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Worker adjustment to unexpected occupational risk: Evidence from COVID-19

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\begin{articleinfo}
\textbf{JEL codes:}
I12 \quad I18 \quad J17 \quad J22 \quad J28
\textbf{Keywords:}
Compensating differential
Mortality risk
COVID-19
\end{articleinfo}

\begin{abstract}
We study the link between the revelation of a hitherto non-existent occupational risk – mortality due to the COVID-19 pandemic in 2020 – and subsequent worker behaviour. We link occupation-specific data on COVID-19 mortality to individual level data sets. We find that wages did not adjust, but workers started leaving high-risk occupations during 2020. These effects are stronger for workers not affected by lockdowns or working from home orders and for those considered to be clinically vulnerable to COVID-19 and are not driven by negative health shocks or employer-initiated separations. Occupation-level results suggest that employment began to rebound in 2021.
\end{abstract}

1. Introduction

The emergence of the virus SARS-CoV-2 has affected labour markets in a multitude of ways. In this paper, we study a particular aspect – worker and labour market adjustments to a sudden and unexpected increase in the mortality risk associated with specific jobs. To fix thoughts and to provide a mental framework to think through possible worker adjustments consider the canonical compensating wage differential setting (see, e.g., Rosen, 1986 for an overview and Rosen, 1974, for the classic reference): Jobs differ in attributes, such as mortality risk, and workers differ in their preferences for attributes, e.g., their willingness to tolerate risk. This leads to a sorting process that matches more risk-tolerant workers to riskier jobs. In equilibrium, less pleasant (riskier) jobs will pay a premium to compensate workers. These compensating wage differentials represent the necessary risk compensation for the marginal worker.

Empirical evidence for compensating differentials has been hard to establish for a number of reasons. Firstly, estimating hedonic models that try to link compensation to observed job characteristics often suffers from omitted variable bias, both at the level of the job – where we typically only observe a limited range of characteristics – and at the level of the worker – as risk preferences are usually unobserved. Secondly, studies exploiting longitudinal variation in earnings, for example, by following workers changing jobs, while allowing to control for unobserved workers characteristics, are prone to suffer from biases due to endogenous job mobility (e.g., Gibbons and Katz, 1992). Thirdly, the theory of compensating differentials is formulated in terms of competitive markets with not all

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\textsuperscript{1} We thank the editors and two anonymous reviewers for helpful comments that greatly improved the paper.

\url{https://doi.org/10.1016/j.euroecorev.2022.104325}

Received 9 April 2022; Received in revised form 7 September 2022; Accepted 14 October 2022
Available online 22 October 2022
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reasoning carrying over to frictional labour markets (see, e.g., Bonhomme and Jolivet, 2009; Dey and Flinn, 2008 and Lavetti and Schmutte, 2018, for discussions). Nevertheless, some studies suggest that compensating differentials are a quantitatively important part of workers earnings. For example, a recent paper by Sorkin (2018) suggests that about half of the firm component of the variance of earnings or about 15 percent of the overall variance in earnings in the US is due to compensating differentials.

The emergence of the virus SARS-CoV-2 and the associated illness COVID-19 from early 2020 can be seen as an unexpected shock to the pre-pandemic labour market equilibrium. It essentially introduces a new, unexpected, and at least initially, poorly understood risk. However, it is important to be clear that our setting is not a natural experiment to “test” the theory of compensating differentials, mainly because the COVID-19 pandemic represents a large shock to the whole of society across a range of domains. Some of these – such as risk averse workers leaving now-riskier occupations – would be in line with some of the mechanisms underpinning the textbook model of compensating differentials. Others, however, could represent labour demand shocks that do not form part of the classical compensating differential models. For example, if some of the jobs at higher risk of mortality due to COVID-19 also make interactions with customers riskier, it might be that the latter stay away, leading to reductions in demand and thus to employer-led adjustments such as layoffs. We will return to the question what drives the observed adjustments below.

Nevertheless, understanding how workers reacted to COVID-19 mortality risk is important for managing the aftermath of the pandemic. There are several features of the COVID-19-related mortality that make drawing on existing literature to predict workers reactions predictions difficult: We believe this is one of the few occasions where within-occupation mortality risk increases – most longitudinal variation within jobs (or worker-job-matches) comes from improvements to safety protocols and standards, i.e., jobs becoming safer over time. An example of the latter is Wissmann (2022) who finds evidence that the introduction of smoking bans in the German hospitality industry led to a reduction in earnings for bar and restaurant workers. The only other study we are aware of that uses increases in risk is Lavetti (2020) who studies the effects of fatality risk on earnings in the context of the fishing industry in the Alaskan Bering Sea, where fatality risks change in both directions over time due to changing weather patterns. Our setting, however, is very different from his: While fatality risks in his context differ within a job, the job in question is already comparatively risky and thus likely held by workers who considered this risk and the possible compensation they might require. In contrast, COVID-19 mortality affects a wider range of occupations, some that were already risky, but also others – such as hairdressers or personal care services – that were not.

There are good reasons to assume that worker adjustments to a job becoming riskier are not simply the reverse of those to a job becoming safer. In the latter case, workers will likely not experience pressure to leave their jobs and will simply see the value of the compensating wage differential decline over time, for example, due to increased competition for these, now overpaying, jobs. In the former case, however, we can imagine several adjustments: The simplest case would be that wages increase sharply to adjust for the new and higher risk workers face in a job. However, one can imagine several reasons why this might not occur: Employers might face a simultaneous shock to demand leading them to not want to maintain current employment levels or employers might be wary of increasing wages given downward stickiness of nominal wages and uncertainty around the duration of COVID-19 related risks. In this case, workers might be faced with a stark choice: Move occupations and possibly lose occupation- and firm-specific human capital2 or stay and accept a higher risk of death.

Another important aspect is how well workers understand COVID-19 related mortality. While, for example, weather-related risks in the fishing industry studied by Lavetti (2020) are likely to be broadly known to workers in that industry, COVID-19 is at least initially an unexpected shock. However, it seems reasonable that over the course of the pandemic workers will have become increasingly aware that they might have a riskier job: While the exact behaviour of the virus is still not fully understood, the fact that physical proximity and contact to others played a large role in transmission was essentially clear from the very early stages of the pandemic.

In this paper, we study worker adjustments to this shock in the context of the UK. The UK was hit hard by COVID: At the end of 2020, it had experienced 1079.39 deaths per million population – placing it just before the United States and 14th in the world – with a total of 73,622 confirmed deaths on December 31, 2020, the 7th highest count in the World (Ritchie et al., 2021). We use data from a variety of sources – occupation-specific COVID-19 and other mortality rates from the Office for National statistics (ONS 2020, 2021a), Understanding Society – a large UK household survey covering the period 2009 to 2020, the Understanding Society COVID-19 surveys that interviewed a subset of Understanding Society participants during 2020 and 2021 and the Annual Population Survey, a representative cross-sectional survey covering labour market and other outcomes at a monthly frequency, for the period January 2018 to June 2021 that we use to construct an occupation-by-month panel.

Looking first at the occupation-level through a dose-response difference-in-difference framework and comparing changes in outcomes across occupations with varying COVID-19 mortality, we find little evidence that COVID-19 mortality risk affects weekly wages in 2020 or 2021. However, we find that employment in occupations with higher COVID-19 mortality risks dropped significantly during 2020 with a more or less full recovery in 2021. We find little evidence that hours worked in these occupations shifted.

We then turn to a more detailed analysis at the individual level using longitudinal data from Understanding Society, which allows us to classify workers based on their occupation just before the pandemic, i.e., we compare workers who worked in occupations that experienced a high COVID-19-risk with workers who worked in occupations with a low COVID-19-risk in a difference-in-differences-

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2 For estimates on the importance of firm-specific human capital see, e.g., Abraham and Farber (1987), Altonji and Shakotko (1987), Kletzer (1989), Topel (1991) and Altonji and Williams (2005) for individual studies and Farber (1999) for a review. Several papers have stressed that specific skills might be more tied to an occupation than to a particular firm (Neal 1999; Parent 2000; Gibbons et al. 2005; Kambourov and Manovskii 2009), while two recent studies (Poletaev and Robinson, 2008, and Gathmann and Schoenberg, 2010) have looked at the transferability of skills across occupations.
We class COVID-19 fatality risk in three ways – using the gender-specific COVID-19-mortality rate for 2020 in a dose-response setting as well as focusing on the top 10% or top 25% riskiest occupations. We then study a range of labour market outcomes ranging from earnings to various employment indicators. In line with the occupation-level analysis, we find little reaction of earnings or working hours. However, we again find that workers leave high-risk occupations in 2020. We find no effect on general employment or unemployment which suggests that workers by and large leave now riskier occupations for safer ones. We also study a range of mental health and life satisfaction indicators and find little change in those, which suggests that workers are not simply locked into their old occupation and become unhappier in the face of increased risk. Using a specification that estimates quarterly effects during 2020 again suggests that employment in high-risk occupations began to rebound towards the end of the year.

An important question is whether the observed mobility is driven by (a) workers reacting to a perceived higher risk by leaving these occupations, (b) employers making adjustments to their workforces, e.g., by redundancies or non-extension of fixed-terms contracts, leading to involuntary job losses for the affected workers and (c) negative health shocks, such as Long COVID, forcing workers to abandon their previous jobs. Using data that directly measures (b) and (c), we find little evidence that workers in riskier occupations became more likely to experience either employer-initiated or health-related job changes during 2020, which suggests that these changes are driven by decisions of workers.

