encouraging high levels of vaccination against the infection. Much of this effort has focused on voluntary measures such as providing vaccination free of charge and public health messages promoting take-up as a way of accounting for potential externalities associated with vaccination such as a reduction in transmission levels. More controversially, a number of countries introduced coercive measures such as vaccine passports or mandates in which people were denied access to some services, venues, or employment without proof of being vaccinated (Bardosh, de Figueiredo, Gur-Arie, et al, 2022)

One particularly widespread policy has been mandatory vaccination as a condition of employment, most commonly for staff in health or elderly care settings. In this paper, we examine the impact of the elderly care home vaccine mandate implemented in England in November 2021 on vaccine take-up among elderly care home staff, staffing levels, and Covid-19 deaths among residents.

England provides a particularly interesting case for several reasons. In the first place, the United Kingdom has a long tradition of relying largely on voluntary measures to encourage vaccination. Although compulsory vaccination for smallpox was introduced in the UK in 1853 the measure proved highly controversial. By 1898 allowance was made for conscientious objection and the mandate was abolished in 1948 (Steward and Devlin 2006). Since then, there has been no legal requirement for any vaccination either as a condition of employment or to access services such as schools.[1]

[1] Vaccination against Hepatitis B is a condition of employment for certain health care workers who may be exposed to blood or other body fluids as part of their work activity, but this is an NHS rather than a legal requirement. Further, evidence of antibodies is usually accepted as an alternative to vaccination.

Second, the care home mandate was introduced only for care home workers in England and not for the other constituent nations of the United Kingdom or workers in other social care settings in England. This means we potentially have a helpful set of control groups for whom the mandate was not implemented and which can help us identify the causal effects of the English mandate.

The primary objective of the mandate was to increase the take-up of Covid-19 vaccination among care home staff as a means of reducing infection and mortality rates among elderly care home residents (UK Government, 2021). The policy was controversial and strongly opposed by the main trade union for care workers (Unite 2021).[2] As elsewhere in the world, much of the debate over mandates has focused on ethics with some (for example, Rodge and Blackshaw, 2022) arguing that using the threat of job loss as a means to pressure individuals to be vaccinated is unacceptable as it breaches an individual's right to refuse medical treatment. Others (Dumyati, Jump and Gaur, 2021; Emanuel and Skorton, 2021) argue that the potential impact of vaccination on saving the lives of vulnerable residents outweighs ethical concerns in this particular case.

Important as they are, we do not consider ethical issues in this paper. Rather we concern ourselves with the practical effects of the mandate. Specifically, what impact did the mandate have on vaccine take-up, and, most importantly, did it actually lead to a reduction in Covid-19-related mortality among elderly care home residents?

A further issue that we consider is what impact if any, the mandate had on staffing levels in elderly care homes. The care sector has been beset for some years by difficulties in recruitment and retention (Daly and Armstrong, 2016) related to low wages (Machin and Wilson, 2004; Vadean and Allan, 2021) and over-reliance on agency workers (King, Svensson and Wei, 2017). Low staffing levels have been associated with poor quality of care (Castle, 2008) and infection outbreaks (Gorges and Konetzka, 2020). When the mandate was announced, many commentators expressed concern that the move would lead to some carers leaving the sector, thus exacerbating staffing difficulties. Indeed, the Government Impact Assessment of the policy concluded that around 7% of the

[2] Kaine (2011) explores the limited impact of unionisation on employer decision making in the residential care sector.

workforce (about 37,000 workers) might need to be replaced as a result of the mandate (HSCC, 2021a).

Despite the controversies, there is only limited empirical evidence on the actual impacts of requiring Covid-19 vaccination as a condition of employment.[3] Cohn et al (2022) report that employer-based vaccine mandates in New York City were associated with a significant increase in uptake and this finding is supported by survey evidence of hypothetical responses to mandates (Lee et al, 2021; Bennet, Bloom and Ferranna, 2022; Fishman et al, 2022). Evidence on real-world impacts for care homes is limited to a case study of a single US nursing home (Ritter et al, 2021) and descriptive data from Mississippi (Syme, Gouskova and Berry, 2021). In their case study, Ritter et al. (2021) also report that some staff resigned rather than comply with a vaccine mandate, but, to our knowledge, there has been no attempt to estimate the magnitude of any impact on staffing or Covid-19 mortality. Given the political, ethical, and personal significance of these policies, the limited evidence on their impacts is unsatisfactory and something we hope to address in this paper.[4]

We use weekly data at the local authority level on staffing and vaccination levels for elderly care home workers in England (subject to the mandate), other social care workers (generally not subject to the mandate), and social care workers in Wales (with no mandate) to estimate the magnitude of any impact of the mandate on staff vaccine take-up and staffing levels. We also explore whether there was any impact of the mandate on Covid-19-related mortality among elderly care home residents in England using Covid-19 deaths occurring at home and care home deaths in Wales as comparisons.[5]

[3] There is somewhat more evidence on the direct impact of vaccine certification aimed at the general population, for example as a condition of entry to hospitality venues. Karaivanov et al. (2021) and Mills and Rüttenauer (2022) both find evidence that such measures contributed to substantial increases in vaccine uptake, particularly among young people. The latter study also examines the impact of certification on Covid-19 cases but finds no consistent pattern.

[4] Some work pre-dating the Covid-19 pandemic examines interventions (though not mandates) to increase vaccination rates among patients and healthcare workers. See, for example, Whitaker, Poland Beckman et al (2018) and Haviari, Bénet, Saadatian-Elahi et al (2015).

[5] As we explain below, data limitations mean it is not possible to include other UK nations in the main empirical analysis.

In the next section of the paper, we discuss in more detail the implementation of the English care home vaccine mandate and its potential impacts. In section 3, we explain our empirical approach and our data. We report and discuss our results in section 4 and then, in the final section, we draw out some policy implications.

2. The care home mandate and its likely impact

2.1 The English care home mandate

On 16th June 2021, the UK Government published the outcome of a consultation on compulsory vaccination for care home workers (UK Government, 2021). Although a majority of respondents to the consultation had expressed opposition, the Government announced that it would introduce new legislation under which from the 11th of November 2021, it would be a condition of employment for all those working at care homes for the elderly that they should have received at least two doses of a Covid-19 vaccine. The mandate covered residential and nursing homes for the elderly but not other assisted living facilities where the resident lives in an independent housing unit but with access to on-site support when needed.

The law was eventually passed on 3rd August. The implementation date was chosen to provide sufficient time for care home workers to receive two doses of the vaccine. Due to the recommended delay between receiving the first and second doses, the Government advised that there should be a deadline of the 16th of September before which all workers should have received the first dose.

Exemptions from the mandate were provided for a limited number of medical reasons which had to be certified by a medical practitioner. There was no exception for conscientious objection to vaccination or immunity from a previous Covid-19 infection.[6]

[6] The Government eventually permitted medical exemptions to be self-certified for a time-limited period.

The mandate was restricted to England as policy relating to Covid in the UK was largely devolved to the constituent nations. Although similar mandates were discussed in Northern Ireland, Scotland, and Wales, none of them implemented a similar law.

2.2 Likely impact on take-up, staffing, and mortality

Potential mechanisms for impacts on take-up and staffing

There are several potential responses from care home staff to vaccine mandates and it is helpful to consider the reactions of different groups of carers. The first comprises those who are not strongly opposed to vaccination but happen to be previously unvaccinated, some perhaps as they felt they were at little personal risk from Covid-19, others who intended to be vaccinated but had not got around to it due to insufficient motivation or organization. We can expect the mandate unambiguously to increase uptake among this group and with little effect on staffing levels.

The second group comprises those who are more fundamentally opposed to vaccination. The net impact here is harder to predict. Opposition to vaccination could be for several reasons including conscientious objection, concerns about side effects, and more general vaccine hesitancy due to distrust of government and public health messaging. We expect some of this group to get vaccinated under the pressure of the mandate whilst others will choose not to be vaccinated even if this means losing their job. Indeed, de Figueiredo, Larson and Reicher (2021) provide evidence that coercion or pressure to be vaccinated can lead to a loss of trust in vaccinations and re-enforce vaccine hesitancy among significant numbers of people.

The eventual decision for those groups initially opposed to vaccination will depend on at least two factors. First, the depth of opposition to the Covid vaccine and, second, the costs incurred by losing their job. The size of the latter will vary depending on the economic circumstances. Where there are good opportunities for alternative employment, the opportunity cost of not being vaccinated is likely to be lower than where there are limited alternative opportunities.

The final group of care home staff to consider are those who are vaccinated but hesitant or unwilling to work with unvaccinated colleagues. It is conceivable that some in this group are more likely to stay in the profession given the mandate than otherwise and this suggests a potential mechanism whereby vaccines as a condition of employment could have a positive impact on staffing.

Before the mandate was implemented, the Government Impact Statement produced estimates of the likely numbers of care workers who would need replacing due to the vaccination requirement. These ranged from 15,000 to 60,000 with a central estimate of 37,000. Figures from the Department of Health and Social Care (DHSC) indicate that the central estimate works out to just under 7% of the workforce (DHSC 2021a). An accompanying Equality Impact Statement also discussed the possibility that employment effects may be felt more strongly in certain minority ethnic and religious groups characterized by relatively high levels of vaccine hesitancy (DHSC 2021b).

It is important to be clear that this does not mean that the Government expected the care home workforce to be reduced by the full 37,000 workers. We also need to consider the response of employers. In the event of an employee choosing not to be vaccinated, employers will make efforts to replace that worker with someone who is vaccinated. Given that many care home posts do not require formal qualifications, replacing existing workers with others may be possible at least to some extent. Indeed, the modeling in the Impact Statement assumes care homes will be able to replace the vast majority of workers who leave the profession (DHSC, 2021a p.33). However, the ease with which employers will be able to do this will depend on the economic circumstances. It is likely to be much harder to recruit replacement workers in areas with very high levels of employment relative to areas in which there is significant unemployment.

These considerations suggest several empirical predictions. First, we expect that the mandate will lead to an overall decrease in the proportion of care home workers who remain unvaccinated due to more care workers being vaccinated (the numerator decreases) but also due to a

reduction in the total number of care workers (numerator and denominator decrease by the same amount, increasing the proportion). Further, the positive impact on take-up will likely be higher in areas with high unemployment, whilst the negative impact on staffing will be greater in areas with low unemployment.

