Leitner and Reiter *J Labour Market Res* (2024) 58:17
https://doi.org/10.1186/s12651-024-00376-9

Journal for Labour Market Research

ORIGINAL ARTICLE

Open Access

The response of labour demand to different COVID-19 containment measures: evidence from online job postings in Austria

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Abstract

This paper analyses changes in the speed of labour demand for new hires in response to the lockdowns that were repeatedly put in place to contain the spread of the COVID-19 pandemic. It tests whether the uncertainty-reducing effect of similar lockdowns occurring in quick succession increased the responsiveness of the labour market, thereby allowing for more rapid adjustment, both at the beginning and at the end of subsequent lockdowns. It uses high-frequency online job-posting data and applies an event study approach to the beginning of three national lockdowns and the subsequent reopening in Austria between 2020 and 2022. In view of the importance of progress in vaccination for labour market recovery, it also looks at vaccine roll-out as an additional COVID-19 containment measure, with 2021 as the main roll-out period. The results indicate very different responses to the three lockdowns, with a decline in job-posting activity of between 47 and 50% during the first lockdown and of between 29 and 31% during the second; but an increase of 23% to 28% during the last lockdown. Moreover, responses to the first lockdown were sluggish, with a slow decline at the beginning and a very slow recovery after it was lifted; but over subsequent lockdowns the responses were more rapid and more symmetrical. Responses to the various events differed by occupation and industry: the strongest responses were to be observed in the highly skilled and more-teleworkable occupations of technicians, and managers and professionals, who were badly affected during the first lockdown; the leisure and hospitality industry, which was the hardest hit on account of the mandatory closures and the widespread travel restrictions and bans, and which recovered only very slowly; and the IT, internet and telecommunications industry, where posting activity developed in a direction opposite to that seen in the other industries. Finally, there is little robust evidence of a differentiated effect of vaccinations during lockdowns, suggesting that vaccination roll-out did not have an additional demand-generating effect, over and above the lockdowns.

Keywords Online job posting, COVID-19, Teleworkability, Vaccinations, Event study analysis

JEL Classification J23, J63, O33, G14

1 Introduction

Labour markets tend to respond asymmetrically to shocks, with contractions in employment being briefer (shorter) and more intense (rapid) than expansions (Neftçi 1984; McKay and Reis 2008; Abbritti and Fahr 2013; Dupraz et al. 2021), making recovery a slow and protracted process. The recent COVID-19 crisis precipitated similar labour market responses, with swift declines in employment at the beginning of the crisis and slower recovery towards its end (Eurofound 2022; Kiss et al. 2022).

What distinguishes the COVID-19 crisis from previous crises is not only its origin in a global health crisis, but also the specific measures—especially the

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lockdowns—that were repeatedly put in place by governments to contain the spread of the disease. These resulted in a series of shocks in a short span of only about 2 years, until the COVID-19 pandemic as a public health emergency was finally declared over (WHO 2023). The measures had a dramatic economic impact (Deb et al. 2022) and led to a sharp fall in labour demand in many sectors—especially in those that had to shut down due to government-imposed social-distancing restrictions, such as non-essential retail or hospitality, leisure and tourism (OECD 2021).

Generally, crises and concomitant recessions are associated with an increase in uncertainty—at each level of aggregation—which affects decision making (Bloom 2014). In particular, uncertainty operates as a real options effect, increasing the value of waiting (Bernanke 1983), especially in the context of convex adjustment costs that make decision reversal costly (Caballero et al. 1997; Nilsen et al. 2007); totally irreversible investments, including hiring (Valletta and Bengali 2013); or risk-averse economic agents who, in the face of high uncertainty, fall back on a wait-and-see approach (Bachmann and Bayer 2013; Schaal 2017). Hence, adjustment is sluggish. However, little is known about how the speed of adjustment changes with repeated shocks that occur in quick succession. Specifically, the repeated—and often very similar—lockdowns that were imposed during the COVID-19 crisis allowed for a degree of learning from one lockdown-induced shock to the next, thus reducing uncertainty. In addition to the general (epistemological) unpredictability about the infectiousness and lethality of the virus, the possibility of further waves of infection and the doubt about the duration of the COVID-19 pandemic, there was uncertainty about the economic effects of the lockdown in terms of changes in demand during the lockdown and the speed of recovery once the lockdown was lifted; this was particularly true of the first lockdown, which was unprecedented for most businesses (Balla-Elliott et al. 2020). The experience with the first lockdown then allowed for a more accurate assessment of changes in demand during and after subsequent lockdowns, and more informed decisions, such as adjustments in labour. In fact, the COVID-19-related uncertainty spike was higher—it peaked in early 2020, when most economies were in their first lockdown—but shorter than in other crisis episodes (Benigno et al. 2020). And while uncertainty again spiked during each subsequent lockdown, each spike was more moderate than the previous one (Janecki 2021). Hence, we can expect the reduced uncertainty after the first major lockdown to have increased the responsiveness of the labour market, allowing for more rapid adjustments at both the beginning and the end of subsequent shocks, and thus a faster labour market recovery after a shock, with less asymmetry in the labour market responses.