We study the robustness of our estimates in three ways: First, we investigate whether using whole-year or early (March to May 2020) COVID-19 mortality rates matters for our results. We find that estimates are essentially identical. Second, some occupations –
usually those with a low absolute number of deaths due to COVID-19 – have missing mortality rates. We study the robustness of our results to various imputations schemes as well to simply dropping occupations with missing mortality rates. We find essentially identical estimates across all of these. Third, we conduct a simple falsification test by randomly assigning COVID-19-mortality to occupations 500 times and recalculating our estimates in a randomisation inference procedure. These again confirm our main results.

A complication that requires addressing are the various non-pharmaceutical interventions that were implemented during 2020 and 2021 to reduce the spread of SARS-CoV-2. In the context of the UK these involved the closure of non-essential businesses and widespread work-from-home orders. Workers whose employers were affected by lockdowns and who could not work from home were offered government support (“furlough”) that paid 80% of their previous earnings (with the possibility for employers to pay the remaining 20%). A particular challenge in the UK context is that lockdown measures do not map neatly into occupations but are a combination of the classification of the employer and the occupation of the worker. To address this problem, we rely on data from the Understanding Society Covid-surveys for 2020 that contain information on whether an individual was furloughed or worked from home in any of the waves. We find that the job mobility effects are largely due to workers who were never furloughed and are driven by COVID-19 mortality in occupations with below-median furlough and working-from-home rates.
In a next step, we provide additional evidence that our main results are indeed due to COVID-19 mortality risks. If this was the case, we would expect stronger effects for individuals who are particularly vulnerable to COVID-19. To test this, we consider heterogenous effects by individual risk factors. We begin by looking at two risk factors that were widely discussed amongst the British public, namely age and ethnicity.

In a final step, we rely on data from the Understanding Society COVID-surveys to look at whether an individual was informed by the National Health Service that they were clinically vulnerable to COVID-19. We generally find that groups at greater risk of COVID-19 are more likely to leave high-risk occupations.

To assess the overall economic importance of COVID-19-related job mobility we conduct a simple back of the envelope calculation on the overall employment changes implied by our estimates for the 10% most affected occupations. For men, our estimates suggest that between 9% and 19% of the 2019 workforce in these occupations left temporarily due to COVID-19-mortality risk while for women the figures range from 3% to 16%. Expressed in absolute employment changes, this translates to 150,000 men and 76,000 women temporarily leaving the riskiest occupations.

2. A short chronology of the Coronavirus pandemic in the UK

Fig. 1 provides an overview of the development of the COVID-19 pandemic in the UK using four relevant outcomes from Ritchie et al. (2021): Confirmed cases (by PCR test), new PCR tests conducted, hospitalisations and deaths. Case numbers during early 2020 are artificially low due to the availability of tests (see panel (b)). Overall the data shows two clearly defined waves during the period covered by this paper – an initial wave during March to June 2020 (visible mainly in the hospital and deaths figures due to the undercounting of cases) and a second wave – visible in all outcomes – in early 2021 (driven by the “Alpha” variant of the virus).

2.1. Non-pharmaceutical policy interventions

Within the context of the World Health Organisation (WHO) defining the COVID-19 outbreak as a global pandemic on 11th March 2020, strict limiting non-pharmaceutical policy interventions (NPIs) were enacted to slow the spread of the virus. Fig. 2 plots an index of the stringency of nine policies from Ritchie et al. (2021) ranging from 0 to 100 (where 100 marks the strictest response, see Roser (2021) for details). The policies used are school closures; workplace closures; cancellation of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls.

The UK government responded to the acceleration of Covid-19 cases in the UK only from March 2020. The government recom-mended that those able to work from home should do so. The first UK national lockdown was announced on 23rd March 2020 with an order to remain at home. New social distancing measures, including for anyone in a household with symptoms of COVID-19 to stay

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3 Ethnicity as a risk-factor for Covid-19 was discussed in the national press as early as April 2020, e.g., BBC (2020), Guardian (2020a, 2020b) or ITV (2020).

4 A third wave driven by the “Delta” and “Omicron” variants occurred in the second half of 2021, when widespread vaccinations had led to a decoupling of case numbers and severe outcomes of the disease.
home for 14 days were enacted. The Coronavirus Act 2020 passed on 25 March 2020 granting the UK government emergency powers to enact policies to repress the COVID-19 spread and to reduce COVID-19 transmissions, infection rates and deaths (House of Commons, 2021). These measures were further designed to ease the unprecedented burden on the National Health Service (NHS) the pandemic posed.

Strict lockdown measures legally commenced on 26th March 2020 with the first national lockdown ending by June 2020. These included stay at home orders, school closures for all pupils but those of essential workers and vulnerable children, closure of most non-essential businesses from 21st March 2020, cancellation of public events, tight restrictions on gatherings (individuals were not allowed to meet individuals from outside their household from 23rd March), reduced public transport and restrictions on internal movements. The public was only allowed to leave their homes to shop for basic necessities, exercise outdoors once a day either alone or with members of the same household, for medical purposes or to provide care to vulnerable individuals and to travel to and from work where this was absolutely necessary and could not be done from home. Further, international travel restrictions and quarantine measures were enacted for arrivals from specific countries. Four sets of restrictions related to non-essential business closures. Businesses such as gyms, hairdressers or personal care had to close their business completely. Other businesses were closed except for providing deliveries or takeaways (e.g., restaurants), processing online orders (e.g., non-essential clothing, other shops) or supplying specified services (e.g., hotels). These measures were supplemented with rigorous public health information campaigns including ‘Stay Home’ and ‘Save Lives’ during the first national lockdown.

Whilst all UK nations enforced similar policies during the first national lockdown, containment measure and timings of these differed across the devolved governments thereafter. The first national lockdown ended in England and Northern Ireland on 20th May, in Scotland on 29th May and Wales on 1st June 2020 and significantly reduced the covid incidence rate and number of deaths across the country.

Focussing on England, from the beginning of May, lockdown measures were eased gradually. Individuals were allowed to leave their homes for reasons other than outdoor recreation and by 1st June individuals were allowed to meet outdoors in groups of 6. From June a phased reopening of schools started and face coverings became mandatory on public transport. Non-essential shops reopened in England on 15th June. From 4th July nearly all lockdown restrictions ceased with the hospitality sector reopening and gatherings of up to 30 individuals being legally allowed. At the same time stricter restrictions continued in areas where infections remained high. From mid-August theatres and other indoor recreational businesses reopened. In early August a one month ‘Eat out to help out’ scheme started to support hospitality businesses reopening their premises. It offered a 10% discount on food and non-alcoholic drink costs up to £10 per individual Mondays to Wednesdays to increase demand for eating out (House of Commons, 2020; see Fetzer, 2021, for an analysis of the link between this scheme and COVID-19 infections).

From July onwards, the UK experienced a steady increase in Covid infection rates and deaths resulting in the reintroduction of the legally binding “rule of six” for indoor and outdoor gatherings after the summer. A suite of local restrictions followed to continue targeting high infection areas and formalised on 14th October as a 3-tier system5 at a time when cases had reached 17,000 per day but with significant differences in different locations (UK Parliament. House of Lords Library, 2020).

A second four-week national lockdown commenced on 5th November in England. Non-essential businesses were forced to close and gatherings with individuals from other households was prohibited indoors. On 24th November a ‘Christmas bubble’ policy was announced restricting meetings over Christmas to three households. 43,676 cases were recorded that day. Restrictions were further tightened on 19th December for London and the South East and a new tier 4 ‘Stay at home’ came into effect. By 26th December further local areas were classified as tier 4 as the new “Alpha” variant was discovered which was more transmissible and spread fast from the south to the north. By end of December 2020 nearly 75% of England was under tier 4 restrictions with concerns growing over the speed of transmission of the alpha variant.

In response England went into a third lockdown on 6th January with almost 30,000 covid patients in hospital, 218,724 reported cases that day and 6594 deaths recorded during that week. People again had strict orders to stay home, but nurseries remained open, the use of support bubbles continued and some gatherings were excluded from the ban.

From 8th March 2021 the ‘roadmap out of lockdown’ began, a phased lockdown exit strategy, designed to allow more individuals to receive their first covid 19 vaccine, which slowly eased restrictions on 8th March, 29th March, 17th May and 19th July when all remaining legal restrictions were lifted8 (Cabinet Office, 2021). No further lockdowns were implemented, and a winter plan B drawn up in case the NHS would come under severe pressures again.