Potential mechanisms for impact on Covid-19 mortality

Deaths among elderly care home residents have been a significant contributor to Covid-related mortality in many countries (see, for example, Chen, Chevalier and Long, 2021; Bjoerkheim and Tabarrok, 2022). The primary aim of the mandate was to reduce infection outbreaks and subsequent serious illness and death among elderly residents by lowering the likelihood of transmission from infected care workers. The Government Impact Statement noted that, although care homes had strict testing requirements for staff, high vaccination rates among residents and other infection controls, deaths among elderly residents continued to make up a significant proportion of all Covid-19-related deaths even in mid-2021. As a result, increasing vaccine takeup among care workers was seen as having the potential to make a significant impact on mortality (DHSC, 2021a).[7]

There are, however, several reasons to question the size and even direction of any effect on mortality. In the first place, recent evidence suggests that, although Covid-19 vaccination seems to be effective against serious illness and death, effectiveness against infection and transmission is much more limited than was originally hoped (Andrews et al., 2022) partly due to relatively fast waning immunity (Goldberg et al., 2021). Second, even if vaccination does provide at least some protection against infection, there may be cohort effects that reduce the risk of unvaccinated care workers as a group. Most obviously, if care workers who have immunity from a previous infection are less likely to get vaccinated than others, then the aggregate reduction in risk of infection in the

[7] Holmdahl et al. (2022) set out a formal epidemiological model outlining a mechanism whereby higher staff vaccination coverage can affect the dynamics of infection outbreaks in nursing homes.

vaccinated group may be much less than that implied by vaccine effectiveness at an individual level.[8]

Vaccination may also induce behavioral effects that reduce the relative risk between the two groups. For example, vaccinated people may, on average, take fewer precautions against Covid-19 infection. Further, Antonelli et al. (2022) find that vaccinated people who get infected are more likely to experience minimal symptoms and they highlight the potential risk of such individuals being unaware of their infection and, hence, infecting clinically vulnerable groups. Finally, there is evidence (Friedrich and Hackmann, 2017) that unanticipated reductions in staffing levels in nursing homes can have significant adverse effects on mortality. If the mandate did significantly impact net staffing levels, this could provide another route whereby deaths might increase in response to the condition of employment requirement. Similarly, Cronin and Evans (2022) find that care homes with higher quality ratings experienced lower Covid-19 mortality in the early part of the pandemic, but this seems to have come at the cost of increased overall mortality in homes rated higher quality. The authors suggest this result may be a consequence of the stricter application of rules that prevented Covid infection spread but which contributed to isolation and loneliness among residents. In contrast, Bjoerkheim and Tabarrok (2022) find no association between nursing home quality and Covid-related deaths.

Finally, to the extent that vaccination provides good protection against death, the very high take-up rates among residents may have meant limited scope for the mandate to reduce mortality even further. That said, there were significant numbers of Covid-related- deaths among residents throughout the observed period, meaning there was still potential for effects to be observed from the mandate.

[8] UKHSA Vaccine Surveillance reports (www.gov.uk/government/publications/covid-19-vaccine-weekly-surveillance-reports) during the roll out of the vaccine mandate indicated that positive test rates in England were higher among vaccinated people of working age than among unvaccinated. These are unadjusted rates, so it is difficult to know if they are the result of this sort of cohort effect or to other differences such as higher testing rates among vaccinated people.

Taking these factors together, although the mandate had the primary objective of reducing mortality, the direction and magnitude of the effect of a mandate on mortality in practice are unclear *a priori.*

Timing of effects

One important consideration is the likelihood that impacts of the policy may be observed well in advance of the final implementation date of 11th November. For example, once the Government announced on 16th June that it was going to proceed with new legislation, some previously unvaccinated care workers may have decided immediately to be vaccinated whilst those who were determined not to be vaccinated may have decided to seek alternative employment. The passing of the law in August and the first deadline in September are also likely to have given further impetus to the process. In the next section, we explain how our empirical strategy deals with this issue.

3. Empirical approach and data

3.1 Empirical approach

The basis of our empirical approach is to compare trends in our key outcome measures (care home vaccine uptake, staffing levels, and mortality) before and after the vaccine mandate in English local authorities relative to trends in different comparison groups. For uptake and staffing levels, we compare English elderly care home staff to (i) staff in other English social care settings who were not directly affected by the mandate and (ii) staff in elderly care homes in Wales where the mandate did not apply.

For the mortality analysis, we compare Covid-19-related deaths occurring in English care homes to (i) Covid-19-related deaths occurring in domestic homes and (ii) Covid-19-related deaths occurring in Welsh care homes. We use deaths occurring in domestic homes as a comparison point to control for underlying community levels of Covid-19 which might vary systematically across local authorities. Note that including hospital deaths in that comparison would not be appropriate as

that series will include an unknown number of care home residents who have been transferred to hospital.

Identifying a causal impact of the mandate is not without difficulties, particularly when comparing England and Wales. Local authorities in England may differ systematically from those in Wales and in ways that might affect trends in, say, vaccine take-up. This could lead to changes in outcome variables after the mandate was announced (or introduced) being incorrectly attributed to the mandate itself.

To give one example, England had several local authorities that, before the mandate announcement in June, had rates of care workers who were completely unvaccinated in excess of 20%. In contrast, no authority in Wales had such a high unvaccinated rate. June was the period in which the vaccine was rolled out to the general population of younger adults (the vaccine had been offered to care workers of all ages several months earlier). It is possible that social pressure arising from observing peers get vaccinated may have led to a boost in vaccination rates from June among younger care workers even had the mandate not been announced. But more importantly, the impact of such an effect on vaccination rates may be more likely to show up in those English areas with very high unvaccinated rates at that point.

Differences in local authorities should not be a concern when comparing English care homes with other care settings (or with deaths in domestic homes for the mortality analysis) as we have identical local authorities in both the intervention and comparison groups. On the other hand, it may be more difficult to separate effects directly caused by the mandate from those related to differential patterns of Covid-19 outbreaks in care homes and other settings. Given these considerations, our view is that the two comparison groups should be seen as complementary to each other.

To help address some of these issues, we employ the generalized synthetic control (GSCM) method developed by Xu (2017) to estimate the average treatment effects of the intervention in care homes in English local authorities. GSCM is an extension of the synthetic control method (SCM)

introduced by Abadie and Gardeazabal (2003) and Abadie et al. (2015). According to Athey and Imbens (2017), it is "arguably the most important innovation in the policy evaluation literature in the last 15 years" (p.9).

The intuition of SCM is to create a synthetic control unit that simulates the outcome of the affected unit had they not been treated. To the extent that the synthetic unit closely mimics the average behavior of the policy (treated) units in the pre-policy period, any post-policy difference in outcome between them can be taken as the causal effect of the policy.

GSCM offers two distinct practical advantages over the standard SCM. First, it allows for the case of multiple treated units with potential treatment heterogeneity as it is based on a linear model with time-varying coefficients interacting with unit-specific effects. This is important not only from an econometric point of view but also for studies seeking to analyze factors (correlates) of treatment effects across treated units. Second, it provides easy-to-interpret treatment effects uncertainty measures by way of simulation-based standard errors and confidence intervals.

We consider three outcome variables; the log proportion of care home staff with no Covid-19 vaccinations[9]; the log number of care home staff, and the log number of Covid-19-related care home deaths, all measured at a weekly frequency.[10] We describe the outcome variable Y by the following linear panel factor model (Bai, 2009)[11]:

$$Y_{it} = \delta_{it} D_{it} + x'_{it}\beta + \lambda'_i f_t + \varepsilon_{it} \qquad [1]$$

The policy indicator D_{it} equals 1 when local authority i has been subject to the mandate before period t and 0 otherwise. The heterogeneous policy effects on unit i at time t are given by δ_{it} and these are the main parameters of interest; x_{it} is a vector of observed covariates measured at the local authority level, which includes lagged values of Y, local unemployment rate, earnings,

[9] Our key vaccination uptake measure is the proportion of staff who have received no vaccinations. An alternative would be to use the proportion who were not considered to be 'fully vaccinated' by having had two doses, though the vast majority of care workers who received the first dose ultimately went on also to receive the second dose. Using this alternative measure provides estimates of the ATT of a similar order of magnitude to those below although the placebo and other diagnostic tests are no longer satisfied in all cases.

[10] We account for zero observations in the conventional way by taking log(x + 1).

[11] For convenience we adopt the notation of Xu (2017).

population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.

In the above equation, $f_t = [f_{1t}, \ldots, f_{rt}]'$ is an $r \times 1$ vector of unobserved common factors with associated factor loadings $\lambda_t = [\lambda_{i1}, \ldots, \lambda_{ir}]'$ and ε_{it} is the usual idiosyncratic error term. The factor component of the model $\lambda_i' f_t$ nests a range of unobserved heterogeneities including additive unit and time fixed effects and unit-specific linear and quadratic time trends. The number of factors r is assumed to be unknown, and Xu (2017) proposes a cross-validation procedure that automates the choice of r.

In line with the potential outcomes framework for causal inference, the treatment effect on treated unit i a time t, δ_{it}, is defined as the difference between two potential outcomes:

$$\delta_{it} = Y_{it}(1) - Y_{it}(0) \qquad [2]$$

where $Y_{it}(1)\ and\ Y_{it}(0)$ are the potential outcomes when $D_{it} = 1\ and\ D_{it} = 0$ respectively. The GSCM estimator is then given by the difference between the actual outcome $Y_{it}(1)$ and its estimated counterfactual $\hat{Y}_{it}(0)$

$$\hat{\delta}_{it} = Y_{it}(1) - \hat{Y}_{it}(0) \qquad [3]$$

In the above, $\hat{Y}_{it}(0)$ is obtained following the steps outlined by Xu (2017). Briefly, this involves first estimating the parameters of model [1] using the control group data only and employing a leave-one-out cross-validation procedure to determine the number of factors r. Next, the optimal number of factor loadings for each treated unit is estimated by minimizing the mean squared errors of the predicted treated outcomes in the pre-treatment periods. Finally, the average treated counterfactuals $\hat{Y}_{it}(0)$ are imputed based on the parameter estimates obtained in the previous two steps. Since the outcome variables are in logs, we report average treatment effects (ATT) as $\left(e^{\hat{\delta}_{it}} - 1\right) \times 100\%$.

The main identifying assumption of GSCM is the absence of time-varying confounders. To probe the validity of this assumption, we conduct a host of diagnostic checks. The first check is a placebo test in which we assume that the treatment had started 4 periods earlier than it actually did

and apply the same estimator to obtain pseudo-average treatment effect estimates. In the absence of time-varying confounders (the null hypothesis of the placebo test), these estimates should be statistically insignificant. The second is a plot of the dynamic average treatment effects on the treated (ATT) for a visual inspection as to whether the coefficients in the pre-treatment period are statistically indistinguishable from zero. More formally, we jointly test a set of null hypotheses that the average treatment effect for any pre-treatment period is zero ($ATT_s = 0 \; for \; any \; s \leq 0$) using a variant of a Wald statistic. The third check is an equivalence test which is motivated by the observation of Hartman and Hidalgo (2018) that the Wald test may lack power in small samples, failing to reject the null of joint zero ATT. Furthermore, even when the sample size is large, a few outliers may lead to the wrong conclusions. An equivalence test is used to guard against such possibilities, and its basic idea is to reverse the null of $ATT_s = 0$, and set it to $ATT_s < -\theta_2 \; or \; ATT_s > \theta_1$, where $-\theta_2 < 0 < \theta_1$ are pre-specified values. Rejection of this null would mean that the pre-treatment ATT falls within a pre-specified narrow range $[-\theta_2 < 0 < \theta_1]$, providing support in favor of the no time-varying confounders assumption.

A useful feature of the GSCM is that, unlike the difference-in-differences strategy, it does not rely on the parallel trends assumption for identification. However, for robustness we also employ the estimator proposed by Sun and Abraham (2021) to estimate dynamic treatment effects within a panel event study difference-in-differences framework.