We test the validity of this assumption using high-frequency, real-time online job-posting data that are better suited to capturing the speed and paths of the processes of adjustment to shocks than are traditional economic data, because of their high granularity and frequency. Online job-posting activity captures employers' hiring activity and is an important indicator of the formation of new employment relationships, as opposed to a resumption of previous employment relationships.

Several studies have used online job-posting data to shed light on the responsiveness of labour markets to lockdowns; but those studies have largely been confined to the first lockdown in the first half of 2020, and often focus only on the response to its beginning, not its end. Evidence for the US, Canada and the EU shows that, in response to the first lockdown, job postings followed a V-shaped pattern: there was a sharp drop in the 2 months following the start of the first lockdown and then country-specific recovery trajectories that depended very much on the country-specific context, trends and policies pursued (Cedefop 2020). The decline in job postings was generally more pronounced in those countries with stricter lockdown (see, for example, Adrjan and Lydon 2020; Forsythe et al. 2020; OECD 2021; Shuai et al. 2021 for the US; Jones et al. 2021; OECD 2021 for Canada; Adrjan and Lydon 2020; Arthur 2021; OECD 2021 for the UK; Hensvik et al. 2020 for Sweden; Holgersen et al. 2020 for Norway; and Bamieh and Ziegler 2022 for Austria). Furthermore, after reopening of the US economy in April, the subsequent recovery was relatively quick (Cheng et al. 2020): thanks to the rapid easing of restrictions, new job postings had mostly returned to their pre-pandemic level by the end of June (Krumel et al. 2023). By contrast, the recovery was more protracted in Canada, where job-posting activity did not return to pre-crisis levels until October 2020 (Jones et al. 2021), and in the UK, where it was only at the end of January 2021 that job-posting activity returned to something like the levels of early 2019 (Arthur 2021), following further national lockdowns in autumn and winter 2020. The short observation periods for Greece and Austria (limited to a couple of weeks after the restrictions were lifted) show that job-posting activity remained sluggish and well below pre-pandemic levels in both cases (Betcherman et al. 2023; Bamieh and Ziegler 2022).

Moreover, the responses also differed by sector and occupation, with a particularly steep decline in the number of online postings in those non-essential sectors that were most heavily affected by COVID-19 measures, such as leisure and hospitality or retail (Cedefop 2020; Costa Dias et al. 2020; Hensvik et al. 2020); meanwhile, in the

US, for example, essential retail occupations experienced a sharp increase (Forsythe et al. 2020). The recovery after April 2020 was particularly strong in healthcare occupations (Hensvik et al. 2020; Costa Dias et al. 2020). In this context, the teleworkability of occupations made a difference and helped to shield some—especially white-collar—occupations from pronounced drops in demand. However, this is not observed in all countries (see Forsythe et al. 2020; Holgersen et al. 2020; Bamieh and Ziegler 2022).

This paper contributes in two important ways to the expanding body of literature that examines the labour market effects of COVID-19. First, it analyses the exact timing of labour demand and its sensitivity to different COVID-19 measures, namely lockdowns and reopening. In this context, it addresses three major shortcomings of the literature summarised above: (i) partly due to its purely qualitative nature, the literature is silent on how quickly labour demand changes in response to a lockdown: the change could occur in anticipation of the announcement/implementation; with the announcement; with the implementation; or with a certain time lag after implementation; (ii) it mainly considers lockdown, but ignores reopening: while related research has shown that low-skilled occupations with limited teleworkability were worst affected by the first lockdown (Cedefop 2020; Costa Dias et al. 2020; Hensvik et al. 2020; OECD 2021), relatively little is known about whether—and how quickly—demand rebounded, especially after subsequent lockdowns. Hence, the analysis of reopening is crucial, as it helps to identify occupations whose sluggish recovery in demand means that they may be left behind as the economy revives, and that therefore deserve particular policy attention; (iii) it only covers the first major lockdown, not subsequent lockdowns. However, the responsiveness of labour demand to the later lockdowns and reopening may be quicker and more symmetrical, because there is less uncertainty, thanks to the experience gleaned from previous lockdowns. Our analysis also accounts for the sector-specificity of COVID-19 measures and examines potential heterogeneity across occupations, industries and regions, with respect to how quickly labour demand responds to a lockdown and the subsequent reopening. Furthermore, it considers the importance of the teleworkability of occupations, and examines whether that made any difference during the lockdowns by helping to prevent a decline in labour demand, as has been shown in other studies (Dey et al. 2020; Flisi and Santangelo 2022; Sostero et al. 2020).

Second, in addition to the lockdowns and periods of reopening, the analysis looks at vaccine roll-out as an additional COVID-19 containment measure, and determines its role in labour demand generally, as well as its (potentially differentiated) effect on labour demand during lockdowns in particular. This is relevant, since progress in vaccination is a critical factor for labour market recovery (Kiss et al. 2022; Mosbah and Dharmapala 2022).