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5 Prior to March 2020, the UK government introduced a rigorous information campaign that focussed on handwashing for 20 seconds.
6 Tier 1: ‘Rule of six’ and 10pm curfew for hospitality; tier 2: No indoor gatherings but outdoor gatherings up to 6 people allowed; Tier 3: Strict ban on household mixing and closure of hospitality sector. Retail sector, schools and personal care remained open.
7 During the first lockdown “support bubbles” were introduced linking two households allowed to meet indoors. Whilst this mechanism ceased on 19th July 2020, it was reintroduced during the 2nd national lockdown in England.
8 Step 1 included school openings in England and two individuals being allowed to meet outdoors. Otherwise people were asked to remain at home. On 29th March outdoor gatherings of six individuals or two households and the reopening of outdoor sports facilities commenced and stay at home orders were lifted. Step 2 commencing on 12th April saw the reopening of non-essential retail, the food hospitality sector opened its doors for outdoor catering, outdoor venues and indoor leisure and recreational business as well as self-catering holiday accommodation. Step 3 increased the number of individuals for outdoor gatherings to 30 and indoor gatherings to follow the ‘rule of six’. Indoor trading for business reopened. Spectator sport was allowed for very large venues to allow up to 10,000 spectators (e.g., football). Step 4 commenced on 19th July (four weeks later than previously anticipated). This removed almost all legal requirements for social contacts in England and the remaining closed sectors reopened (e.g., nightclubs).
2.2. Vaccination rollout

The mass Covid-19 vaccination rollout started in the UK on 8th December 2020. The vaccine rollout commenced in phases according to individual vulnerability and age. The first four priority cohorts included care home residents and residential care workers, individuals aged 80+ and healthcare workers, social care workers, individuals 75–79, those aged 70–74 and the clinically extremely vulnerable individuals under the age of 70. These cohorts received a first dose by mid-February 2021 (21.7% of the population). Phase 1 proceeded with further five cohorts including those aged 65–69, those at risk under 65, 60–64, 55–59 and 50–54 year olds who were offered a vaccine by mid-April 2021 at which point 48.5% of the population had their 1st vaccination.

The second vaccination phase proceeded through the remaining age cohorts with (those aged 40 to 40, 30–39 and 18 to 29). Adults in their 20s were offered vaccination from May 2021 and adults age 18+ from June 2021. The roll-out of the vaccination campaign continued following the period covered in this paper: Twelve to 16 year olds were offered a first dose later in the year on grounds of vulnerabilities and to avoid education disruptions. Second doses were offered initially from 12 weeks after the first dose. Booster vaccinations were offered to those aged 50 and over, vulnerable individuals over the age of 16, health and social care workers, individuals aged 16 and over living in a household with immunosuppressed individuals and anyone aged 16–49 who suffers from a health condition that poses a high risk of serious illness from Covid-19. The programme started to offer booster vaccination to those in their 40s at the beginning of November and those aged 18 and over were eligible later that month if they have had their second vaccination no more than three month ago. The government responded to the discovery of the Omicron variant by stepping up the booster programme to get all eligible adults a third dose by the end of 2021. The government further reduced the period between the second and the third (booster) dose from 6 to 3 month. At the end of 2021, 90.1% of the population aged 12 and over in the UK had received one vaccination, 82.5% a second vaccination and 59.3% a third dose. Fig. 3 plots the proportion of the population with at least 1 vaccination, 2 doses and those having received a booster dose until the end of June 2021.

3. Data

We combine data from various sources: COVID-19 mortality rates from the Office for National Statistics at the occupation level (ONS 2020, 2021a), Understanding Society – a large UK household survey covering the period 2009 to 2020, the Understanding Society COVID-19 survey that interviewed a subset of Understanding Society participants during 2020 and 2021 and the Annual Population Survey for the period January 2018 to June 2021.

3.1. COVID-19 mortality data

We use data from the ONS (2020, 2021a) that provide early and whole year COVID-19 mortality rates by 3-digit occupation as well as 5-year average all-cause mortality based on the Standard Occupation Classification 2010. Early COVID-19 mortality rates are based on deaths occurring between March 9 and May 25, 2020, while whole-year mortality rates are based on the period March 9 to December 28, 2020. COVID-19 related deaths were identified using the International Classification of Diseases, 10th Revision (ICD-10) and include those with an underlying cause, or any mention, of ICD-10 codes U07.1 (COVID-19, virus identified) or U07.2 (COVID-19, virus not identified). ONS mortality rates are based on the deaths of those aged 20 to 64 at the time of death, are age-standardised and split by gender.
Occupations are those recorded on the death certificate, which was the case for 82.5% (82.4%) of male deaths and 62.5% (61.5%) of female deaths involving COVID-19 in the early (whole-year) period. Reasons for missing occupation data included the information not being recorded on the death certificate, the deceased being recorded as having been a full-time (unpaid) carer of the home and/or dependant relatives, the deceased having been working voluntarily, or the deceased having been retired.

Mortality rates are missing for a number of occupations, specifically those with a low number of COVID-19 related deaths. For men the number of occupations without missing rates increases from 54 to 64 from the early to the full 2020 data, for women from 26 to 35. We use a range of imputations for occupations with missing mortality rates, specifically replacing missing rates a mortality rate of zero, the sample minimum and the 10th percentile. We also repeat our estimates using only occupations with non-missing rates.

For most of the paper we rely on whole-year mortality rates due to the lower number of missing values. However, we also use estimates using the early mortality rates in a robustness check and find identical results. Fig. 4 compares early and late COVID-19 mortality rates by occupation for those occupations with non-missing mortality rates. The correlation between male mortality rates is 0.96, while it is 0.92 for female rates. Table A.1 in the online appendix contains mortality rates for all occupations as well as the total number of COVID-19 related deaths in an occupation in 2020.

Fig. 4. Comparison of early 2020 and full 2020 COVID-19 mortality rates by occupation. Note: Only occupations with data for both early and late Covid mortality rates. Occupations with missing Covid mortality rates have a low absolute number of deaths. For men the number of occupations without missing rates increases from 54 to 64 from the early to the full 2020 data, for women from 26 to 35.
3.2. Occupation-level data

We provide some initial estimates using data from the Annual Population Survey (APS) for the period January 2018 to July 2021. The APS, conducted by the Office for National Statistics, is cross-sectional at the individual level. Our estimation sample for the APS is 580,088 individuals. We use this data to create two monthly occupation-level panel datasets, one for men, one for women, that we use to assess pre-trends as well as for some initial analysis on occupation-level changes to employment, wages and working hours. It also allows us to gain some insight into changes in early 2021 when COVID-19 vaccines were widely rolled out to the UK population.

3.3. Individual-level longitudinal data

Understanding Society is a household panel that replaced the British Household Panel Survey and has been running since 2009. The most recent data from wave 11 covers interviews until the end of 2020. Each wave covers approximately 40,000 households. Waves in Understanding Society cover two years each but fieldwork for consecutive waves overlaps so that individual respondents are usually interviewed annually. The data also contains the exact date of the interview. We only use interviews from 2015 onwards and limit the sample to individuals aged 20 to 64 to match the mortality data. We match gender-specific mortality rates based on the basis of the last occupation observed for an individual before the pandemic began. Individuals who did not work during the period 2017 to 2019 are dropped from our sample. Our final estimation sample comprises 72,324 observations from 17,615 individuals.

In addition, we use data from the Understanding Society COVID-19 surveys. These interviewed a subset of individuals participating in Understanding Society in 8 waves during 2020 and 2021. Each wave covered a different range of topics. We use data from waves 1 to 4 covering the period April to July 2020 to gather information on topics such as clinical vulnerability, lockdown/furlough and working from home.

Table 1 provides descriptive statistics for the various datasets.

4. Empirical approach

4.1. Occupation level analysis

We begin our analysis by modelling the effect of COVID-19 mortality risk on occupational level wages, employment and hours worked in an event-study difference-in-differences setup relative to January 2020.\(^9\) Given the fact that our measure of COVID-19 mortality risk is gender-specific we conduct this analysis separately for men and women. For each gender, we estimate:

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\(^9\) Note that in our case all units are treated at the same time, but with different intensity. The former factor means that the problems with differences-in-difference estimates with varying timing highlighted in Goodman-Bacon (2021), de Chaisemartin and D’Haultfouillée (2020) and Callaway and Sant’Anna (2021) do not apply in our case.
where \( o \) indexes occupations and \( m \) months (from January 2018 to June 2021). COVID – risk\(_o\) is the gender-specific COVID-19 mortality rate in an occupation during 2020. \( \tau \) gives a treatment effect for each month relative to January 2020, i.e., directly before the pandemic. Coefficients prior to 2020 measure pre-trends, which should be zero if our empirical design is valid as COVID-19 mortality was not relevant prior to 2020. Coefficients in 2020 and 2021 allow us to measure changes in outcomes at the occupation level following the onset of the COVID-19 pandemic. We cluster standard errors at the level of the occupation. As outcomes we focus on (log) weekly wages, (log) employment and weekly working hours.

### 4.2. Main individual-level analysis

Our main analysis using Understanding Society builds on the occupation-level analysis and models the reactions of workers who worked in an occupation that suddenly became riskier due to COVID-19. We again think about this problem in a difference-in-differences setup where some occupations faced a much-increased risk of death in 2020. We use three different definitions of the treatment – our main setup uses the actual (gender-specific) mortality rates in a dose-response/continuous treatment intensity setup.
As a robustness check we also define treatment groups as working in the 25% and 10% of occupations with the highest COVID-19 mortality. Definitions of the treatment and control groups are based on individuals last observed occupation before 2020, i.e., the last observed occupation during 2017 to 2019. Individuals not employed at the time of at least one interview during this period are dropped from the analysis. Fixing the treatment (intensity) variable at a pre-pandemic level allows us to study outcomes such as people moving out of their pre-pandemic occupations in response to COVID-19 risk.