The panel event study framework also allows us to combine our two comparison groups to generate triple difference estimates. For staffing, this involves comparing the difference between care homes and other social care staff in England relative to the equivalent difference in Wales. One caveat is that, although we do have data on workers from other social care sectors in Wales, these are not directly comparable to the English data.[12] For mortality, the triple difference estimates

[12] Specifically for England this category includes "other frontline social care staff working in close and personal contact with people clinically vulnerable to COVID-19 who need care and support". For Wales, the category is "other social care workers". In other words, the Welsh series cover a broader range of social care settings than England. However, given that the vaccine mandate did not apply to any social care workers in Wales, the triple difference estimates should still provide a useful comparison.

compare the difference in care homes deaths and deaths in domestic homes for England relative to the equivalent difference in Wales.

3.2 Data

We use weekly data from the DHSC on the numbers of staff in elderly care homes as well as the proportion of those staff who remain unvaccinated for each English upper-tier local authority. The data are counts of employees so one limitation is that we are unable to measure the total number of hours worked. Staff numbers include those employed directly as well as agency workers, i.e. those working at a home but employed through a private agency rather than directly by the care home. Such workers will typically be temporary, though in some cases, they may be assigned to a particular care home for a longer period. Data are based on returns provided weekly by individual care homes and coverage is around 99% of care homes throughout the period studied.[13]

We also have equivalent data for staff in "Other social care settings" a group who were not directly affected by the mandate.[14] Staff in this category are frontline social care staff working in close and personal contact with people clinically vulnerable to COVID-19 who need care and support and are employed by local authorities, the National Health Service (NHS), or the private sector. This will include, for example, staff employed by local authorities or the NHS and who provide personal care at home, social workers, and occupational therapists.

The data are published for Upper Tier Local Authorities. These authorities vary in size but, have a mean population of just over 400,000 and an average of about 75 elderly care homes. Due to boundary changes mid-sample, we dropped Northamptonshire from the sample leaving a total of 148 English authorities. Weekly data on staffing and vaccinations were collected from the end of

[13] www.gov.uk/government/statistics/adult-social-care-in-england-monthly-statistics-may-2022/adult-social-care-monthly-statistics-england-april-2022

[14] This category excludes those employed to work in care homes (whether directly or via an agency) and those employed by Independent CQC-Registered domiciliary care providers. Some staff in this category may be expected to visit elderly care homes as part of their role. As a result, we cannot rule out that some staff within this group experienced some pressure because of the mandate. In that case, our estimates of the impact on staffing and uptake compared against this group may be lower bounds. Missing data or discontinuities for a small number of local authorities mean the sample size is slightly lower when using this comparison.

2020 but response rates from care homes were initially very low. The rates improved throughout the early part of 2021 and were close to 100% by week 16 (week ending 23rd April).[15]

We end our observations in week 8 of 2022 (week ending 4th March). The care home mandate was formally abolished with effect from 15th March 2022. However, the Government announced its intention to abolish the mandate towards the end of January, making data after that point harder to interpret.[16]

Equivalent data for care homes in the 22 Welsh local authorities are not publicly available but were supplied to the authors following a Freedom of Information request, with data coming from the Welsh Immunisation System for Covid19.

We collect data from the Office of National Statistics (ONS) on the number of deaths taking place each week in elderly residential care homes in each local authority. The ONS report includes the total number of deaths as well as those in which Covid-19 is mentioned as a cause on the death certificate.[17] We use the ONS series by week of death occurrence (rather than week of registration).

For each local authority, we also collected annual data on the unemployment rate in 2021, as well as demographic information on population density, population by age, and ethnicity.

Weekly data on care home staffing levels and vaccination data are not available for other UK nations. For this reason, we restrict our main analysis to English and Welsh local authorities. However, in the Appendix, we do present some supplementary estimates of mortality impacts including Scotland.[18]

Typically we start our pre-policy period in week 16 of 2021. In the case of the GCSM estimates for vaccine take-up and staffing, our diagnostic tests hold even when using a longer pre-

[15] The ONS weekly data are reported using a system of 52 weeks for most years (for leap years, they use 53 weeks). In 2021, Week 1 is the week ending 8th January 2021 and Week 52 is the week ending 31st December. For a small number of local authorities in England, there are missing observations or discontinuities in the social care sector data which reduce the sample size a little.

[16] We include up to week 8 of 2022 in our synthetic control estimates below as deaths in this period will still reflect infections before the end of the mandate was announced. However, none of our key results are unduly affected by ending our sample earlier than this point.

[17] This does not necessarily mean that Covid-19 was the underlying cause of deaths.

[18] In our main Synthetic Control Method analysis, ethnicity is an important predictor variable. Unfortunately, equivalent data on ethnicity is unavailable for local authorities in Scotland meaning the mortality analysis including those nations is somewhat tentative.

period and so we extend it back to week 10. For mortality, using a longer pre-period means some of the diagnostic tests no longer hold. In all cases, our estimates of the causal effects of the mandate are similar whenever we start the pre-policy period.[19]

Details on the definition of each variable and data sources are provided in Appendix Table A1. In Table 1 we present some descriptive statistics of each variable, separately for England and Wales. For weekly observations, we present the average for each local authority in the four weeks before the announcement of the vaccine mandate and then the final four-week period of our sample.

We supplement the summary statistics by reporting (in Figures 1-3), national trends in reported weekly care home staffing levels, percentage of unvaccinated staff, and care home deaths related to Covid over the full period. On each graph we plot trends separately for England and Wales and indicate 4 key intervention points during 2021 as follows:

Week 25: the announcement by the Government on 16th June of their intention to legislate for mandatory vaccination of care home workers in England.

Week 32: the final passage of the mandatory vaccination law through Parliament on 3rd August.

Week 38: first deadline of 16th September by which time care home workers needed to have had their first vaccination to enable sufficient time to meet the final deadline for double vaccination.

Week 46: the final deadline of Thurs 11th November after which care home workers without an exemption were required to have had two vaccinations.

In Figure 1 we show the percentage of elderly care home staff who were unvaccinated in England relative to staff in other social care settings in England and to elderly care home staff in Wales. The percentage unvaccinated in care homes was already lower than in other social care

[19] The mortality results using a longer pre-period are presented in the Appendix Figures A19 and A20. We do not go back earlier than week 10 as there are significant gaps in the weekly data for vaccination and care home staffing before this point.

settings before the mandate was announced, but the gap increases rapidly after the announcement with notable drops after each of the September and November deadlines.

There was a higher proportion of unvaccinated care home staff in England relative to Wales before the initial announcement but again we see a much steeper decline in unvaccinated staff in England from the time of the announcement. There is also no sign from the Welsh data of the steep drops in unvaccinated that we observe in England after each of the two deadlines. By the time of the final deadline in November, the positions had reversed and there was a lower unvaccinated proportion in England. We should note that take-up seems to have been increasing faster in England even before the mandate announcement in June, confirming the importance of controlling for pre-existing trends in establishing the counterfactual when comparing against Wales. However, both comparisons are suggestive that the mandate was effective in increasing take-up.

In Figure 2 we report weekly staffing levels in care homes for England relative to staff in other social care settings in England and to care home staff in Wales. For ease of comparison, we normalize both series to 100 in the week before the England mandate announcement. English staffing levels in both care homes and other social care settings decline throughout the mandate rollout but there is a clear discontinuity at the time of the mandate announcement with care home staffing levels declining at a faster rate. At the end of the period, staffing levels in English care homes are about 3% lower overall than just before the mandate announcement. Further, there is a noticeable drop in staffing after each of the announcements, the September deadline, and the final November deadline (but not the passing of the law in August) consistent with a causal effect.

Reported care home staffing in Wales is much more stable than in England throughout the period. There is a small decline over the period but this is very marginal and, in contrast to England, there is no sign of an impact at the time of any of the mandate-related events. As with vaccine takeup, there is some evidence of a differential trend in staffing before the mandate

announcement, again emphasizing the importance of controlling for pre-event trends when comparing England and Wales.

Finally, in Figure 3, we report weekly trends in Covid-19-related deaths occurring in elderly care homes in England relative both to Covid-19-related deaths occurring at home in England and to care home deaths in Wales. Note that due to the time lag between infection and death, we should not expect to observe any impact of the mandate on care home mortality until at least three to four weeks following each event.

It is more difficult to pick out clear effects from the mandate events in the mortality trends. Deaths at home increase more rapidly than in care homes immediately following the mandate announcement in June but this seems unlikely to be causal as the trends diverge before we could plausibly expect to see any impact of the announcement. Comparing care home deaths in Wales and England, over the period of the mandate rollout, deaths increase and then stabilize before culminating in a spike in both nations in early 2022. The Welsh series is somewhat more variable than the English one but both nations follow a similar trend.

Overall the national trends suggest a strong association between the mandate rollout and both vaccination take-up and staffing levels, but little obvious association with mortality. However, the summary statistics in Table 1, indicate some clear differences between local authorities in England and Wales. On average, English local authorities are significantly larger in terms of population and the number of care home staff. They also have a higher proportion of the population with non-white-British ethnicities. We cannot rule out that differences in trends in England and Wales are affected in some way by these characteristics, an issue we deal with explicitly in our more formal econometric estimates of the impacts of the mandate.

4. Generalized Synthetic Control Method results

In Figures 4, 5, 6, and 7, we present our dynamic difference-in-difference and triple difference estimates of the ATT for each week from the announcement of the vaccine mandate in June using

our various comparison groups and for each of our three outcome variables: proportion of care home staff unvaccinated, total care home staffing and care home deaths related to Covid.

As a complement to the graphs, in Table 2 we report the estimated coefficients for our two comparison groups for representative weeks towards the end of each intervention period. We also report the p-values of the placebo pre-trend tests. In each case, we cannot reject the null hypothesis of common trends in our intervention and comparison groups before the announcement. This finding is also strengthened by the equivalence test. The placebo tests did not find any anticipation effects which further fosters faith in our empirical approach.

We focus first on the estimated effect of the mandate on the proportion of unvaccinated staff in elderly care homes using other staff in other social care settings and staff in Welsh elderly care homes (Figure 4) as comparison groups. The results are similar for both comparisons: the ATTs are significantly negative from the time of the initial vaccine mandate announcement and then decrease steadily. The implication is that the mandate caused a reduction in the number of care workers in England who remained unvaccinated. There are particularly steep dips in the run-up to the first deadline (week 38) and then again at the time of the final deadline (week 46), by which point, we estimate that the mandate had led to the proportion unvaccinated being between 60% and 70% lower than without the mandate.

The percentage of English care workers who were unvaccinated was about 16% just before the announcement, dropping to just 4% after the final implementation of the mandate. Our GSCM estimates imply that the mandate caused a substantial proportion of this reduction and that there were between 28,000 and 41,000 fewer unvaccinated staff than had the mandate not been in place.[20]

Turning to the impact of the mandate on staffing levels, using both comparison groups, the ATTs are again significantly negative and declining throughout the period after the mandate announcement (Figure 5). As we would expect, there are particularly significant declines at the

[20] The ATT estimates of a 60%-70% reduction imply that, absent the mandate, the percentage unvaccinated would have been between 10% and 13% rather than 4%. Based on about 460,000 staff, that is equivalent to between 27,600 and 41,400 fewer unvaccinated staff.

time of the final deadline in November. The fact that the ATT is consistently negative indicates that it did not prove possible to replace all workers who left their position due to the mandate.[21]

Immediately after the final deadline in November, our estimates suggest that the mandate had caused a net reduction in staffing of about 3.5%, equivalent to over 16 thousand employees across England. The upward slopes of the ATT in the Welsh comparison after the final deadline suggests a gradual recovery in staffing levels, but even by week 5 in 2022, the ATT is still around -3% indicating the mandate had caused a reduction in net staffing of about 14 thousand employees at that point. The comparison with other social care workers suggests a slightly larger effect.