The analysis uses a unique dataset of online job-posting data from the largest online job portal in Austria—karriere.at. The information is available on a daily basis and allows us to identify the responses within days or weeks around a particular COVID-19 event—i.e. the beginning of a lockdown and its end, when restrictions were lifted and the economy reopened—as well as during the vaccine roll-out; this is not possible using official labour market data, as they are not available with such frequency. In this context, Austria represents an interesting case, since it went through several national lockdowns that were always among the strictest in the world (Badelt 2021; see also the OxCGRT).[1] We focus on three national lockdowns in Austria and analyse six related events, namely the beginning of three national lockdowns and the reopening after each: (i) the *first* national lockdown (16 March to 29 May 2020); (ii) the *second and third* national lockdowns taken together (they were separated by only 2 days) (3 November 2020 to 8 February 2021); and (iii) the *fifth* national lockdown for the unvaccinated (15 November 2021 to 31 January 2022). The fourth lockdown was a regional lockdown and is therefore not considered. In our analysis, we use the first lockdown (both its beginning and reopening) as a benchmark against which the two subsequent national lockdowns (again, their beginnings and reopenings) are compared. Moreover, we focus on 2021 as the key vaccine roll-out period, and use weekly vaccination data at the regional level. During all national lockdowns, general curfews were imposed and only essential services remained open; other sectors—and most importantly the leisure and hospitality industry, which is of particular importance in tourism-dependent Austria—had to shut down entirely. Furthermore, to prevent a possible wave of insolvencies among domestic companies and a rapid rise in unemployment, several financial support measures were developed and implemented by the Austrian government in the course of 2020 and 2021 for companies, individuals and organisations—most notably, the COVID-19 short-time working scheme.

Methodologically, it applies an event study approach from the finance literature, developed by Ball and Brown

[1] See the Stringency Index from the Oxford Coronavirus Government Response Tracker (OxCGRT): https://ourworldindata.org/covid-stringency-index.

(1986), and specifies a 7-week time window around each of the events tested.

Our results point to very different responses to the various lockdowns, but confirm a change in the speed and patterns of adjustment across the lockdowns. Specifically, posting activity was still above trend in the 2 weeks before the first lockdown began; it dropped below trend as the first lockdown began and then declined further over the following 4 weeks. It recovered slowly, but failed to return to trend even several weeks after the measure was lifted. By contrast, posting activity responded much more rapidly and more symmetrically at both the start and the finish of the next lockdown considered. The same holds true for the last lockdown; however, above-trend posting activities were visible both at the time the start of the lockdown was announced and at the end. The positive developments during the final lockdown are likely associated with the relatively modest slump it triggered and with the strong mood of optimism among employers, as they prepared for the post-lockdown recovery (which took off soon after the measure was lifted). While there is little difference across regions, responses to the various events do differ by occupation and industry. For instance, technicians, and managers and professionals were also temporarily affected: they saw a pronounced decline in posting activity in response to the first lockdown and a very slow recovery after it was lifted; but significantly above-trend activity at the beginning and the end of the final lockdown. Interestingly, their higher level of teleworkability did not shield them from the negative effects during the first lockdown. The advantage of teleworkability only became apparent during the subsequent lockdowns. Across industries, the most notable effects are to be observed in the leisure and hospitality industry sector, which was the hardest hit, due to the mandatory closures and the widespread travel restrictions and bans, but which recovered only very slowly; and in the IT, internet and telecommunications industry sector, where posting activity developed in the opposite direction to the other industries other sectors. This is related to the increased demand during the first lockdown for IT experts to implement the new digital solutions triggered by the surge in e-commerce and the increase in working-from-home arrangements (which, however, soon reached saturation point). Finally, there is little robust evidence of a differentiated effect of vaccinations during lockdowns, suggesting that during the lockdowns vaccination uptake may not have had an additional demand-enhancing effect.

The rest of the paper is structured as follows: Sect. 2 discusses the data source and the COVID-19 containment measures analysed here, in terms of the nature of the different lockdowns that were imposed by the Austrian government between 2020 and 2022 and the timing of the associated events that we tested, as well as the vaccination roll-out programme that started at the end of 2020 and took off over the ensuing months. Section 3 lays out the methodological approach used to determine how sensitive online job-posting activity was to the various COVID-19 measures. The findings of the analysis are presented and discussed in Sect. 4—also differentiating by occupation, industry and region. Section 5 summarises the results and offers some conclusions.

2 Data and events tested

2.1 Online job-posting data

The data used in the analysis are drawn from the largest private online job portal in Austria—karriere.at,[2] which has been operating since 2005. It is the market leader in online recruitment for professional and managerial workers, and therefore caters more to job seekers at the upper end of the skills hierarchy. It is the job portal with the greatest online reach in Austria, with more than 4.9 million visitors and over 30 million page views each month (GfK Austria 3/2019; Google Analytics 1/2019).

For the purposes of our analysis, karriere.at provided the online job postings (OJPs) that were posted on its platform from 2005 until May 2022—a total of 2.2 million. For our analysis, we use OJPs that were posted on the karriere.at platform from 2 years before the start of the pandemic—used to establish a pre-pandemic reference period and baseline—up to the latest available day: i.e. between 1 January 2018 and 31 May 2022. A comparison of the number of new monthly job postings on the karriere.at platform with those reported by the Austrian Public Employment Service (AMS)—Austria's largest public provider—shows that the number of vacancies reported by karriere.at was around 35% of the number of vacancies reported by the AMS. The OJP raw text includes detailed information on the job title, education and skills requirements, and other information on the vacant position, such as geographical location (federal state, district), industry or type of job (full time, part time). Of key importance for the analysis is the date of issuance—i.e. the date on which the job ad was created and published on the karriere.at website. This allows us to assign OJPs to the different lockdown phases and associated lockdown events in terms of their beginning and end. For the estimation, we aggregate daily OJPs to weekly counts.