We estimate an event-study DiD with estimates relative to 2019 as

\[ y_{it} = \alpha_i + \delta_t + \sum_{j=2015}^{2019} \tau_j \ast (COVID - risk; \ast 1\{t = j\}) + \epsilon_{it}, \]

where \( i \) indexes individuals and \( t \) time. All estimates include individual fixed effects and quarter-by-year fixed effects. In addition, our preferred estimates include additional interactions between year dummies and either the 5-year average mortality rate by occupation or the two-digit industry of the individual’s last pre-pandemic job. We include the former as COVID-19 mortality risk and the general mortality risk at the occupation level are correlated as shown in Fig. 5 and the latter as different industries were affected differently by population behaviour changes due to the pandemic, e.g., people avoiding crowded places, as well as government policies, e.g., lockdowns. A trade-off with the latter specification is that some occupations, such as social care or health care, are closely linked to specific industries. Controlling for industry-time interactions in these cases essentially removes a significant amount of the variation of interest. However, estimates from the various specifications are usually qualitatively identical and quantitatively similar. In our main specification, we cluster standard errors at the level of the individual (17,615 clusters) and the pre-pandemic occupation (90 clusters).

There are several outcomes of interest depending on the specific adjustment to COVID-19 risk that occurs. It seems possible that, in line with simple compensating differential considerations, employers increase wages to compensate workers for the increased mortality risk. To investigate this possibility, we look at gross labour income as our first outcome. As income is measured at the monthly rather than the hourly level, we additionally investigate whether individuals’ usual working hours changed. In principle, it would also be possible that workers are compensated for the increased risk due to COVID-19 through one-off bonus payments. While Understanding Society does not contain information on those, data from the Annual Population Survey suggests that only 0.8% of workers received any form of bonus between January 2018 and July 2021. Consequently, we believe that bonus payments are unlikely to be a major adjustment mechanism.

Wage adjustments, however, might either take time or might not occur. For example, employers might be financially constrained due to losses sustained during the pandemic or, given downward wage rigidity, might prefer to wait and see how permanent a change in mortality due to COVID-19 is before deciding whether to increase wages. If wages do not adjust, workers can either move out of the risky occupations, either into another job or into a different employment state or remain in their current job. The former might involve the loss of occupation- and firm-specific human capital, while the latter essentially requires workers to tolerate an increased mortality risk without being compensated for it. To test whether workers move out of risky jobs we look at employment in the top 25% and top 10% riskiest occupations. We also look at general employment to get an idea whether these workers leave the labour force or become unemployed. If workers are stuck in a suddenly more dangerous occupation, we would expect this to have an impact on satisfaction or other mental health and life satisfaction indicators. Hence, we look at a range of related outcomes, namely the General Health Questionnaire (GHQ), a screening device for identifying minor psychiatric disorders in the general population, in its Likert scoring version (ranging from 0 to 36 with higher values indicating worse mental health), the SF-12 mental health summary scale (ranging from 0 to 100 with higher values indicating worse outcomes) and several simple question on life satisfaction, measuring general life satisfaction as well as satisfaction with health and income, ranging from 1 to 7 (with higher values indicating higher satisfaction).

In a next step we explore heterogeneity of treatment effects during 2020 to explore whether there are changes to workers behaviour as the pandemic progresses. To do so, we estimate Eq. (2) with separate effects for each of the post-COVID quarters during 2020. It is important to stress that – as individuals are interviewed only once during 2020 – estimates for quarter 2 essentially use a different sample than those for quarter 3. However, the timing of interviews in Understanding Society is essentially randomised, suggesting that the risk of composition bias is comparatively small.

We also study the important question to what extent worker mobility is based on voluntary decisions by workers or driven by employer- or health-related reasons. To do so we create two indicators measuring (a) whether a worker experienced a job change due to redundancy, layoff or the end of a fixed-term contract, which could be a sign of involuntary employer-initiated mobility and (b) whether a worker had to change jobs due to a health shock.

### 4.3. Robustness checks and heterogeneity

We conduct multiple robustness checks. The first investigates whether using whole-year or early (March to May 2020) COVID-19 mortality rates matters for our results. In a second step, we study the robustness of our results to various imputations schemes for missing COVID-19 mortality rates as well as simply dropping occupations with missing mortality rates. Third, we conduct a simple falsification test by randomly assigning COVID-19-mortality to occupations 500 times and recalculating our estimates in a randomisation inference procedure.

In a next step we investigate the role non-pharmaceutical interventions that were brought in during 2020 to reduce the spread of SARS-CoV-2. In the context of the UK these involved the closure of non-essential businesses and widespread work-from-home orders. Workers whose employers were affected by lockdowns and who could not work from home were offered government support
Finally, we provide additional evidence that our main results are indeed due to COVID-19 mortality risks. If this is the case, we would expect stronger effects for individuals who are particularly vulnerable to COVID-19. To test this, we consider heterogeneous effects by individual risk factors. We begin by looking at two risk factors that were widely discussed amongst the British public, namely age and ethnicity. In a next step, we rely on data from the Understanding Society Covid-surveys to look at whether an individual was informed by the National Health Service that they were clinically vulnerable to COVID-19.

4. Results

4.1. Occupation-level results

We begin our analysis at the occupation-level. Figs. 6 and 7 plot monthly treatment effects relative to January 2020 based on Eq. (1). Panel (a) of Fig. 6 considers the evolution of male (log weekly) wages, while panel (b) looks at female wages. Both panels suggest no link between COVID-19 risk and wage changes during 2018 and 2019, which is reassuring for our empirical design. Tests of joint

Fig. 6. COVID-19 mortality and ln(weekly wages), occupation level analysis. Note: Coefficient of the interaction between the COVID-19 mortality rate and month dummies with 95% confidence intervals based on standard errors clustered at the occupation level. Estimates relative to January 2020. Panel formed from 90 occupations over 42 months.
significance of the monthly interactions in 2018 and 2019 yield a p-value of 0.15 for men. For women, the pre-trend coefficients are jointly significant at the 1%-level. However, this rejection of the null is largely caused by the large negative effect in June 2018 with all other pre-treatment coefficients small and statistically insignificant. Turning to the effect of COVID-19, we find little evidence that wages in higher-risk occupations changed after the onset of the pandemic.

In Fig. 7 we repeat the estimation using log employment as the outcome. Results prior to 2020 are similar to those in Fig. 6. There is little evidence for pre-trends for men, both visually and through a joint significance test which yields a p-value of 0.29. For women, the joint test suggests that the pre-treatment coefficients are jointly significant at the 1% level, which again appears to be driven by large negative effects in May and June 2018, while all remaining interactions are close to zero and statistically insignificant. The post-pandemic pattern suggests sharp drops in employment in higher risk occupations from March 2020 until December 2020.
Beginning in 2021, there appears to be a partial to full recovery of employment. Interestingly this recovery coincides with the rollout of the COVID-19 vaccine to frontline health and social care workers, clinically extremely vulnerable individuals and the over 70 population from mid-January 2020. It also occurs despite the UK entering its 3rd national lockdown on January 6, involving school closures, contact restrictions and widespread business closures, in response to the spread of the Delta-variant. There is little evidence that employment changes with the gradual lifting of this lockdown from March 2021 onwards or that employment recovers during the months in 2020 (July to late September) when restrictions were comparatively light. In fact, contrasting the pattern of treatment effects in Fig. 7 with the stringency of government NPI policies from Fig. 2 suggest that the observed pattern of drops and recovery in riskier occupations is unlikely to be driven by the imposition and lifting of lockdowns and other NPIs.

In Fig. 8 we investigate employment changes at the intensive margin by looking at weekly working hours (including overtime).

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The vaccine rollout started on December 8, 2020 for care home residents and their carers and the population over the age of 80. In addition, following the approval of the Pfizer-BioNTec vaccine on December 2, 2020, the Oxford-AstraZeneca vaccine was approved on December 30, 2020 and deployed from January 4, 2021.

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Fig. 8. COVID-19 mortality and weekly working hours (including overtime), occupation level analysis. Note: Coefficient of the interaction between the COVID-19 mortality rate and month dummies with 95% confidence intervals based on standard errors clustered at the occupation level. Estimates relative to January 2020.
We now turn to our main analysis investigating the behaviour of workers who suddenly faced a change in mortality risk following the onset of the COVID-19 pandemic. Table 2 presents our main estimates for employment outcomes. Columns (1) to (3) use the whole sample, the remaining columns provide corresponding estimates by gender. The coefficient of interest in all columns is the interaction between the gender-specific COVID-19-mortality rate in an individual's last pre-pandemic occupation and a year dummy for 2020. All estimates are relative to 2019 and include additional interactions between the treatment variable and year dummies for the years 2015 to 2018. Columns (1), (4) and (7) are our most basic specification with individual and quarter-by-year fixed effects. Columns (2), (5) and (8) add interactions between the year dummies and an occupation’s 5-year average all-cause mortality. Finally, columns (3), (6) and (9) additionally include interactions between the two-digit industry of an individual’s last pre-pandemic job and year dummies. These take into account some of the differential economic impacts of the pandemic and related non-pharmaceutical interventions and