It is reasonable to assume that the vast majority of care workers leaving as a result of the mandate were unvaccinated. On this basis, the net reduction in the number of staff would, other things equal, have increased the total number of staff vaccinated of between 12 and 25 thousand. Note this figure includes both those already employed and who decided to get vaccinated as a result of the mandate as well as staff newly recruited to replace unvaccinated workers who left employment.

One important aspect of the impact on staffing is any impact on the mix of directly employed and agency staff. If the mandate caused staff a particularly high degree of turnover in care home staffing, we would expect care homes to be forced into greater reliance on the use of agency staff. Unfortunately, data on the percentage of agency staff are only available for English care homes so it is not possible to replicate our difference-in-difference analysis on this measure. However, the proportion of agency staff increased quite sharply from 3.7% in the run-up to the first deadline in September to around 5% after the final deadline (see Appendix Figure A1). This is at least consistent with the mandate causing greater reliance on the use of agency staff.

Next, we report estimates of the impact of the mandate on Covid-19-related deaths in English care homes. As noted above, we would expect a lag of at least 3-4 weeks before we might observe any impact of the mandate on mortality. When we use deaths in domestic homes as the

[21] Note the drop in the ATT in week 52 of 2021 is a seasonal affect related to Christmas/New Year holidays.

comparison group (Figure 6 and Table 2), the ATTs vary in sign and statistical significance. They are more likely to be negative in the very early post-announcement period but become positive and statistically significant from the start of 2022. One concern is that deaths in domestic homes may have deviated from those in elderly care homes at this time due to differential patterns of Covid spread that are unrelated to the mandate. When comparing against Welsh care homes (Figure 6 and Table 2) the ATTs are generally (but not always) positive and sometimes significantly so, especially later in the sample. We consider this further in our discussion of the panel data triple difference estimates.

Event Study Panel Framework

As an alternative to the GSCM approach, we also consider dynamic difference-in-difference estimation within an event study panel framework. For all of our outcome measures, the pattern of estimated ATTs is very similar to that using GSCM. The main difference is that the estimated ATT for the percentage unvaccinated at the end of the sample is a little lower than using GSCM though the effect is still strongly statistically significant. Given this similarity and to save space, we present the graphs and associated tables for the difference-in-difference estimates in the Appendix (see Figures A2 to A4 and Table A2).

Using the event study framework allows us to estimate triple difference estimates by combining our two comparison groups. We report these results in Figures 7a-7c and Table 3.

The estimated effect of the mandate on vaccine take-up among staff using triple differences (Figure 7a) is very similar to that found from the difference-in-difference estimates. Similarly, for staffing levels, the triple difference estimates (Figure 7b) continue to suggest the mandate had the effect of reducing staffing numbers by a little under 4% (equivalent to about 18,000 staff) with a particularly steep drop at the time of the final deadline in November.

The triple difference estimates are especially important for our mortality analysis given concerns of differential patterns in underlying Covid infections in different settings that may be

unrelated to the mandate. We report these estimates in Figure 7c and Table 3. The triple difference point estimates are on average positive but characterized by relatively large confidence intervals. This indicates that the significant effects on care home deaths observed in some of the individual GCSM comparisons are unlikely to be causal. Taken together, our results do not provide evidence that the vaccine mandate was successful in its primary aim of reducing care home deaths, but inferences regarding mortality are more uncertain than for vaccination uptake and staffing.

Correlates of ATT

With the GSCM approach, we are also able to generate ATTs at the individual level. We conduct regression analysis of the impact of unemployment rates on these ATT values (using the last four weeks of the sample data) for each of our three main outcome variables. In the regressions we also control for the ethnic composition of local authority populations as these may be correlated with both the unemployment rate and Covid-related outcomes (and by extension the ATTs themselves).[22]

The results (reported in Table 4) are reasonably similar whichever comparison group is used. We find a significant and negative association between unemployment and the ATT for the proportion of unvaccinated staff whilst the association for total care home staffing is significantly positive. In other words, the vaccine mandate appears to have a bigger impact on take-up (and a smaller reduction in staffing) in high unemployment areas where care workers have fewer alternative sources of employment and care homes are likely to find it easier to replace unvaccinated employees. The effects are sizeable. Consider an authority like Birmingham that has an unemployment rate close to double the national average. The coefficient on proportion unvaccinated using other social care settings as a comparator (-5.296) suggests that the mandate would be associated with a reduction in the proportion unvaccinated by about 5.3 percentage points

[22] In fact, the unemployment estimates are reasonably robust to the exclusion of the ethnicity variables. We also experimented with outlier robust regression estimates to guard against the possibility of extreme ATT values exerting undue influence on our correlation analysis (Rousseeuw, and Leroy, 1987). These results are very similar to the OLS results presented in Table 4.

more in Birmingham than in an area with average unemployment. Similarly, the mandate is estimated to be associated with a reduction in staff numbers in Birmingham that is about 1.4 percentage points less than average.

Unemployment is also negatively associated with the ATT for Covid-19 deaths in care homes. In other words, we are more likely to observe a positive ATT (indicating the mandate increased care home Covid deaths) in areas with lower unemployment rates. As the triple difference estimates indicate no statistically significant impact of the mandate on mortality overall, we are more cautious about interpreting this result. However, given lower unemployment rates are associated with a bigger reduction in staffing due to the mandate, it is at least consistent with previous work (Gorges and Konetzka, 2020) suggesting that lower staffing levels in care homes are a contributory factor to Covid outbreaks among residents.

Supplementary Analysis

We conducted several further experiments to test the robustness of our results. For reasons of space, these results are reported in the Appendix.

First, we compared vaccine take-up among care home staff in England against a third comparison group: take-up among the general population. With both the GCSM and dynamic difference-in-difference approaches (Figure A5), we continue to find a strong causal impact of the vaccine mandate on take-up, consistent with our other comparison groups.

We also explore the impact of the mandate on the total number of care home staff fully vaccinated relative both to other social care staff, to Wales, and the combined comparison (using the dynamic difference-in-differences-in-difference approach). This provides another way of identifying how much of the reduction in the percentage of unvaccinated staff is due to an increase in the number of staff being vaccinated rather than to unvaccinated staff leaving.[23] The triple difference estimates suggest the mandate caused an increase in the number of fully vaccinated of

[23] We are grateful to anonymous referees for this suggestion.

about 7%. This is equivalent to about 28 thousand workers, a little higher than that implied by our main estimates above. The estimates (Figures A6 and A7) based on the individual comparisons (i.e. versus other care sectors and versus Wales) show quite a lot of variation and the triple difference estimates suggest some pre-intervention differences. As a result, we are a little cautious about these results.

Next, we repeat all our estimates excluding all London local authorities. The motivation for this is that London is particularly different from the rest of the UK in terms of its demographics and also mobility between local authority boundaries. This may be especially important when comparing English local authorities with those in Wales. Reassuringly, the results (Figures A8-A13) are very similar whether or not London's local authorities are included.

We then re-estimate our mortality results including Scottish local authorities in the comparison group. This increases the number of local authorities in our control group from 22 to 54. Due to missing data, we use a different set of matching variables to the previous analysis, though again we cannot reject the null hypothesis of common trends in the intervention and control groups before the announcement. As with the results excluding Scotland, the estimated ATTs (Figures A14 and A15) do not suggest any evidence that the mandate was successful in reducing mortality amongst care home residents.

A further experiment is to model Covid-19 deaths as a proportion of all deaths occurring in care homes with Wales as the counterfactual. Using this approach (Figure A16), the ATT point estimates continue to vary in sign but are less commonly positive than when using numbers of deaths. Confidence intervals are relatively wide and there is little evidence of a significant impact on mortality in either direction.

The final experiment is to explore whether we can observe any impact of the vaccine mandate on the number of deaths from any cause (i.e. not just Covid) in English care homes relative both to mortality in domestic homes and relative to care homes in Wales. To the extent that lower staffing levels affect the quality of care, we may observe an increase in all-cause mortality

associated with the mandate. When comparing against mortality in domestic homes (Figure A17), we find a positive impact of the mandate on care home mortality whilst, for the comparison with Wales (Figure A17), the effect is generally insignificant. The triple difference estimates (Figure A18) suggest a positive effect that is significant in some time periods. That is consistent with lower staffing levels contributing to higher mortality in care homes though we note that the confidence intervals in the triple difference estimates are particularly wide.

5. Conclusions

The use of mandatory vaccination for Covid-19 as a condition of employment remains a highly contentious policy but one with a dearth of empirical evidence to inform the debate. In this paper, we have examined the effects of a mandate on elderly care home workers instituted in England during 2021. That the mandate was not implemented for workers in other social care settings in England or for any care workers in other UK nations provides helpful sources of identification.

Using a range of empirical techniques to establish causality, our results suggest the mandate was effective in achieving one of its proximate objectives, namely decreasing the proportion of care home staff who were unvaccinated. This is consistent with research on vaccine certification for access to hospitality among the general population and which also finds a substantial impact on take-up (Karaivanov et al., 2021; Mills and Rüttenauer, 2022; Oliu-Barton, Pradelski, Woloszko, et al, 2022). However, in the case of English care homes, at least some of the reduction in the proportion of staff remaining unvaccinated was due to a reduction in total staffing levels.

The impact on vaccination take-up was strongest in those areas characterized by high levels of unemployment in which care workers had relatively few alternative opportunities for employment had they chosen not to take up vaccination. We can expect that it was easier to hire vaccinated workers in such areas but the result may also indicate that the mandate worked not just in ‘nudging’ employees with neutral attitudes towards the vaccine, but in exercising an element of

coercion among employees who were opposed to being vaccinated but complied due to concerns about the loss of employment.

In contrast, the negative impact on staffing levels was strongest in areas with low unemployment. This is consistent with care homes in low-unemployment areas in England finding it difficult to replace workers who had left their positions due to the mandate.

We estimate that the vaccine mandate caused a net reduction in staffing of between three to four percent equivalent to 14 to 19 thousand employees in elderly care homes in England. Further, there is some evidence that the mandate may have contributed to increased reliance on agency workers. Given that high use of agency workers in nursing homes has been associated with lower-quality care (see, for example, Castle and Engberg, 2008), this is a potential concern that would merit further investigation.

More recent data on staffing levels suggest that at least some of the impact on staffing persisted even after the mandate was lifted. For example, by the start of June 2022, the total employed in elderly residential care was still about 2% lower than just before the mandate was announced in the previous year. Although this represented a recovery in staffing numbers from when the mandate was in operation, the was driven almost entirely by agency workers.[24]

Despite the impact of reducing the proportion of staff who were unvaccinated, our results do not provide evidence that the mandate had a causal impact on the key policy objective of reducing Covid-19 mortality in elderly care homes. However, the relatively wide confidence intervals suggest more uncertainty for our mortality results than for those relating to vaccination uptake and staffing.