For the subsequent analysis, from the rich OJP raw text we use the information on job title, education and skills requirements, industry, geographical location and date of issuance.

[2] See https://www.karriere.at.

Table 1 Occupational groups, according to one-digit ISCO-08 classification

Group	ISCO-08 classification
Managers, professionals	Managers (ISCO-08: 1) and professionals (ISCO-08: 2)
Technicians	Technicians and associate professionals (ISCO-08: 3)
Clerks, clerical workers	Clerical support workers (ISCO-08: 4) and service and sales workers (ISCO-08: 5)
Craft workers	Skilled agricultural, forestry and fishery workers (ISCO-08: 6) and craft and related trades workers (ISCO-08: 7)
Manual workers	Plant and machine operators and assemblers (ISCO-08: 8) and elementary occupations (ISCO-08: 9)

Specifically, the job title and the education and skills requirements are used to classify occupations: these are not only important control variables in our analysis, but also allow us to shed light on occupation-specific responses to the COVID-19 containment measures. For this, we apply Big Data techniques. Specifically, we use the two-step statistical machine-learning algorithm proposed by Schierholz and Schonlau (2020): as a first step, it matches the occupation titles from a German translation of the ISCO classification document[3] to the job titles given in the postings, using three different matching procedures: exact, bag-of-words and approximate (or 'fuzzy') matching.[4] That way, 62% of all OJPs can be assigned an ISCO code. For the three matching procedures, we use the occupation titles of the four-digit ISCO classification.

As a second step, the wording of the ISCO-classified OJPs from step 1 is used as training data for a machine-learning algorithm—an XGBoost classifier. The text contains detailed information on the education and skills requirements for the posted job, which allows the algorithm to learn which specific words and phrases are typically associated with a particular job (i.e. a specific ISCO code). The trained algorithm can then predict the ISCO codes of the OJPs that have not yet been classified in step 1, based solely on their wording. For this step, we aggregate the four-digit ISCO codes to one-digit ISCO codes.

In view of the small number of OJPs for particular one-digit occupations (especially in the lower occupational segment), we form five occupational groups, based on the ISCO-08 one-digit classification: (i) *managers, professionals* (ISCO-08: 1–2); (ii) *technicians* (ISCO-08: 3); (iii) *clerks* (ISCO-08: 4–5); (iv) *craft workers* (ISCO-08: 6–7); and (v) *manual workers* (ISCO-08: 8–9) (for further details see Table 1 below).

Industries in the postings follow a classification scheme defined by karriere.at, which we adjusted to align better with the NACE Rev. 2 industry classification (see Table A.1 (Supplementary Material 1) in the online appendix for an overview and correspondence with the NACE Rev. 2 industry classification). All in all, we defined 14 industries (which in some cases refer to sub-industries).

We also classify the geographical location of the job advertised in a posting, according to NUTS regions.[5] In the analysis, we report the results separately by NUTS region. To this end, we follow closely the NUTS 1 regional classification, based on groups of Austrian federal states, since the number of OJPs varies widely across federal states, being particularly low in some (e.g. Burgenland, Carinthia, Vorarlberg) and very high in others (e.g. Upper Austria, where the headquarters of karriere.at is located). Specifically, we distinguish the following four regions: (i) *Northern region* (Upper Austria); (ii) *Eastern region* (the capital city of Vienna, Lower Austria and Burgenland); (iii) *Southern region* (Styria and Carinthia); and (iv) *Western region* (Salzburg, Tyrol and Vorarlberg). The four regions differ in terms of industry structure; in view of the industry-specificity of the COVID-19 measures, this may elicit different responses at the regional level. Specifically, manufacturing dominates in the North and South; public services and utilities in the East (due to the dominance of administrative activities concentrated in the capital Vienna); and wholesale, as well as leisure and hospitality in the West.

An overview of the frequency of the OJPs in the sample used for the analysis (2018–2022), differentiated by occupational group, industry and region, can

[3] See https://www.statistik.at/KDBWeb/kdb_DownloadsAnzeigen.do?KDBtoken=ignore.

[4] In the 'exact' procedure, we only use perfect matches between the ISCO occupation title and the job title of the OJP. In the 'bag-of-words' procedure, we split the occupation titles as well as the job titles into separate words, compare them to each other and consider it a match if the Jaccard index is greater than 0.6. Finally, the 'fuzzy' matching uses the generalised Levenshtein edit distance to compare the two titles and considers it a match if the maximal distance between the two is less than 0.1. The threshold values for the 'bag-of-words' and 'fuzzy' matching were chosen so that the number of false matches (evaluated through manual inspection) was minimised.

[5] We classify the geographical location of the job according to NUTS 1–3 regions (to the most detailed level possible for a given OJP), again using a regular expression search for municipality and NUTS 1–3 region names (as well as derivations thereof). Despite its simplicity, this method successfully assigns 89% of OJPs NUTS 2 regions (i.e., federal states) and 84% of OJPs NUTS 3 regions (i.e., detailed districts).

be found in Figure A.1 (Supplementary Material 2) in the online appendix. Given the industry-specificity of the lockdowns, Figure A.2 (Supplementary Material 3) shows the frequency of OJPs by industry for each of the five occupational groups (as an average between 2018 and 2022), while Figure A.3 (Supplementary Material 4) shows the respective annual frequencies (for 2018 to 2022), and thus shows important pandemic-related changes in the demand for new hires by occupational group and industry.