| Treatment | Whole sample | Men | Women |
|-----------|--------------|-----|-------|
| COVID-19 mortality rate (10)* | -0.066** (0.051) | -0.066 (0.069) | -0.056 (0.072) |
| COVID-19 mortality rate (10)* | -0.004 (0.046) | -0.019 (0.069) | -0.025 (0.074) |
| COVID-19 mortality rate (10)* | 0.026 (0.084) | -0.155 (0.107) | -0.140 (0.115) |
| COVID-19 mortality rate (10)* | -0.002 (0.003) | -0.008 (0.006) | -0.008 (0.006) |
| COVID-19 mortality rate (10)* | -0.001 (0.002) | -0.002 (0.002) | -0.003 (0.002) |
| COVID-19 mortality rate (10)* | -0.001 (0.002) | -0.001 (0.002) | -0.001 (0.002) |
| COVID-19 mortality rate (10)* | 0.001 (0.002) | 0.000 (0.002) | 0.001 (0.002) |
| COVID-19 mortality rate (10)* | -0.001 (0.002) | -0.001 (0.002) | -0.001 (0.002) |
| COVID-19 mortality rate (10)* | -0.001 (0.002) | -0.001 (0.002) | -0.001 (0.002) |
| COVID-19 mortality rate (10)* | 0.001 (0.002) | 0.000 (0.002) | 0.000 (0.002) |
| COVID-19 mortality rate (10)* | -0.018*** (0.003) | -0.018*** (0.004) | -0.018*** (0.004) |
| COVID-19 mortality rate (10)* | 0.001 (0.002) | 0.000 (0.002) | 0.000 (0.002) |
| COVID-19 mortality rate (10)* | 0.001 (0.002) | 0.000 (0.002) | 0.000 (0.002) |
| COVID-19 mortality rate (10)* | -0.012*** (0.003) | -0.010** (0.005) | -0.007** (0.005) |
| COVID-19 mortality rate (10)* | 71,073 (71,073) | 71,073 (71,073) | 71,073 (71,073) |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. ***/**** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 and 2016 respectively are not shown. All estimates are relative to 2019. There is again little evidence that pre-trends differ between higher- and lower-risk occupations. Following the onset of the COVID-19 pandemic, there does not appear to be any change to average hours worked in higher risk occupations. Together with Fig. 7, this suggests that all adjustment occurred at the extensive margin -through reduced employment – rather than the intensive margin – reduced hours of those employed in these occupations.

4.2. Main results

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control for possible confounding influences, but they could also create possible multicollinearity in cases where occupations and industries are closely aligned – which is the case, for example, for health and social care or teaching. However, estimates are generally very similar, leading us to prefer to more comprehensive specifications in (3), (6) and (9). We will also revisit the role of lockdown and working from home in Section 4.5.

Consistent with the occupation-level analysis we find little evidence for a change in labour income caused by COVID-19 mortality risk. With the exception of the most basic specification for men, which suggests an increase in labour income by around 1.6% for each additional 10 fatalities per 100,000 workers, point estimates are generally small and in fact often negative. We also find little evidence for a change in either working hours or general employment for workers in more risky jobs. However, estimates are generally very small, leading us to prefer to more comprehensive specifications in (3), (6) and (9). We will also revisit the role of lockdown and working from home in Section 4.5.

In Table 3 we look at the various mental health and life satisfaction outcomes. Overall, there is little evidence for any economically significant shift in life satisfaction. While some coefficients are statistically significant and consistent across specifications, all
coefficients are small relative to the respective means. For example, significant coefficients for the GHQ range from -0.05 to -0.26, which is small relative to an outcome mean and standard deviation of respectively 11.1 and 5.4.

Overall, this pattern of results suggests that (a) wages did not adjust, (b) workers were able to find other jobs, enabling them to leave now-risky occupations without much of an effect on their income and (c) as a consequence their mental health and life satisfaction did not change meaningfully.

4.3. Additional analysis: dynamics and sources of job mobility

Given the rebound in employment observed in the occupation-level analysis in Section 4.1, it seems worthwhile to ask whether a similar pattern can be observed in Understanding Society. As the latest available interviews are from December 2020, we can only study this question in a more limited way.

Table 4 presents results. Broadly the evidence suggests a sharp initial drop in high-risk occupations that rebounds as the year progresses, which by and large matches the pattern observed in Section 4.1. A plausible explanation for this pattern is worker initially reacting strongly to a poorly understood risk that was perceived to be severe and subsequently returning to their old occupations once COVID-19 became better understood.

In a next step, we investigate to what extent the observed mobility out of high-risk occupations might have been caused by negative coefficients are small relative to the respective means. For example, significant coefficients for the GHQ range from -0.05 to -0.26, which is small relative to an outcome mean and standard deviation of respectively 11.1 and 5.4.

Overall, this pattern of results suggests that (a) wages did not adjust, (b) workers were able to find other jobs, enabling them to leave now-risky occupations without much of an effect on their income and (c) as a consequence their mental health and life satisfaction did not change meaningfully.

4.3. Additional analysis: dynamics and sources of job mobility

Given the rebound in employment observed in the occupation-level analysis in Section 4.1, it seems worthwhile to ask whether a similar pattern can be observed in Understanding Society. As the latest available interviews are from December 2020, we can only study this question in a more limited way. Specifically, we estimate separate treatment effects for the second, third and fourth quarter of 2020, i.e., the full quarters after the onset of the pandemic.

Table 4 presents results. Broadly the evidence suggests a sharp initial drop in high-risk occupations that rebounds as the year progresses, which by and large matches the pattern observed in Section 4.1. A plausible explanation for this pattern is worker initially reacting strongly to a poorly understood risk that was perceived to be severe and subsequently returning to their old occupations once COVID-19 became better understood.

In a next step, we investigate to what extent the observed mobility out of high-risk occupations might have been caused by negative

| Treatment                                      | (1)             | (2)             | (3)             |
|------------------------------------------------|-----------------|-----------------|-----------------|
|                                                | Whole sample    | Men             | Women           |
| Weekly working hours                          |                 |                 |                 |
| COVID-19 mortality rate (10) * Q2 2020         | 0.036           | 0.090           | 0.395           |
|                                                | (0.131)         | (0.190)         | (0.398)         |
| COVID-19 mortality rate (10) * Q3 2020         | 0.091           | 0.147           | -0.146          |
|                                                | (0.129)         | (0.190)         | (0.289)         |
| COVID-19 mortality rate (10) * Q4 2020         | -0.203*         | -0.245**        | 0.158           |
|                                                | (0.110)         | (0.123)         | (0.267)         |
| N                                              | 54,890          | 23,629          | 31,265          |
| Ln(monthly gross labour income)                |                 |                 |                 |
| COVID-19 mortality rate (10) * Q2 2020         | -0.011          | -0.004          | 0.017           |
|                                                | (0.010)         | (0.013)         | (0.019)         |
| COVID-19 mortality rate (10) * Q3 2020         | 0.012           | 0.020           | 0.016           |
|                                                | (0.013)         | (0.017)         | (0.024)         |
| COVID-19 mortality rate (10) * Q4 2020         | -0.019*         | -0.011          | -0.019          |
|                                                | (0.011)         | (0.012)         | (0.025)         |
| N                                              | 63,494          | 28,395          | 35,095          |
| Employment                                    |                 |                 |                 |
| COVID-19 mortality rate (10) * Q2 2020         | -0.004          | -0.006          | 0.022***        |
|                                                | (0.005)         | (0.006)         | (0.008)         |
| COVID-19 mortality rate (10) * Q3 2020         | -0.005          | -0.013**        | 0.020           |
|                                                | (0.005)         | (0.007)         | (0.016)         |
| COVID-19 mortality rate (10) * Q4 2020         | -0.006          | -0.008          | -0.014          |
|                                                | (0.006)         | (0.007)         | (0.012)         |
| Employment in occupation in top 25% of COVID-19 mortality |                 |                 |                 |
| COVID-19 mortality rate (10) * Q2 2020         | -0.021***       | -0.030***       | -0.032**        |
|                                                | (0.004)         | (0.004)         | (0.010)         |
| COVID-19 mortality rate (10) * Q3 2020         | -0.014***       | -0.019***       | -0.000          |
|                                                | (0.005)         | (0.006)         | (0.022)         |
| COVID-19 mortality rate (10) * Q4 2020         | 0.005           | 0.003           | -0.020          |
|                                                | (0.005)         | (0.006)         | (0.021)         |
| Employment in occupation in top 10% of COVID-19 mortality |                 |                 |                 |
| COVID-19 mortality rate (10) * Q2 2020         | -0.012***       | -0.015***       | -0.023***       |
|                                                | (0.004)         | (0.004)         | (0.008)         |
| COVID-19 mortality rate (10) * Q3 2020         | -0.010*         | -0.016*         | 0.011           |
|                                                | (0.006)         | (0.009)         | (0.018)         |
| COVID-19 mortality rate (10) * Q4 2020         | 0.003           | 0.003           | -0.017          |
|                                                | (0.004)         | (0.005)         | (0.014)         |
| N                                              | 71,054          | 31,313          | 39,746          |
| Individual FE                                  | Yes             | Yes             | Yes             |
| Quarter-by-year FE                             | Yes             | Yes             | Yes             |
| 5-year avg. mortality * year interactions      | Yes             | Yes             | Yes             |
| 2-digit industry * year interactions           | Yes             | Yes             | Yes             |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.
demand shocks to the industries where these workers were employed or by negative health shocks, e.g., "long Covid" forcing workers to change jobs. To do so, we construct an indicator whether workers experienced either (a) a dismissal, redundancy or the end of a fixed-term contract, all of which could be indicative of employers laying of temporary or permanent staff or (b) a health-related employment change. Results are displayed in Table 5. There is little indication that workers in high-risk occupations were more likely to experience an employer-initiated separation or were forced to change jobs for health related reasons. Overall, these results suggest that the observed mobility is driven by worker decisions who voluntarily leave high-risk occupations for work elsewhere.