One caveat to our results relates to data reliability. Weekly data on vaccination take-up and staffing levels come from reports by individual care homes. Although reporting was a requirement of the regulatory authorities and was completed by nearly all care home establishments[25], they were

[24] The number directly employed in elderly care homes was still 4% lower in June 2022 than a year previously.

[25]The English data cover over 98.5% of elderly social care homes www.gov.uk/government/statistics/adult-social-care-in-england-monthly-statistics-may-2022/adult-social-care-monthly-statistics-england-may-2022 The reporting data rate is not published for Wales.

not subject to systematic quality checks. In contrast, data on Covid-related mortality in care homes are official Office of National Statistics publications and can be considered highly reliable.

A further limitation of our research is that our estimates of the impact of the vaccination mandate on staffing relate only to the total numbers employed. We do not have consistent data on the total number of hours worked or on staffing quality apart from reliance on agency staff.

Our results have important policy implications. For some, ethical considerations such as the right to refuse health care and objections to the use of coercion mean a policy to mandate vaccination as a condition of employment is never justified. Others believe that ethical objections need to be weighed against benefits to the well-being of vulnerable residents. However, even with the latter view, mandating a health intervention is a serious step and one that requires a high bar of evidence that the public health benefits exceed the likely costs.

The evidence we have presented suggests that, in the case of the English care home mandate, there does not appear to be any observable benefit to residents in terms of Covid-related mortality, but there were significant costs arising from staffing reductions directly attributable to the mandate. These results raise questions for policymakers about the wisdom of continuing with existing mandates. They also suggest that care home managers operating in jurisdictions without a legal mandate should reconsider local policies regarding vaccination as a condition of employment.

It is important also to consider the extent to which our results can be generalized to other workplace contexts such as healthcare, education, and military establishments. Care homes in most countries have been subject to particularly tight procedures regarding infection control, visitors, and testing requirements. Although vaccine mandates seem to have had little or no observable impact on mortality in that context, the situation may be different when, say visiting restrictions are relaxed, or in other workplaces where infection control is less rigorous. On the other hand, care home residents are at much higher risk of serious complications from Covid than in most other workplace contexts. Further, despite rigorous infection controls, care homes in England have continued to see periodic Covid-19 outbreaks and associated mortality suggesting that, if mandates

were highly effective, we should still expect to be able to observe effects in the data. Policymakers and managers considering vaccination as a condition of employment in sectors other than elderly care should carefully consider the current lack of evidence for the benefits of vaccine mandates.

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Tables

Table 1: Descriptive statistics

	England LAs		Wales LAs	
Weekly data	Mean	SD	Mean	SD
% staff no vaccination: elderly care homes				
weeks 20-24, 2021	17.58	5.43	7.62	3.14
weeks 02-05, 2022	3.55	1.68	4.66	2.09
% staff no vaccination: other social care settings				
weeks 20-24, 2021	27.06	15.96	2.29	2.22
weeks 02-05, 2022	24.53	15.40	1.35	1.46
% no vaccination: general population				
weeks 20-24, 2021	39.04	9.40	N/A	N/A
weeks 02-05, 2022	21.35	7.63		
Staffing: elderly care homes:				
weeks 20-24, 2021	3,158	3,028	1,710	631.8
weeks 02-05, 2022	3,062	2,957	1,709	631.0
Staffing: other social care settings:				
weeks 20-24, 2021	3,951	3,496	2,066	1,134
weeks 02-05, 2022	3,888	3,489	2,064	1,132
% of staff in elderly care homes agency employed				
weeks 20-24, 2021	3.63	1.74	N/A	N/A
weeks 02-05, 2022	4.94	2.22		
Deaths related to Covid-19: care homes				
weeks 20-24, 2021	0.071	0.270	0	0
weeks 02-05, 2022	1.64	2.04	0.693	0.889
Deaths related to Covid-19: domestic homes				
weeks 20-24, 2021	0.061	0.239	0	0
weeks 02-05, 2022	0.554	0.886	0.182	0.416
Covid deaths as a % of all care home deaths				
weeks 20-24, 2021	0.91	4.61	0	0
weeks 02-05, 2022	11.25	12.68	13.87	18.71
Deaths from any cause: care homes				
weeks 20-24, 2021	11.08	11.41	3.92	2.33
weeks 02-05, 2022	15.01	15.21	4.93	3.41
Deaths from any cause: domestic homes				
weeks 20-24, 2021	19.32	17.01	8.73	4.38
weeks 02-05, 2022	22.56	19.45	10.11	5.26
Annual data	**Mean**	**SD**	**Mean**	**SD**
Unemployment	4.76	1.61	3.97	0.71
Earnings	622.0	84.11	565.44	35.16
Total population	376,891	280,962	144,072	71,127
Population density	2,811.3	3,230.9	441.3	538.9
Population % over 90 years old.	0.87	0.27	1.02	0.30
Population % non-British white ethnicity	5.21	5.00	1.77	0.87
Population % Black ethnicity	4.36	6.31	0.50	0.63
Population % Asian ethnicity	9.26	10.28	1.89	1.95
Number of local authorities	148		22	

Notes:

(i) Values are the means and standard deviations (SD) for upper-tier local authorities (LAs) in England and Wales respectively.

(ii) The time periods for the weekly variables cover the 4 weeks before the vaccine mandate announcement and the final four weeks in our sample.

(iii) The number of local authorities with other social care setting data is slightly lower due to missing data or data discontinuities in a small number of cases.

(iv) Covid deaths as % of all care home deaths exclude local authorities with no care home deaths in that period. As a result, data for this variable are missing for two English local authorities and one Welsh local authority.

Table 2: GSCM average treatment effects on the treated of the mandate for selected time periods.

Timing	vs other social care settings/deaths at home			vs Wales		
	Proportion staff unvaccinated	Number of care home staff	Number of COVID related deaths	Proportion staff unvaccinated	Number of care home staff	Number of COVID related deaths
Post Announcement (2021 wk 31)	-0.246***	-0.008*	-0.122***	-0.241***	-0.011***	0.055
	(0.039)	(0.004)	(0.042)	(0.033)	(0.002)	(0.047)
Post law passage (2021 wk 37)	-0.683***	-0.013	-0.016	-0.609***	-0.016***	0.083
	(0.055)	(0.009)	(0.052)	(0.050)	(0.002)	(0.073)
Post first vaccination deadline (2021 wk 45)	-1.144***	-0.028***	-0.015	-1.065***	-0.027***	0.173***
	(0.056)	(0.008)	(0.051)	(0.069)	(0.003)	(0.055)
Post second vaccination deadline (2022 wk 1)	-1.398***	-0.042***	0.073	-1.358***	-0.037***	0.211*
	(0.059)	(0.009)	(0.065)	(0.098)	(0.004)	(0.110)
Placebo (p-value)	0.691	0.317	0.675	0.591	0.459	0.947
Wald test for pre-trend (p-value)	0.62	0.535	0.665	0.035	0.20	0.820
Equivalence test	Pass	Pass	Pass	Pass	Pass	Pass
Number of English local authorities	148	148	148	148	148	148
Number of Welsh local authorities	n/a	n/a	n/a	22	22	22

Notes:

(i) Coefficients are obtained using the GSCM method where all outcome variables are in logs. Standard errors in parentheses.

(ii) As described in the main text, the covariates used the GSCM models include, local unemployment rate, earnings, population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.

(iii) ***p<0.01, **p<0.05, *p<0.1.

Table 3: Dynamic triple differences average treatment effects on the treated of the mandate for selected time periods

Timing	vs other social care settings/deaths at home and vs Wales		
	Proportion staff unvaccinated	Number of care home staff	Number of COVID related deaths
Post Announcement (2021 wk 31)	-0.209***	-0.010***	-0.110*
	(0.031)	(0.003)	(0.065)
Post law passage (2021 wk 37)	-0.575***	-0.014***	0.153
	(0.044)	(0.005)	(0.120)
Post first vaccination deadline (2021 wk 45)	-0.974***	-0.028***	0.060
	(0.053)	(0.005)	(0.090)
Post second vaccination deadline (2022 wk 1)	-1.202***	-0.040***	-0.047
	(0.058)	(0.006)	(0.134)
Number of English local authorities	148	148	148
Number of Welsh local authorities	22	22	22

Notes:

(i) Coefficients are obtained using the dynamic triple differences estimator where all outcome variables in logs. Standard errors are in parentheses.

(ii) As described in the main text, the covariates used the GSCM models include, local unemployment rate, earnings, population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.

(iii) ***p<0.01, **p<0.05, *p<0.1.

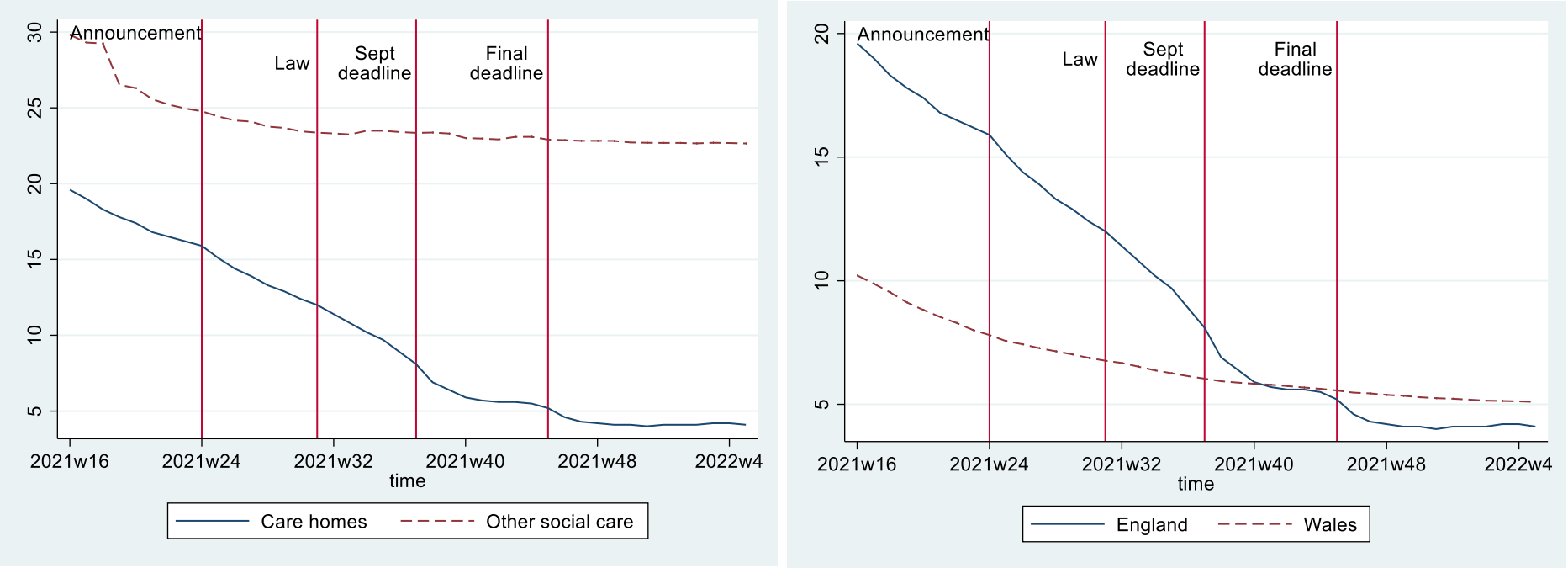
Table 4: Heterogeneity analysis: correlates of ATT

	vs other social care settings/deaths at home			vs Wales		
	Proportion staff unvaccinated	Number of care home staff	Number of COVID related deaths	Proportion staff unvaccinated	Number of care home staff	Number of COVID related deaths
Log unemployment rate	-5.296***	1.441**	-85.11***	-4.011**	1.685***	-82.46***
	(1.627)	(0.585)	(17.33)	(1.782)	(0.579)	(16.75)
Population proportion non-British white	-0.193*	-0.114*	-3.199***	-0.211**	0.0565	-3.109***
	(0.108)	(0.0667)	(0.669)	(0.105)	(0.0581)	(0.649)
Population proportion Black	-0.469***	-0.0531	-1.135**	-0.482***	-0.206***	-1.095**
	(0.0790)	(0.0474)	(0.561)	(0.0838)	(0.0425)	(0.548)
Population proportion Asian	-0.181***	0.0641***	-0.137	-0.229***	0.0715***	-0.137
	(0.0435)	(0.0191)	(0.353)	(0.0440)	(0.0185)	(0.343)
Observations	592	592	592	592	592	592
R-squared	0.266	0.0550	0.136	0.264	0.0796	0.136