From the OJP requirements wording, we also use information on teleworkability[6] options to compute two different teleworkability indices, which we use in our empirical analysis as important occupation-specific control variables. Both are based on the number of mentions of keywords—indicating that a certain job can be carried out from home/remotely—found in the OJPs.[7] We label a job 'teleworkable' if there is at least one reference in the text of the advert. The first index is time invariant and is based on the number of mentions of keywords before the pandemic (2010 to 2019) in each occupational category. The second index is time variant and refers to the number of mentions of relevant keywords for a given occupation within a certain timeframe—in our case, a week. Thus, this teleworkability index allows us to capture the change in teleworkability for each occupation over time.

Both teleworkability indices are shown in Fig. 1 for all occupations (all ISCOs), and for each of the five occupational groups. This highlights the fact that prior to the COVID-19 pandemic, only around 0.1% of all adverts contained a reference to teleworking, with considerable variation across occupational groups. Hardly any reference to teleworking was to be found in adverts for manual, craft or clerical workers: most references were in adverts for managers and professionals, followed by technicians. With the onset of the pandemic, however, teleworking came to be mentioned more frequently: between 2020 and 2022, the share of adverts that contained a reference to teleworking almost quadrupled, rising from the 0.1% prior to the pandemic to around 0.4%. Apart from manual workers, teleworkability increased across the occupations, but most notably for technicians, and managers and professionals. A small increase can also be observed for clerical workers—albeit with a delay, mainly between 2021 and 2022.

Teleworkability also differs across industries (as shown in Figure A.4 (Supplementary Material 5) for the time-variant teleworkability index). In the years before the COVID-19 pandemic, references to teleworking were most frequently found in adverts for jobs in the IT, internet and telecommunications industry; that said, such references were on the decline until the pandemic struck, since when there has been a sharp rise. With the onset of the pandemic, references to teleworking in job postings increased in all industries, but especially in manufacturing, personal services and consulting services. In many industries, this was only temporary, and a decline can be observed towards the end of the pandemic.

2.2 Tested events

During the COVID-19 pandemic, Austria experienced five lockdowns of various durations and severity (see Table 2 for an overview). The first national lockdown, between mid-March and the end of May 2020, was the most dramatic, bringing public life to a near standstill. Aside from basic supplies, all businesses (as well as federal parks and public baths) had to remain closed until further notice; schools and universities were shut; air traffic was largely suspended; and strict contact restrictions and curfews came into effect, based on a newly passed COVID-19 law.

The second national lockdown in autumn 2020 was characterised by a succession of light and strict lockdowns. Restaurants, recreational facilities and museums had to remain closed, while all shops were initially kept open, though they then had to close from 17 November, with the beginning of a 'strict' lockdown (when only essential services remained open). Universities and colleges switched to distance learning, while primary and secondary schools and kindergartens remained open; a night-time curfew was introduced, which was later converted into a general curfew. It ended at Christmas (in order to allow for limited Christmas shopping and family gatherings), but 2 days later led directly into the third strict national lockdown, which again imposed similar measures.

The third lockdown also marks the start of Austria's public immunisation campaign: on 27 December 2020, 5 days after the European Medicines Agency (EMA) gave the green light to the BioNTech/Pfizer vaccine, the first vaccination against the coronavirus was administered in Austria. However, larger quantities of vaccines only

[6] In Austria, there is neither a unilateral obligation nor a right to work from home; instead, working from home is voluntary and needs to be agreed by the employer and the employee, which makes the announcement in a job advert of the option to undertake remote work an important signal.

[7] The keywords refer to expressions in either German or English that describe remote work and encompass home office, home work, *heim arbeit*, *heim office*, tele work, *tele arbeit*, *tele heimarbeit*, *zuhause arbeiten*, *arbeit zuhause*, *arbeiten von zuhause*, *arbeitsplatz zu hause*, working from home, home working, *mobiles arbeiten*, *mobile arbeit*, remote work, remote home, *remotes team*, *remote teilweise*, *remote möglich*, *remote umständen möglich*, *remote möglichkeit*, remote, remote option.

Fig. 1 Teleworkability—total and by occupational group, 2010–2022. Yearly aggregates of the time-variant teleworkability indicator are shown. The two teleworkability indices are reported for all ISCOs (i.e. the total) as well as for five occupational groups: managers, professionals [managers (ISCO-08: 1), professionals (ISCO-08: 2)]; technicians [technicians and associate professionals (ISCO-08: 3)]; clerks, clerical workers [clerical support workers (ISCO-08: 4) and service and sales workers (ISCO-08: 5)]; craft workers [skilled agricultural, forestry and fishery workers (ISCO-08: 6) and craft and related trades workers (ISCO-08: 7)]; and manual workers [plant and machine operators and assemblers (ISCO-08: 8) and elementary occupations (ISCO-08: 9)] (Source: karriere.at, own calculations)