4.4. Robustness

We now provide a range of robustness checks and additional analysis focusing largely on the employment outcomes

Table 5
Voluntary and involuntary job changes.

| Treatment                                    | (1) Mortality rate per 100,000 workers (scaled by factor 10) | (2) | (3) |
|----------------------------------------------|--------------------------------------------------------------|-----|-----|
| Whole sample                                 |                                                             |     |     |
| Experienced job change due to redundancy,    |                                                              |     |     |
| dismissal or end of fixed-term contract      |                                                              |     |     |
| COVID-19 mortality rate (*10) * 2020         | -0.001 (0.002)                                               | 0.001 (0.002) | -0.005 (0.004) |
| Experienced job change due to health reasons|                                                              |     |     |
| COVID-19 mortality rate (*10) * 2020         | -0.000 (0.002)                                               | -0.001 (0.002) | 0.000 (0.005) |
| N                                            | 71,054                                                      | 31,313 | 39,706 |
| Individual FE                                | Yes                                                         | Yes | Yes |
| Quarter-by-year FE                           | Yes                                                         | Yes | Yes |
| 5-year avg. mortality * year interactions    | Yes                                                         | Yes | Yes |
| 2-digit industry * year interactions         | Yes                                                         | Yes | Yes |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.

Table 6
Robustness: Alternative treatment definitions.

| Treatment                                    | (1) Mortality rate per 100,000 workers (scaled by factor 10) | (2) Top 25% COVID-19 mortality occupation | (3) Top 10% COVID-19 mortality occupation |
|----------------------------------------------|--------------------------------------------------------------|------------------------------------------|------------------------------------------|
| Weekly working hours                         |                                                             |                                          |                                          |
| Treatment * 2020                             | -0.140 (0.115)                                              | 0.329 (0.281)                            | -0.087 (0.711)                          |
| Ln(monthly gross labour income)              |                                                             |                                          |                                          |
| Treatment * 2020                             | -0.013 (0.008)                                              | 0.013 (0.022)                            | -0.027 (0.027)                          |
| Employment                                   |                                                             |                                          |                                          |
| Treatment * 2020                             | -0.000 (0.004)                                              | 0.006 (0.016)                            | -0.012 (0.020)                          |
| Employment in occupation in top 25% of      |                                                             |                                          |                                          |
| COVID-19 mortality                           |                                                             |                                          |                                          |
| Treatment * 2020                             | -0.012*** (0.004)                                           | -0.117*** (0.020)                        | -0.006 (0.028)                          |
| Employment in occupation in top 10% of       |                                                             |                                          |                                          |
| COVID-19 mortality                           |                                                             |                                          |                                          |
| Treatment * 2020                             | -0.007** (0.003)                                            | -0.005 (0.008)                           | -0.137*** (0.035)                       |
| Individual FE                                | Yes                                                         | Yes                                      | Yes                                      |
| Quarter-by-year FE                           | Yes                                                         | Yes                                      | Yes                                      |
| 5-year avg. mortality * year interactions    | Yes                                                         | Yes                                      | Yes                                      |
| 2-digit industry * year interactions         | Yes                                                         | Yes                                      | Yes                                      |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.
### Table 7
Robustness – early vs. whole year COVID-19 mortality risk.

| Treatment | (1) Whole year mortality rate per 100,000 workers (scaled by factor 10) | (2) March to May 2020 mortality rate per 100,000 workers (scaled by factor 10) |
|-----------|-------------------------------------------------|---------------------------------------------------------------------|
|           | (3)                                             | (4)                                                                |
|           | (5)                                             | (6)                                                                |
|           | (7)                                             | (8)                                                                |
|           | (9)                                             | (10)                                                               |
| Weekly working hours | COVID-19 mortality rate * (10) * 2020 | 0.026 (0.084) |
|           | (10,000 workers) (scaled by factor 10) | -0.155 (0.107) |
|           | N (10,000 workers) (scaled by factor 10) | -0.140 (0.115) |
|           | Ln(monthly gross labour income) | 0.007 (0.005) |
|           | COVID-19 mortality rate * (10) * 2020 | -0.011 (0.008) |
|           | (10,000 workers) (scaled by factor 10) | -0.013 (0.008) |
|           | N (10,000 workers) (scaled by factor 10) | 0.008* (0.005) |
|           | Employment | -0.001 (0.002) |
|           | COVID-19 mortality rate * (10) * 2020 | -0.001 (0.002) |
|           | (10,000 workers) (scaled by factor 10) | -0.000 (0.004) |
|           | N (10,000 workers) (scaled by factor 10) | -0.001 (0.003) |
|           | Employment in occupation in top 25% of COVID-19 mortality | -0.018*** (0.003) |
|           | COVID-19 mortality rate * (10) * 2020 | -0.018*** (0.004) |
|           | (10,000 workers) (scaled by factor 10) | -0.012*** (0.004) |
|           | N (10,000 workers) (scaled by factor 10) | -0.018*** (0.004) |
|           | Employment in occupation in top 10% of COVID-19 mortality | -0.012*** (0.003) |
|           | COVID-19 mortality rate * (10) * 2020 | -0.010*** (0.003) |
|           | (10,000 workers) (scaled by factor 10) | -0.007*** (0.003) |
|           | N (10,000 workers) (scaled by factor 10) | -0.011*** (0.004) |
|           | Individual FE | Yes |
|           | Quarter-by-year FE | Yes |
|           | 5-year avg. mortality * year interactions | Yes |
|           | 2-digit industry * year interactions | Yes |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.

### Table 8
Robustness to different imputations of missing mortality rates.

| Treatment | (1) Base estimates: missing rates set to zero | (2) Missing rates set to minimum observed rate | (3) Missing rates set to 10th percentile | (4) Only occupations with non-missing rates |
|-----------|------------------------------------------------|---------------------------------------------|-----------------------------------------|-------------------------------------------|
| Weekly working hours | COVID-19 mortality rate * (10) * 2020 | -0.140 (0.115) | -0.135 (0.121) | -0.130 (0.122) |
|           | N (10,000 workers) (scaled by factor 10) | 54,913 (54,913) | 54,913 (54,913) | 54,913 (54,913) |
| Ln(monthly gross labour income) | COVID-19 mortality rate * (10) * 2020 | -0.013 (0.008) | -0.014 (0.009) | -0.015 (0.009) |
|           | N (10,000 workers) (scaled by factor 10) | 63,516 (63,516) | 63,516 (63,516) | 63,516 (63,516) |
| Employment | COVID-19 mortality rate * (10) * 2020 | -0.000 (0.004) | -0.002 (0.004) | -0.002 (0.004) |
|           | N (10,000 workers) (scaled by factor 10) | 71,073 (71,073) | 71,073 (71,073) | 71,073 (71,073) |
| Employment in occupation in top 25% of COVID-19 mortality | COVID-19 mortality rate * (10) * 2020 | -0.012*** (0.004) | -0.011** (0.004) | -0.010** (0.004) |
|           | N (10,000 workers) (scaled by factor 10) | 71,073 (71,073) | 71,073 (71,073) | 71,073 (71,073) |
| Employment in occupation in top 10% of COVID-19 mortality | COVID-19 mortality rate * (10) * 2020 | -0.007** (0.003) | -0.008** (0.003) | -0.009** (0.003) |
|           | N (10,000 workers) (scaled by factor 10) | 71,073 (71,073) | 71,073 (71,073) | 71,073 (71,073) |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.
In Table 5, we present estimates where we discretize the treatment into having worked in an occupation that ended up in the top 25% or top 10% in terms of COVID-19 mortality. To provide some perspective: While the average male (female) COVID-19 mortality rate is 32 (8) per 100,000 workers (including imputed values), this increases to an average of 72 (26) for the riskiest 25% of occupations and to 94 (35) in the top 10%. Table 6 suggests that we broadly find the same pattern of results than those in Table 2.

In Table 7 we contrast results using the whole year mortality rate in columns (1) to (3) with results using the early mortality rate from March to May 2020. Results using both treatments are essentially identical. Given the high correlation between early and whole year mortality rates (0.96 for men, 0.92 for women), this result is not unexpected.

In Table 8 we explore the impact of different imputation schemes for missing mortality rates. As missing mortality rates generally correspond to a low number of deaths, we impute a range of values from the lower end of the observed mortality rates, specifically zero, the sample minimum or the 10th percentile. In column (4) we also drop all individuals in occupations with missing mortality rates. As the table demonstrates the impact of these modelling choices is usually small to non-existent.

Finally in Table 9 we conduct a permutation test as a falsification exercise. We randomly assign COVID-19 mortality rates at the occupation-level 500 times and re-calculate our estimates using these fake treatments. The resulting distribution of treatment effects is comparable to a standard sampling distribution of estimates. Genuine treatment effects that are not driven by chance should be found in the tails of this distribution. The results generally confirm both the absence of a compensating wage differential and our out-mobility results from earlier specifications.