Notes:
(i) Robust standard errors in parentheses.
(ii) Outcome variables are measured in natural logarithms.
(iii) All models are estimated by OLS using data on the last four weeks observations (week 2 – week 5, 2022)
(iv) The dependent variables are the estimated ATTs generated from the GSCM results.
(v) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

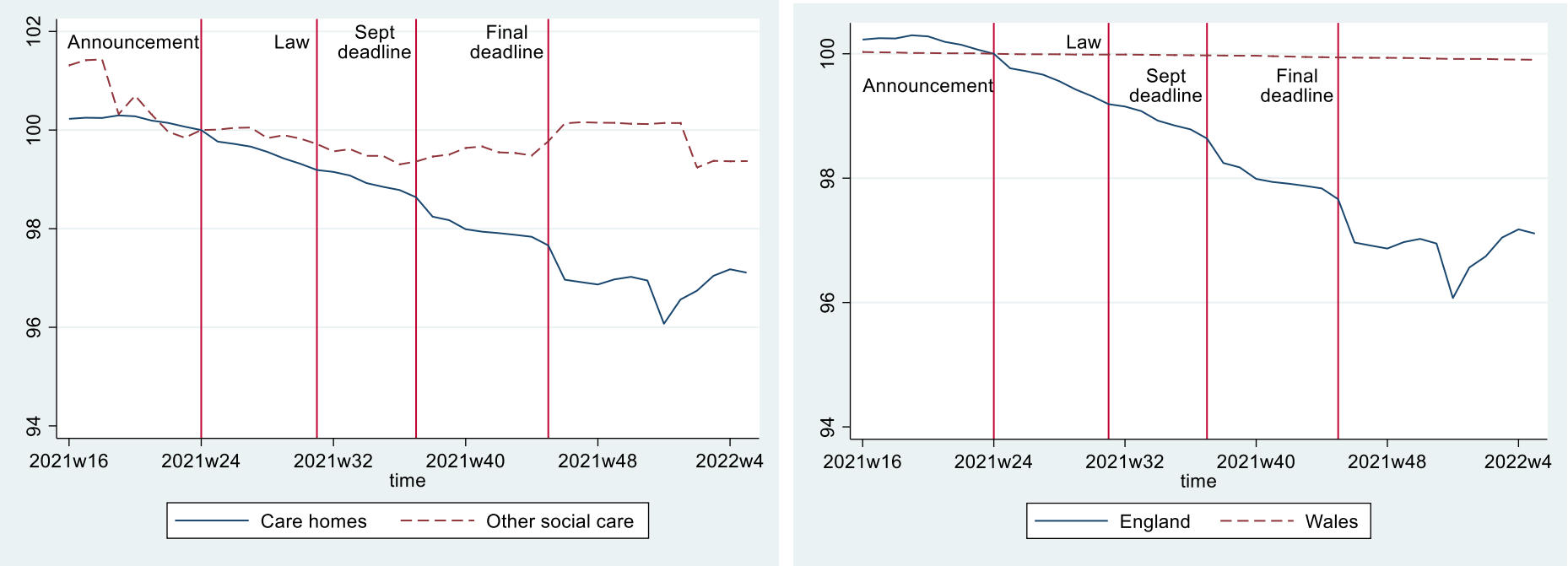
Figures

Figure 1: Weekly percentage staff unvaccinated in English care homes vs other social care settings and vs Welsh care homes



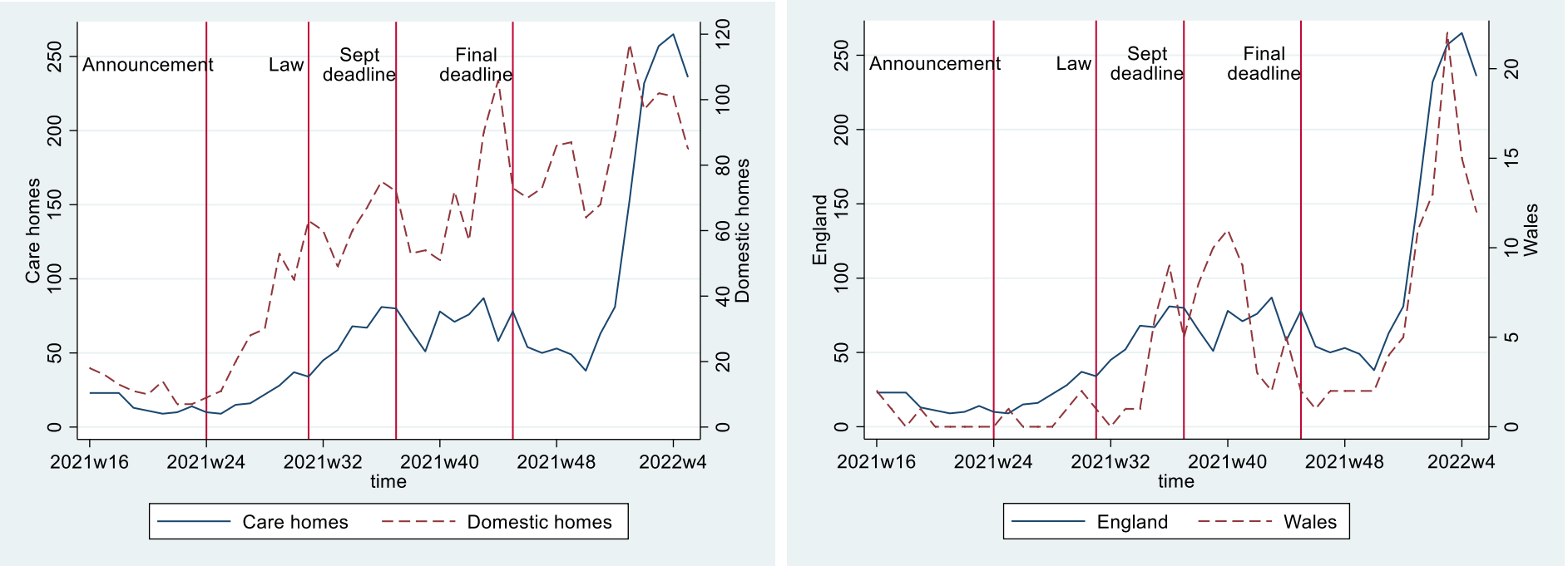
Notes:
(i) Vertical lines indicate the week prior to each of the specified events.
(ii) The series show the reported percentage of all staff in elderly care homes/other social care settings who have not received at least one Covid-19 vaccination by that week.

Figure 2: Weekly staffing levels in English care homes vs other social care settings and vs Welsh care homes



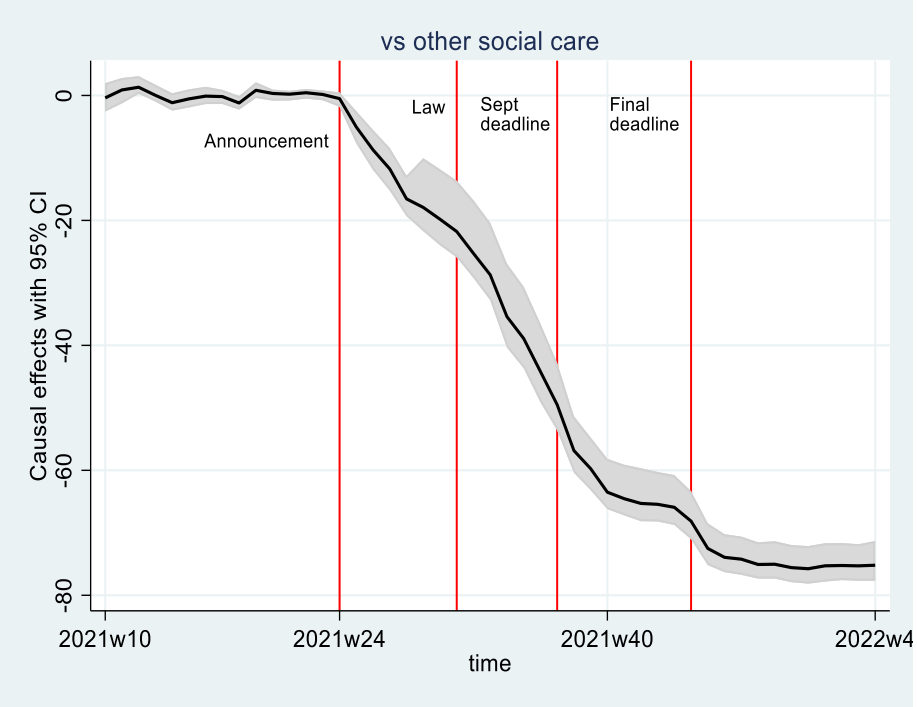
Notes:
(i) Vertical lines indicate the week prior to each of the specified events.
(ii) The series show the reported number of care staff working in elderly care homes/other social care settings each week, normalized to 100 for week 24 in 2021 (week ending 14th June).