Table 2 Events tested

Measure	Beginning	End	Nature
1st lockdown	16 March 2020	29 May 2020	Strict
2nd lockdown	3 Nov. 2020	16 Nov. 2020	Light
	17 Nov. 2020	6 Dec. 2020	Strict
	7 Dec. 2020	23 Dec. 2020	Light
	24/25 Dec. 2020		Easing of restrictions
3rd lockdown	26 Dec. 2020	8 Feb. 2021	Strict
4th lockdown	1 April 2021	19 May 2021	Hard (Eastern provinces only)
5th lockdown	15 Nov. 2021	31 Jan. 2022	Strict—unvaccinated
	22 Nov. 2021	12 Dec. 2021	Strict—vaccinated (and recovered)

became available in 2021. Initially, priority was given to people who were immunocompromised and to those over the age of 80; gradually, access was opened up for younger and healthier groups (Desson et al. 2022). In May 2021, all vaccination priority rules were lifted, and by January 2022 vaccination rates had plateaued at around 73% (Stamm et al. 2022).

The fourth strict ('East') lockdown was limited to Austria's three easternmost federal states (the capital Vienna, Lower Austria and Burgenland) and envisaged round-the-clock restrictions on contact and mobility, and the closure of shops (except for basic supplies), schools and recreational facilities.

Finally, the fifth strict national lockdown, in autumn 2021, differentiated by vaccination status and initially only applied to the unvaccinated, whose lockdown started 7 days earlier and lasted 6 weeks longer than the lockdown for those who had been vaccinated or had recovered. Unvaccinated people aged 12 and over were only allowed to leave home for a limited number

of reasons (i.e. to work and to buy food), which made Austria the first EU country to confine people who had not yet received the COVID-10 vaccine. As with previous lockdowns, entire sectors were shut down completely (i.e. the leisure and hospitality industry, which includes accommodation and food services and arts, entertainment and recreation) and all-day curfews were imposed. However, schools remained open.

On 1 February 2022, the day after the end of the lockdown for the unvaccinated, COVID-19 jabs became mandatory for all adults in Austria—which made it the first country in the EU to impose compulsory vaccination (the measure had been announced on 19 November 2021, 4 days after the start of the lockdown for the unvaccinated). The law stipulated that any person aged 18 or over who refused a jab would face a penalty of up to EUR 3600 every 3 months, unless pregnant or severely ill. The penalties were to be introduced from March 2022. However, the vaccine mandate was never enforced and was eventually suspended on 9 March 2022.

For the analysis, we focus on three national lockdowns: (i) the first and most dramatic national lockdown, which started on 16 March 2020 and ended on 29 May 2020; (ii) the second and third national lockdowns (taken together, because the break in between was very brief), which started on 3 November 2020 and ended on 8 February 2021; and (iii) the fifth strict national lockdown for the unvaccinated, which started on 15 November 2021 and ended on 31 January 2022. The fourth lockdown was only in effect in the three easternmost federal states, and is thus not considered here.

The above discussion of the COVID-19 containment measures shows that the start and end points of the fifth lockdown fell in the same weeks as the vaccination mandate was announced and implemented, respectively. Hence, the findings for the fifth lockdown may be biased by the potentially optimistic assessment and outlook of employers who were looking to hire new employees, and therefore posted job advertisements online in response to the vaccination mandate. However, there is generally only limited trust among the Austrian population in the effectiveness of vaccines (Kittel et al. 2021), a high degree of hesitancy related to COVID-19 vaccines and strong opposition to compulsory COVID-19 vaccination (Paul et al. 2021). This was well known and was discussed incessantly in the media in the run-up to implementation of the vaccine mandate. Thousands of people took to the streets in cities and towns across Austria to protest against the vaccination mandate. Hence, in view of the generally strong COVID-19 vaccine hesitancy and the strong opposition to compulsory COVID-19 vaccination, the anticipated effectiveness of the vaccination mandate was low right from the beginning; it is therefore likely that it generated only limited optimism and little response in posting activity.

Hence, while there seems to be little to be learned from Austria's vaccination mandate, its general COVID-19 vaccination roll-out programme (which was voluntary and allowed everyone to be vaccinated by a general practitioner free of charge) may have had an impact. The programme started on a small scale at the end of 2020, when Austria was in its third lockdown, and came as something of a relief to many—a source of hope and an alternative to further lockdowns. Over subsequent months, over 70% of the population was immunised. The uptake then stagnated, prompting the Austrian government to make vaccination mandatory (see the discussion above). In view of this, we also look at the COVID-19 vaccination roll-out programme and determine whether OJP activity was affected by an increase in population immunisation levels (which may have helped boost optimism and encourage posting activity). Furthermore, we examine whether population immunisation levels affected OJP activity differently during the lockdowns and during periods without a lockdown. Since vaccinations mainly became available from early 2021 onwards, we focus on the second/third and the fifth lockdowns. This analysis will be taken up in Sect. 4.3 below. It uses daily vaccination data (aggregated at the weekly level) from Austria's Federal Ministry of Social Affairs, Health, Care and Consumer Protection at the regional level as the (log of the) share of those persons in the total population who had received two doses. The vaccination data are available at the NUTS 2 level, which we aggregate to the NUTS 1 level, in accordance with the OJP regional classification (see Sect. 2.1 above). The share of vaccinated person in the total population (by the number of doses) is shown in Figure A.5 (Supplementary Material 6) in the online appendix. It points to two strong uptake phases for one and two doses, with the strongest phase occurring in the first half of 2021, and a much weaker phase in autumn 2021, which began several weeks before the fifth lockdown. This phase also saw a sharp increase in the uptake for three doses, which is considered to provide basic immunisation.