### 4.5. The role of furlough and lockdown

As explained in Section 2.1, during 2020, the UK Government implemented various lockdowns that closed down certain businesses at various points in time. In addition, legislation mandated that workers who could work from home were obliged to do so. Workers whose employers were affected by lockdowns and who could not work from home were offered government support (“furlough”) that paid 80% of their previous earnings (with the possibility for employers to pay the remaining 20%). Recent evidence from Italy (Di Porto, Naticchioni and Scrupinio, 2022) suggests that a higher proportion of essential workers in a province led to more COVID-19 cases as well as higher death rates. In our context, furlough and work from home are likely to cause important heterogeneity in worker responses to COVID-19 mortality risk – both furloughed workers and those working from home are likely to face a much lower effective risk than those workers who still had to travel to work and interact with colleagues and customers once there.

A particular challenge in the UK context is that lockdown measures do not map neatly into occupations but are a combination of the classification of the employer and the occupation of the worker. For example, plant operatives working for a chemical company could be considered essential workers if the company produced medical supplies, while administrative staff in the same company would likely be ordered to work from home. However, neither would be considered essential if working for a chemical company producing, say, paint for domestic use. Similarly, cleaners in a hospital would be essential workers who would be needed at their workplace while domestic cleaners or those cleaning hospitality premises would likely be on furlough. In addition, recent evidence has documented large within-occupation and within-industry differences in the percentage of work-tasks that can be done from home (Adams-Prassel et al., 2022), suggesting again considerable heterogeneity depending on specific workplace arrangements.

To address this problem, we rely on data from the Understanding Society Covid-surveys for 2020 that contain information on whether an individual was furloughed or worked from home in any of the waves. We use this information in two ways. First, we aggregate this information at the level of the occupation and split the sample into individuals working in occupations with a furlough/ work from home rate above or below the median. For furlough, the observed range goes from a minimum of 0% of workers furloughed to a maximum of 56% with a mean of 21% and a median of 20% (std. dev. of 13). For working from home, we collapse the original four response categories (never/seldomly/often/always worked from home) into two – “never worked from home” and “able to work from home” – and aggregate these first at the level of the individual – essentially was a specific individual able to work from home in any of the waves – and then at the level of the occupation. Aggregated at the occupation level, the proportion of workers who can work from home ranges from 0.6% to 88% with a mean of 47% and a median of 44%. In a second step, we focus on the subset of individuals who...
replied to the COVID-surveys and class individuals based on their individual responses into ever furloughed/ worked from home and never furloughed/ worked from home.

Figs. 8 and 9 plot Covid-19 mortality rates at the occupation level against the proportion of workers ever furloughed (Fig. 9) and ever working from home (Fig. 10). Not unexpectedly, Fig. 8 suggests that high-risk occupations were more likely to be affected by lockdowns and furlough, while Fig. 9 suggests that working from home goes hand-in-hand with lower COVID-19 mortality. Neither of these are surprising.

Table 10 presents our estimates for labour market outcomes by furlough status. Column (1) replicates our base estimates from Table 2, while columns (2) and (3) split the sample by the proportion of workers ever furloughed at the occupation level and columns (4) and (5) look at individuals who were ever or never furloughed. We again find little evidence for a relationship between COVID-19 mortality and general employment or earnings. Looking at movements out of riskier occupations, we find evidence that these are larger for workers in occupation with a below median-furlough rate and for workers who were never furloughed.

In Table 11, we do the same but look at working-from-home instead of furlough. We again find little evidence for any relationship between COVID-19 mortality and employment and wages. We also find more mixed results for mobility out of high-risk occupations. While point estimates are generally larger for occupations with a below-median proportion of workers who ever worked from home, the picture is much more mixed at the individual level. A possible explanation could be that we treat workers as being able to work from home if they worked from home even just seldomly at any point in 2020, i.e., it is entirely possible that a lot of these workers...
might had to travel to their workplaces for most of 2020.

Overall, our estimates suggest again that there is no link between higher occupational COVID-19 risk and either overall employment or income. However, mobility out of high-risk occupations appears to be driven by workers who had to travel to their workplaces during most of the pandemic, which appears to be plausible – these workers would have faced a much higher risk than those working in shut-down sectors or in occupations that easily allow working from home.

4.6. Heterogeneity by risk factors: age, ethnicity and clinical vulnerability

Finally, we consider heterogeneity in worker responses by risk factors. We begin by looking at two risk factors that were widely discussed amongst the British public, namely age and ethnicity. COVID-19 has a strong age gradient that has been widely discussed in the public sphere, while ethnicity as a risk factor was discussed in the UK national press as early as April 2020, e.g., BBC (2020), Guardian (2020a, 2020b) or ITV (2020). In a next step, we rely on data from the Understanding Society COVID-surveys to look at whether an individual was informed by the National Health Service that they were clinically vulnerable to COVID-19.

Table 12 suggests little treatment effect heterogeneity by ethnicity. However, mobility out of high-risk occupations appears to be strongest for the 40 to 49-year age group. A possible explanation is that younger age groups do not face a particularly high mortality risk from COVID-19, while older age groups would face larger losses of occupation/job-specific human capital due to their longer

Fig. 10. 2020 COVID-19 mortality rates and working from home by occupation.
Table 10
Furlough, COVID-19 risk and labour market outcomes.

|                        | (1) Base estimates | (2) Proportion of workers in occupation ever furloughed | (3) Individual worker | (4)  |
|------------------------|--------------------|-------------------------------------------------------|----------------------|------|
|                        |                    | Above median                                           | Below median         | Ever furloughed | Never furloughed |
| **Weekly working hours**|                    |                                                       |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.140             | -0.086                                                | -0.136              | -0.206         | -0.118           |
|                         | (0.115)            | (0.146)                                               | (0.180)             | (0.397)         | (0.165)          |
| N                      | 54,890             | 30,290                                                | 24,555              | 18,776          | 14,708           |
| **Ln(monthly gross labour income)** |                    |                                                       |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.013             | -0.011                                                | -0.016              | 0.011           | -0.026           |
|                         | (0.008)            | (0.011)                                               | (0.016)             | (0.025)         | (0.020)          |
| N                      | 63,516             | 33,802                                                | 29,714              | 6694            | 29,693           |
| **Employment**         |                    |                                                       |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.000             | -0.002                                                | 0.003               | -0.007          | -0.003           |
|                         | (0.004)            | (0.005)                                               | (0.008)             | (0.014)         | (0.006)          |
| N                      | 71,073             | 37,349                                                | 33,724              | 7299            | 32,812           |
| **Employment in occupation in top 25% of COVID-19 mortality** |                    |                                                       |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.012***           | -0.013*                                               | -0.012**            | -0.006          | -0.012*          |
|                         | (0.004)            | (0.006)                                               | (0.005)             | (0.009)         | (0.006)          |
| N                      | 71,073             | 37,349                                                | 33,724              | 7299            | 32,812           |
| **Employment in occupation in top 10% of COVID-19 mortality** |                    |                                                       |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.007**           | -0.001                                                | -0.016***           | -0.000          | -0.004           |
|                         | (0.003)            | (0.004)                                               | (0.003)             | (0.010)         | (0.004)          |
| N                      | 71,073             | 37,349                                                | 33,724              | 7299            | 32,812           |
| **Individual FE**      | Yes                | Yes                                                   | Yes                 | Yes             | Yes              |
| Quarter-by-year FE     | Yes                | Yes                                                   | Yes                 | Yes             | Yes              |
| 5-year avg. mortality * year interactions | Yes          | Yes                                                   | Yes                 | Yes             | Yes              |
| 2-digit industry * year interactions | Yes          | Yes                                                   | Yes                 | Yes             | Yes              |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.

Table 11
Working from home, COVID-19 risk and labour market outcomes.

|                        | (1) Base estimates | (2) Proportion of workers ever worked from home during 2020 | (3) Individual worker | (4)  |
|------------------------|--------------------|------------------------------------------------------------|----------------------|------|
|                        |                    | Above median                                               | Below median         | Ever worked from home | Never worked from home |
| **Weekly working hours**|                    |                                                          |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.140             | -0.388*                                                   | -0.112              | -0.418**         | 0.082            |
|                         | (0.115)            | (0.220)                                                   | (0.121)             | (0.203)          | (0.178)          |
| N                      | 54,890             | 25,960                                                    | 28,884              | 6144            | 25,792           |
| **Ln(monthly gross labour income)** |                    |                                                          |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.013             | -0.016                                                   | -0.010              | -0.032           | -0.000           |
|                         | (0.008)            | (0.018)                                                   | (0.009)             | (0.024)          | (0.022)          |
| N                      | 63,516             | 34,569                                                    | 28,947              | 21,491          | 17,017           |
| **Employment**         |                    |                                                          |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.000             | 0.016                                                    | -0.002              | -0.010           | 0.002            |
|                         | (0.004)            | (0.011)                                                   | (0.005)             | (0.012)          | (0.004)          |
| N                      | 71,073             | 37,936                                                    | 33,137              | 22,940          | 19,705           |
| **Employment in occupation in top 25% of COVID-19 mortality** |                    |                                                          |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.012***           | -0.013                                                   | -0.010**            | -0.016*          | -0.011**          |
|                         | (0.004)            | (0.009)                                                   | (0.004)             | (0.009)          | (0.005)          |
| N                      | 71,073             | 37,936                                                    | 33,137              | 22,940          | 19,705           |
| **Employment in occupation in top 10% of COVID-19 mortality** |                    |                                                          |                      |                 |
| COVID-19 mortality rate (*10) * 2020 | -0.007**           | -0.000                                                   | -0.008**            | -0.005           | -0.007           |
|                         | (0.003)            | (0.001)                                                   | (0.003)             | (0.006)          | (0.005)          |
| N                      | 71,073             | 37,936                                                    | 33,137              | 22,940          | 19,705           |
| **Individual FE**      | Yes                | Yes                                                       | Yes                 | Yes             | Yes              |
| Quarter-by-year FE     | Yes                | Yes                                                       | Yes                 | Yes             | Yes              |
| 5-year avg. mortality * year interactions | Yes          | Yes                                                       | Yes                 | Yes             | Yes              |
| 2-digit industry * year interactions | Yes          | Yes                                                       | Yes                 | Yes             | Yes              |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.
Table 12
Heterogeneity by age and ethnicity: Labour market outcomes.