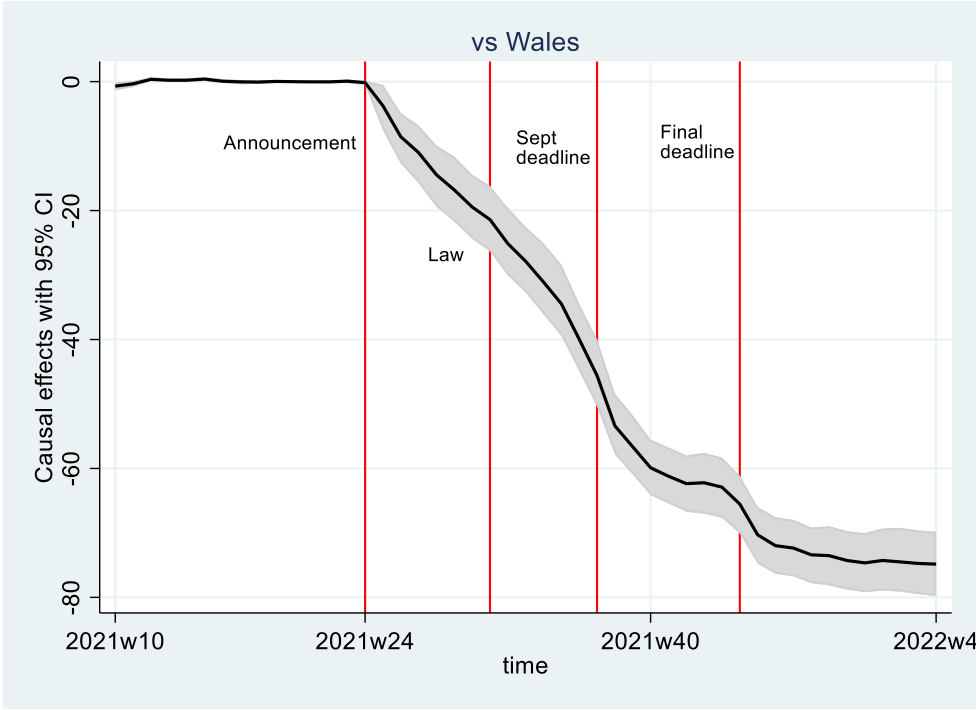
Figure 3: Covid-19 deaths in English care homes vs Covid-19 deaths at home and vs Welsh care homes



Notes:
(i) Vertical lines indicate the week before each of the specified events. Note any impact on deaths would be expected to be observed at least 3-4 weeks after each event.
(ii) The series show the weekly number of Covid-19-related deaths occurring in care homes or domestic homes.

Figure 4: GSCM estimates of impact of mandate on proportion of English care home staff unvaccinated: other social care settings England and care homes Wales as counterfactuals.





Notes

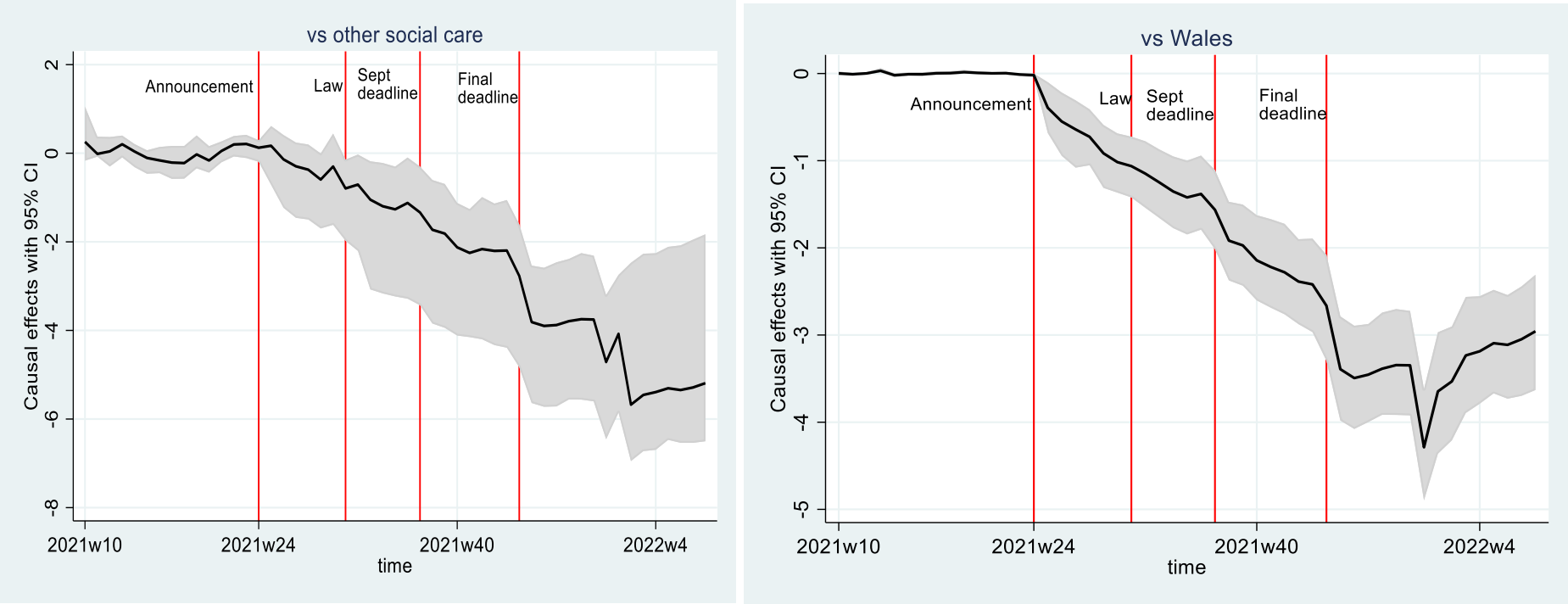
(i) The ATTS are in percentages and are obtained using the GSCM method.

(ii) The covariates used in the GSCM models are: local unemployment rate, earnings, population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.

(iii) The middle line traces the dynamics of these ATTS through the sample period, whereas the grey band is doing the same for the 95% confidence intervals. Accordingly, whenever the 95% confidence interval excludes 0, the ATT in that week can be taken as being statistically significant.

(iv) Vertical lines indicate the week before each of the specified events.

Figure 5: GSCM estimates of impact of mandate on English care home staffing: other social care settings England and care homes Wales as counterfactuals.



Notes

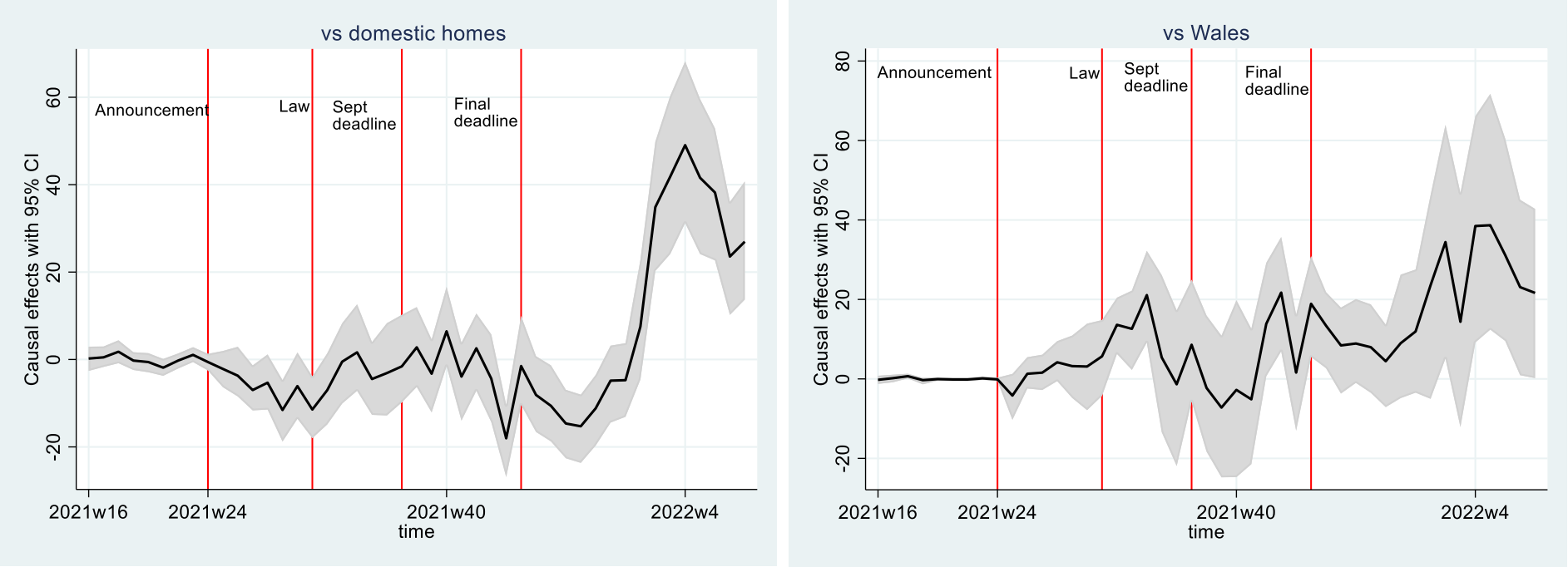
(i) The ATTS are in percentages and are obtained using the GSCM method.

(ii) The covariates used in the models are: local unemployment rate, earnings, population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.

(iii) The middle line traces the dynamics of these ATTS through the sample period, whereas the grey band is doing the same for the 95% confidence intervals. Accordingly, whenever the 95% confidence interval excludes 0, the ATT in that week can be taken as being statistically significant.

(iv) Vertical lines indicate the week before each of the specified events.

Figure 6: GSCM estimates of impact of mandate on Covid-19-related mortality in English care homes: deaths at home England and care home deaths Wales as counterfactuals.



Notes

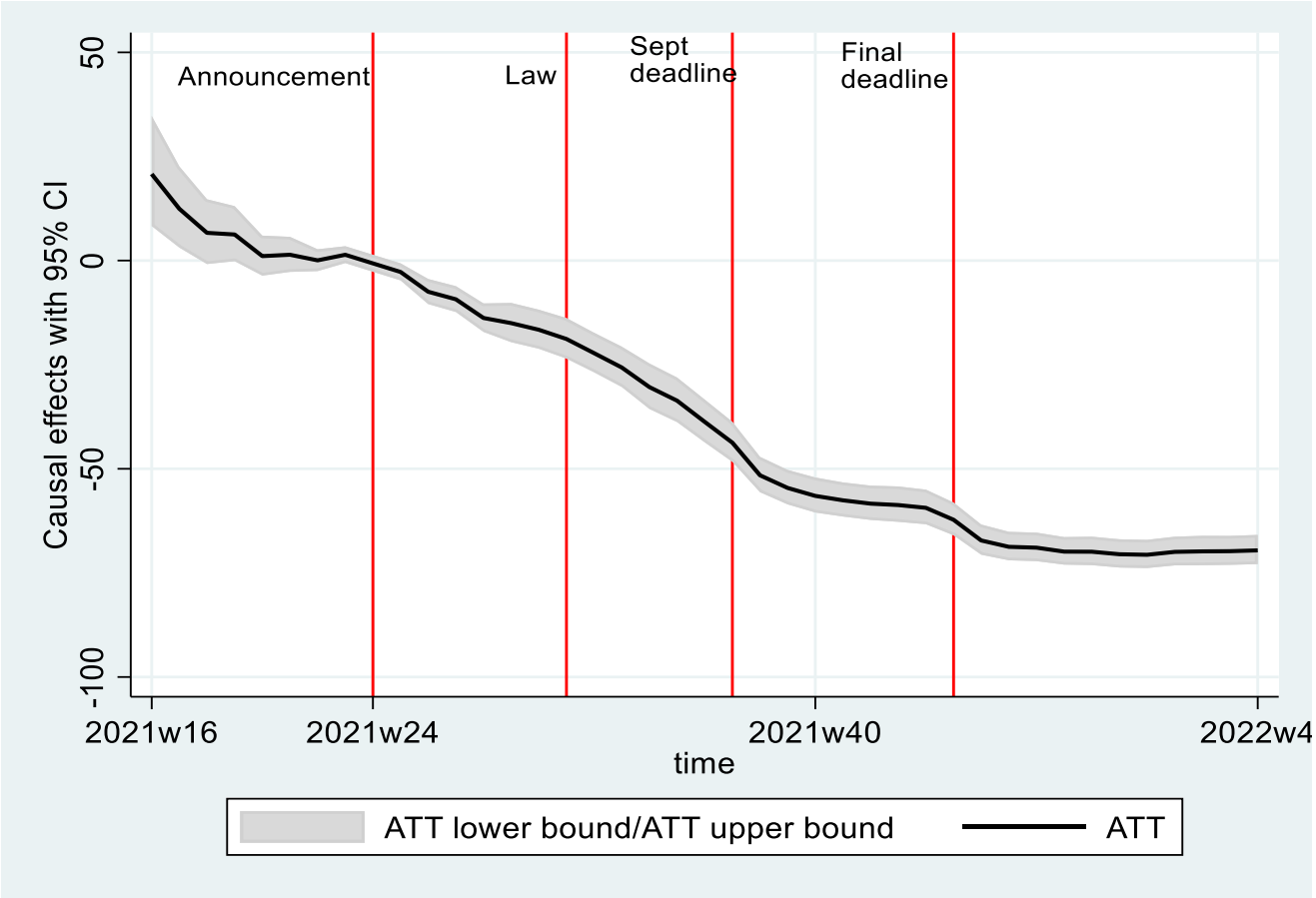
(i) The ATTS are in percentages and are obtained using the GSCM method.