During 2020, the Austrian government also introduced several financial support measures (some of them new) for companies, individuals and organisations. These were intended to prevent a possible wave of insolvencies among domestic companies and a rapid rise in unemployment. The public aid package was substantial, amounting to more than 10% of Austria's 2019 GDP. The measures affected demand for labour, as well as demand for new hires (which is the focus of our analysis). We do acknowledge the importance of these measures, but do not consider them in our analysis, due to the limited granularity and frequency of the data. Nonetheless,

for the sake of completeness, we briefly discuss here the most important measures and the timing of their implementation. Of particular importance was the COVID-19 short-time working scheme (*COVID-19-Kurzarbeit*), which was implemented in March 2020 and provided for a replacement rate of net wages of 80% to 90%. Initially, it was available for 3 months, but the scheme was repeatedly modified and extended over 2020 and 2021, before eventually being phased out in October 2023. Of similar importance were the immediate assistance payments (*Soforthilfen*) to companies, especially the emergency funds (*Notfallfonds*) and fixed-cost subsidies (*Fixkostenzuschüsse*). Both were available from April 2020 onwards, and were intended to compensate firms for the substantial loss of business due to the COVID-19 crisis. The latter was phased out at the end of August 2020, to be replaced by a new version at the end of November 2020 (*Fixkostenzuschuss 800.000*). At the end of 2020, additional financial support measures became available to companies, all intended to compensate them for the crisis-induced loss of sales (*Verlustersatz*, *Lockdown Umsatzersatz I*). Both were available for a limited duration only and were replaced with two other schemes in February 2021 (*Lockdown Umsatzersatz II, Ausfallsbonus*). In parallel, liabilities and warranties for bank loans were available. Many of the schemes were administered by the COVID-19 Federal Financing Agency Ltd (COFAG), which was established in March 2020.

3 Methodological approach

Methodologically, we proceed in two steps. As a first step, we focus on the entire lockdown—from beginning to end—and determine the total average effect of each of the three lockdowns considered (Sect. 3.1). Then we take a close look at the period surrounding the start and the end of the three lockdowns as the two key lockdown-related events, in order to identify the announcement effect, the immediate implementation effect and any lagged responses to either of the two key measures (Sect. 3.2).

3.1 Complete lockdown estimation

The total average effect of each lockdown will be analysed using the following specification:

$$OJP_{ijt} = \alpha + \sum\nolimits_{i\in 1\text{st,2nd/3rd,5th}} \beta_i lockdown_i + \mu_{i(t)} + \chi_j + \theta_t + \varepsilon_{ijt}. \tag{1}$$

where OJP_{ijt} refers to the number of online job postings for occupation i in industry j in week t. The dummies $lockdown_i$ are equal to one if the date of the OJP falls in the period of one of the three lockdowns (1st, 2nd/3rd, 5th), and zero otherwise. Thus, this definition of a lockdown does not include the announcement period before the beginning of the lockdown. $\mu_{i(t)}$ refers to occupation-specific indicators that can be either (1) a teleworkability index for every occupation that is constant over time ('constant'); (2) a teleworkability index for each occupation that is variable over time ('time dependent'); or (3) four occupational dummies (at the one-digit level) as specified in Table 1 above (with manual workers as the reference category). The two teleworkability indices are shown in Fig. 1 above and are defined as the share of the total number of OJPs per occupation. All three indicators account for occupation-specific variation. χ_j are industry fixed effects, θ_t refers to a weekly linear time trend that captures long-term developments and ε_{ijt} is the error term.

Furthermore, we introduce an interaction term between each of the three lockdown dummies $lockdown_i$ and the different occupation-specific indicators $\mu_{i(t)}$ to allow for their differentiated effect on posting activity for each lockdown. The interaction terms will show whether more-teleworkable occupations responded to the three lockdowns in ways that were different from less-teleworkable ones, and which occupation was more or less strongly affected by each lockdown (relative to manual workers as the reference category). This will be tested by the following specification:

$$\begin{aligned} OJP_{ijt} = \; & \alpha + \sum\nolimits_{i\in 1\text{st,2nd/3rd,5th}} \beta_i lockdown_i + \mu_{i(t)} \\ & + \sum\nolimits_{i\in 1\text{st,2nd/3rd,5th}} \gamma_i lockdown_i * \mu_{i(t)} \\ & + \chi_j + \theta_t + \varepsilon_{ijt}. \end{aligned} \tag{2}$$

The effect of the vaccination roll-out programme will be tested in a way similar to Eq. (1), but with the number of online job postings for occupation i in industry j of region r and in week t (OJP_{ijrt}) as the dependent variable and the log of the share of the population of a NUTS 1 region that had had two doses of the vaccine $lnvaccD2_r$, as well as region fixed effects π_r as additional control variables (in addition to the lockdown dummies $lockdown_i$, occupation and industry fixed effects $\mu_{i(t)}$ and χ_j, a weekly trend θ_t and the error term ε_{ijrt}). As with Eq. (2), we add an interaction term $lockdown_i * lnvaccD2_r$ to account for the differentiated effect of vaccinations during the lockdowns. Moreover, we also test for non-linearity in the vaccination roll-out programme by including a squared term of the log of the share of the vaccinated in a region (in addition to the log of the share of the vaccinated in a region). A non-linear relationship has important health and labour market policy implications in terms of the potential optimal share of the vaccinated in a region—in the case of a maximum/inverse U relationship—or the minimum

share of the vaccinated to be exceeded—in the case of a minimum/U relationship. We also include the squared term in the interaction model (and interact it with the lockdown dummies) to test for non-linearities in the share of the vaccinated that are lockdown specific.