|                           | (1) Base estimates | (2) By age | (3) 20 to 39 | (4) 40 to 49 | (5) 50 to 64 | (6) By ethnic group | (7) White | (8) Not white |
|---------------------------|--------------------|------------|--------------|--------------|--------------|---------------------|-----------|--------------|
| **Weekly working hours**  |                    |            |              |              |              |                     |           |              |
| COVID-19 mortality rate (*10) * 2020 | -0.140             | -0.272     | -0.092       | -0.142       | -0.044       | -0.002              |           |              |
|                           | (0.115)            | (0.169)    | (0.257)      | (0.144)      | (0.168)      | (0.178)             |           |              |
| N                         | 54,890             | 25,001     | 13,651       | 14,646       | 11,384       | 9287               |           |              |
| **Employment**            |                    |            |              |              |              |                     |           |              |
| COVID-19 mortality rate (*10) * 2020 | -0.013             | -0.016     | -0.011       | -0.012       | -0.027       | -0.034*             |           |              |
|                           | (0.008)            | (0.011)    | (0.019)      | (0.020)      | (0.018)      | (0.018)             |           |              |
| N                         | 63,494             | 27,885     | 16,022       | 17,750       | 13,707       | 11,090             |           |              |
| **Employment in occupation in top 25% of COVID-19 mortality** |            |            |              |              |              |                     |           |              |
| COVID-19 mortality rate (*10) * 2020 | -0.000             | -0.006     | -0.004       | 0.006        | 0.002        | 0.005               |           |              |
|                           | (0.004)            | (0.009)    | (0.006)      | (0.006)      | (0.009)      | (0.010)             |           |              |
| N                         | 71,054             | 31,867     | 17,548       | 19,852       | 16,028       | 13,101             |           |              |
| **Employment in occupation in top 10% of COVID-19 mortality** |            |            |              |              |              |                     |           |              |
| COVID-19 mortality rate (*10) * 2020 | -0.012***           | -0.014*    | -0.025***    | 0.004        | 0.001        | 0.003               |           |              |
|                           | (0.004)            | (0.008)    | (0.009)      | (0.006)      | (0.007)      | (0.008)             |           |              |
| N                         | 71,054             | 31,867     | 17,548       | 19,852       | 16,028       | 13,101             |           |              |
| **Ln(monthly gross labour income)** |                    |            |              |              |              |                     |           |              |
| COVID-19 mortality rate (*10) * 2020 | -0.007**           | -0.005     | -0.013**     | 0.003        | 0.000        | 0.001               |           |              |
|                           | (0.003)            | (0.004)    | (0.006)      | (0.005)      | (0.005)      | (0.007)             |           |              |
| N                         | 71,054             | 31,867     | 17,548       | 19,852       | 16,028       | 13,101             |           |              |
| Individual FE             | Yes                | Yes        | Yes          | Yes          | Yes          | Yes                 |           |              |
| Quarter-by-year FE        | Yes                | Yes        | Yes          | Yes          | Yes          | Yes                 |           |              |
| 5-year avg. mortality * year interactions | Yes            | Yes        | Yes          | Yes          | Yes          | Yes                 |           |              |
| 2-digit industry * year interactions | Yes            | Yes        | Yes          | Yes          | Yes          | Yes                 |           |              |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.

Table 13
Heterogeneity by clinical vulnerability: Labour market outcomes.

|                           | (1) Base estimates | (2) Clinically vulnerable | (3) Not clinically vulnerable |
|---------------------------|--------------------|----------------------------|-------------------------------|
| **Weekly working hours**  |                    |                            |                              |
| COVID-19 mortality rate (*10) * 2020 | -0.140             | -0.608*                    | -0.052                        |
|                           | (0.115)            | (0.327)                    | (0.192)                       |
| N                         | 54,890             | 6315                       | 19,032                        |
| **Ln(monthly gross labour income)** |                    |                            |                              |
| COVID-19 mortality rate (*10) * 2020 | -0.013             | 0.037                      | -0.042*                       |
|                           | (0.008)            | (0.031)                    | (0.024)                       |
| N                         | 63,494             | 7174                       | 21,873                        |
| Employment               |                    |                            |                              |
| COVID-19 mortality rate (*10) * 2020 | -0.000             | 0.002                      | 0.002                          |
|                           | (0.004)            | (0.014)                    | (0.006)                       |
| N                         | 71,054             | 8017                       | 24,055                        |
| **Employment in occupation in top 25% of COVID-19 mortality** |            |                            |                              |
| COVID-19 mortality rate (*10) * 2020 | -0.012***          | -0.011                     | -0.009*                       |
|                           | (0.004)            | (0.012)                    | (0.006)                       |
| N                         | 71,054             | 8017                       | 24,055                        |
| Individual FE             | Yes                | Yes                        | Yes                            |
| Quarter-by-year FE        | Yes                | Yes                        | Yes                            |
| 5-year avg. mortality * year interactions | Yes            | Yes                        | Yes                            |
| 2-digit industry * year interactions | Yes            | Yes                        | Yes                            |

Coefficients, standard errors adjusted for two-way clustering at the individual and 2017–2019 SOC2010 occupation level in parentheses. */**/*** denote statistical significance at the 10%, 5% and 1% level. Coefficients for interactions between the treatment and dummy variables for 2015 to 2019 respectively are not shown. All estimates are relative to 2019.
Looking at effect heterogeneity by clinical vulnerability provides much stronger evidence for heterogeneity. While there is little evidence for any difference in effects on wages, as Table 13 demonstrates, clinically vulnerable individuals are about twice as likely to leave high-risk occupations than other individuals—although these estimates do not always reach statistical significance due to the much smaller sample sizes. For the same reason estimates for the groups are not statistically significant from each other.

5. Discussion and conclusion

Using a range of datasets, we found little evidence that UK employers increased wages to compensate workers for an increase in mortality risk due to COVID-19. Across both the Annual Population Survey and Understanding Society, wages in occupations with higher COVID-19 mortality do not appear to have increased following the onset of the COVID-19 pandemic in March 2020. However, we find conclusive evidence that workers reacted to the higher mortality risk and the lack of compensation for it, by temporarily leaving high-risk occupations during 2020. These effects survive a range of robustness checks and are stronger for workers who (a) were less affected by business closures and working from home during 2020 and (b) are clinically vulnerable to the effects of COVID-19. We also find evidence that these effects are due to voluntary worker mobility and are not driven by either employer-initiated separations (such as redundancies) or health-related shocks. Evidence from the Annual Population Survey suggests that employment rebounded following the vaccine rollout from January 2021, while the pattern of non-pharmaceutical interventions seems unlikely to be able to explain these results.

In terms of external validity, it is important to stress that results related to COVID-19 are difficult to generalise to different contexts, e.g., to learn about the general reaction of workers to new occupational risks, as COVID-19 was a rare shock in terms of magnitude and reach across society. However, it seems likely that results would generalise to other countries similar to the UK.

To assess the overall economic importance of COVID-19-related job mobility, we conduct a simple back of the envelope calculation
on the overall employment changes implied by our estimates for the 10% most affected occupations. We construct the overall employment change implied by our estimates - displayed in Table 14 - using the outmobility estimates from Table 2 (column (6) for men, (9) for women), the respective COVID-19 mortality rate and ONS estimates total employment in an occupation for 2019. For men, our estimates suggest that between 9% and 19% of the 2019 workforce in these occupations left temporarily due to COVID-19 mortality risk while for women the figures range from 3% to 16%. Expressed in absolute employment changes, this translates to 150,000 men and 76,000 women temporarily leaving the riskiest occupations.

An open question is why employers did not react to the increased mortality risk and the resulting outflow of workers by increasing wages. There is a range of possible explanations. First, most of 2020 was a period of high uncertainty in relation to both the pandemic and the necessity of future restrictions on business activities – for example, a period of lockdown was followed by a gradual opening of businesses and society which was then followed by another lockdown. It seems plausible that this uncertainty could have made employers reluctant to increase their cost base. In 2021 the availability of vaccines and the expectation of a future decline in mortality might well have dampened the need for a monetary compensation for a – at that point in time – declining risk for workers. Second, several of the high-risk occupations, in particular in health care and education, are in state-run, highly unionised sectors. It seems plausible that these employers lacked the agility to increase wages quickly and unbureaucratically. The fact that workers appear to return towards the end of 2020 and early 2021 suggests that employers might well have been able to maintain employment levels in the longer run despite the shock due to COVID-19. That being said, reports about labour shortages in various media outlets have become widespread towards the end of 2021 (e.g., Dhingra and De Lyon, 2021; Guardian, 2021; Independent, 2021; ONS, 2021b). Our results suggest that COVID-19 mortality risks and resulting worker choices might at least be partially responsible for these.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at do:10.1016/j.euroecorev.2022.104325.

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