(ii) The covariates used in the models are: local unemployment rate, earnings, population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.

(iii) The middle line traces the dynamics of these ATTS through the sample period, whereas the grey band is doing the same for the 95% confidence intervals. Accordingly, whenever the 95% confidence interval excludes 0, the ATT in that week can be taken as being statistically significant.

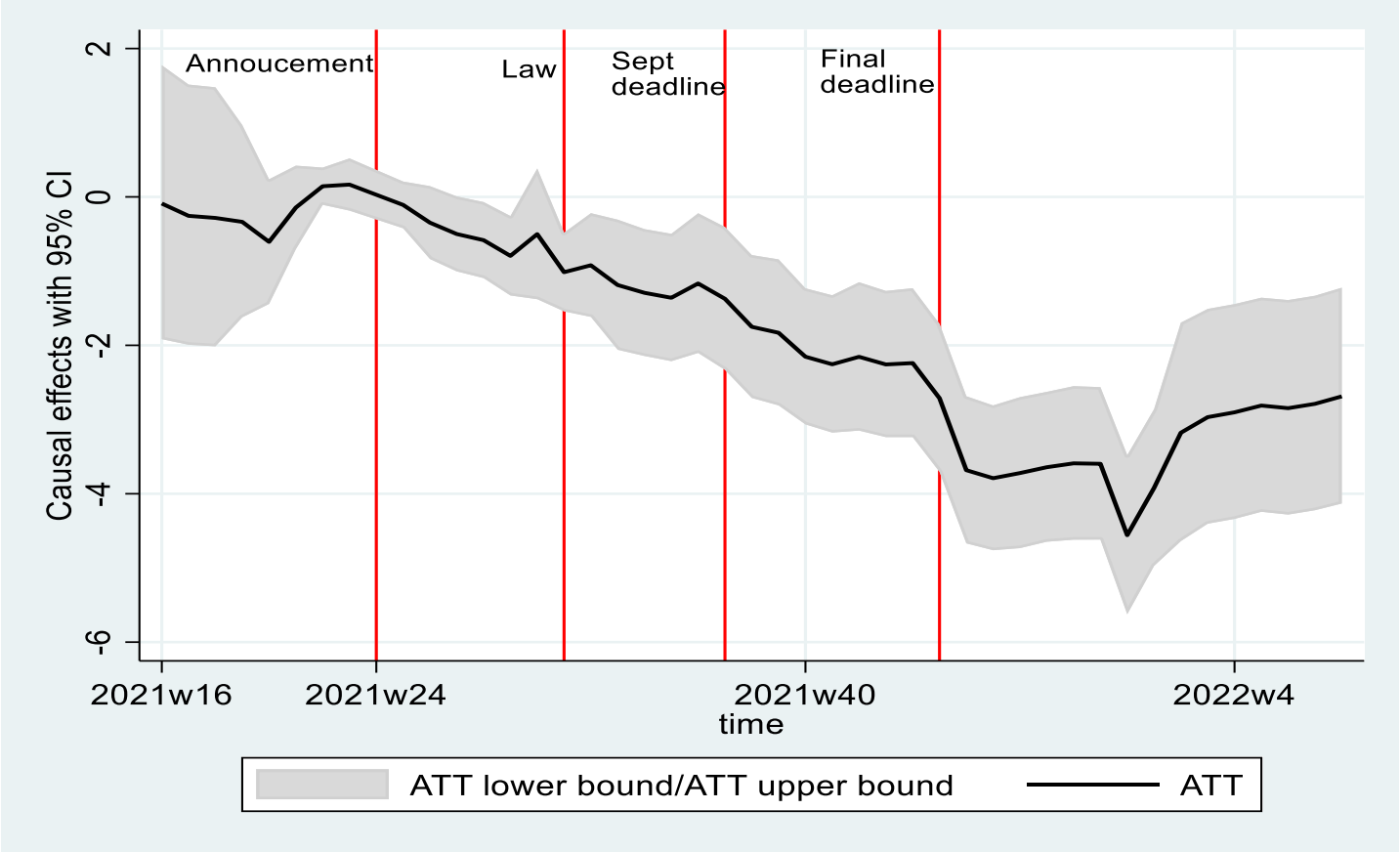
(iv) Vertical lines indicate the week before each of the specified events. Any impact on deaths would only be expected to be observed at least 3-4 weeks after each event.

Figure 7a Dynamic triple difference estimates of impact of mandate on proportion staff unvaccinated: care homes vs other social care setting England vs care homes vs other social care workers Wales



Notes
(i) The ATTS are in percentages and are obtained using the dynamic triple differences estimator.
(ii) The covariates used the models are: local unemployment rate, earnings, population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.
(iii) The middle line traces the dynamics of these ATTS through the sample period, whereas the grey band is doing the same for the 95% confidence intervals. Accordingly, whenever the 95% confidence interval excludes 0, the ATT in that week can be taken as being statistically significant).
(iv) Vertical lines indicate the week before each of the specified events.

Figure 7b Dynamic triple difference estimates of impact of mandate on staffing: care homes vs other social care settings England vs care homes vs other social care workers Wales



Notes

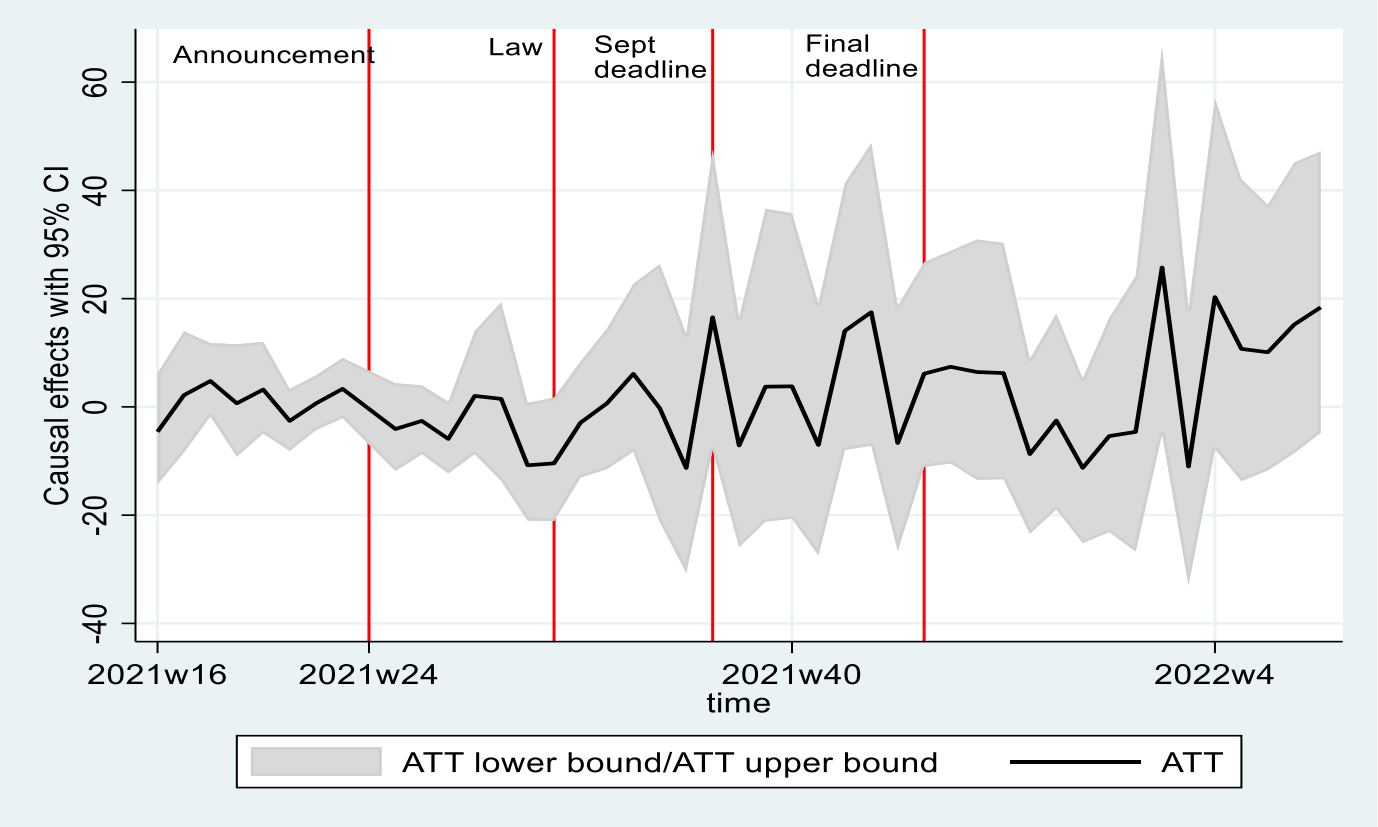
(i) The ATTS are in percentages and are obtained using the dynamic triple differences estimator.

(ii) The covariates used the models are: local unemployment rate, earnings, population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.

(iii) The middle line traces the dynamics of these ATTS through the sample period, whereas the grey band is doing the same for the 95% confidence intervals. Accordingly, whenever the 95% confidence interval excludes 0, the ATT in that week can be taken as being statistically significant).

(iv) Vertical lines indicate the week before each of the specified events.

Figure 7c Dynamic triple difference estimates of impact of mandate on Covid-19-related mortality: care homes vs domestic homes England vs care homes vs domestic homes Wales



Notes

(i) The ATTS are in percentages and are obtained using the dynamic triple differences estimator.

(ii) The covariates used the models are: local unemployment rate, earnings, population density, and the proportions of the population that are over 90s years old, Black, Asians and non-British White.

(iii) The middle line traces the dynamics of these ATTS through the sample period, whereas the grey band is doing the same for the 95% confidence intervals. Accordingly, whenever the 95% confidence interval excludes 0, the ATT in that week can be taken as being statistically significant).

(iv) Vertical lines indicate the week before each of the specified events. Any impact on deaths would only be expected to be observed at least 3-4 weeks after each event**.**