Methodologically, a Poisson Pseudo Maximum Likelihood (PPML) estimator is used for both specifications, to account for the non-negative count nature of the data. We report the results using clustered covariance matrix estimation standard errors for panel data, which are robust to general forms of cross-sectional and serial correlation.[8]

3.2 Weekly effects estimation

Furthermore, we apply the event study approach developed by Ball and Brown (1968) to identify the weekly responses of online job-posting activity to the two key COVID-19 containment measures—the beginning of a lockdown and its end (reopening). For this purpose, we estimate the following specification:

$$OJP_{ijt} = \alpha + \sum_{\tau=-a}^{b} \beta_t^{\tau} week_t^{\tau} + \mu_{i(t)} + \chi_j + \theta_t + \varepsilon_{ijt}, \tag{3}$$

where OJP_{ijt} refers to the number of online job postings for occupation i in industry j in week t. The dummies $week_t^{\tau}$ are equal to one if the date of the OJP falls within τ weeks of the event, and zero otherwise, where τ is the time window, set to $-a$ weeks before and b weeks after the event ($\tau = 0$). In this respect, each COVID-19-related event has its own time window. All in all, we test six events—the beginning and the end of three lockdown periods—and look at 2 weeks before each event ($-a = 2$) and 5 weeks after ($b = 5$); thus there are eight dummies per event that we estimate. The 2 weeks before each event capture the announcement effect, since each lockdown was announced a week ahead of its enforcement. $\mu_{i(t)}$, χ_j, θ_t and ε_{ijt} are defined as above. We again use a PPML estimator, with panel-adjusted standard errors.

Moreover, accounting for the sector-specificity of COVID-19 measures, we identify the heterogeneity across occupations, industries and regions, and estimate Eq. (3) separately for (i) each of the five one-digit occupations (as specified in Table 1 above); (ii) 14 industries (see Table A.1 (Supplementary Material 1) in the online appendix); and (iii) four regions (roughly corresponding to the NUTS 1 regional classification: the Northern, Eastern, Southern and Western regions—see Sect. 2.1 for a discussion).[9]

The effect of the vaccination roll-out programme will be tested as outlined above, but with weekly dummies (instead of dummies for the complete lockdowns), and with an interaction term $\sum_{\tau=-a}^{b} \omega_t^{\tau} lnvaccD2_r week_t^{\tau}$ added as a second step to account for the differentiated effect of vaccinations during the second/third and the fifth lockdowns. However, we expand the time window to cover the *entire period* of the lockdowns (including the 2-week pre-implementation and the 5-week post-implementation periods), in order to account for the fact that the vaccination roll-out started only slowly, which potentially elicited a strongly delayed effect on posting activity. We again test for non-linearity in the vaccination roll-out programme by including a squared term of the log of the share of the vaccinated in a region and also interact it with the weekly lockdown dummies.

4 Results

The results of the empirical analysis are discussed in the following sections. Section 4.1 reports the results for the complete lockdown, and then Sect. 4.2 takes a closer look at the weeks around the start and the end of a lockdown (the reopening), in the context of an event study approach. Sections 4.2.1, 4.2.2 and 4.2.3 provide additional results differentiated by occupation, industry and region, respectively. Section 4.3 focuses on the vaccination roll-out programme and its potentially differentiated effect on posting activity during the lockdowns, providing results for both complete and weekly lockdown estimations. Throughout the analysis, we use the root mean squared error (RMSE) as an indicator of the goodness-of-fit of the regressions.

4.1 Complete lockdown estimation results

Our findings for the complete lockdown effects are shown in Fig. 2 below. The first two rows provide the results when the time-invariant pre-pandemic teleworkability index is used; the third and fourth rows report the results with the time-dependent teleworkability index; while the remaining rows report the results when one-digit occupational dummies are used instead (as indicated by the labels on the right). In each of these three blocks of results, the first row refers to the main model [see Eq. (1) above], while the second row refers to the interaction model [see Eq. (2) above], where interaction terms were included between each of the three lockdown dummies and the afore-mentioned occupation-specific indicators. We only show the coefficients for the lockdown dummies from Eq. (1) and the interactions between the lockdown dummies and the different occupation-specific indicators from Eq. (2). All regressions also include a time trend and industry fixed effects—the full results

[8] See Zeileis (2006), who implements the procedures proposed in Newey and West (1987) and Driscoll and Kraay (1998).

[9] We also further differentiate the complete lockdown effect by occupation, industry and NUTS region. For the sake of brevity the results are not presented here, but are available from the authors upon request.

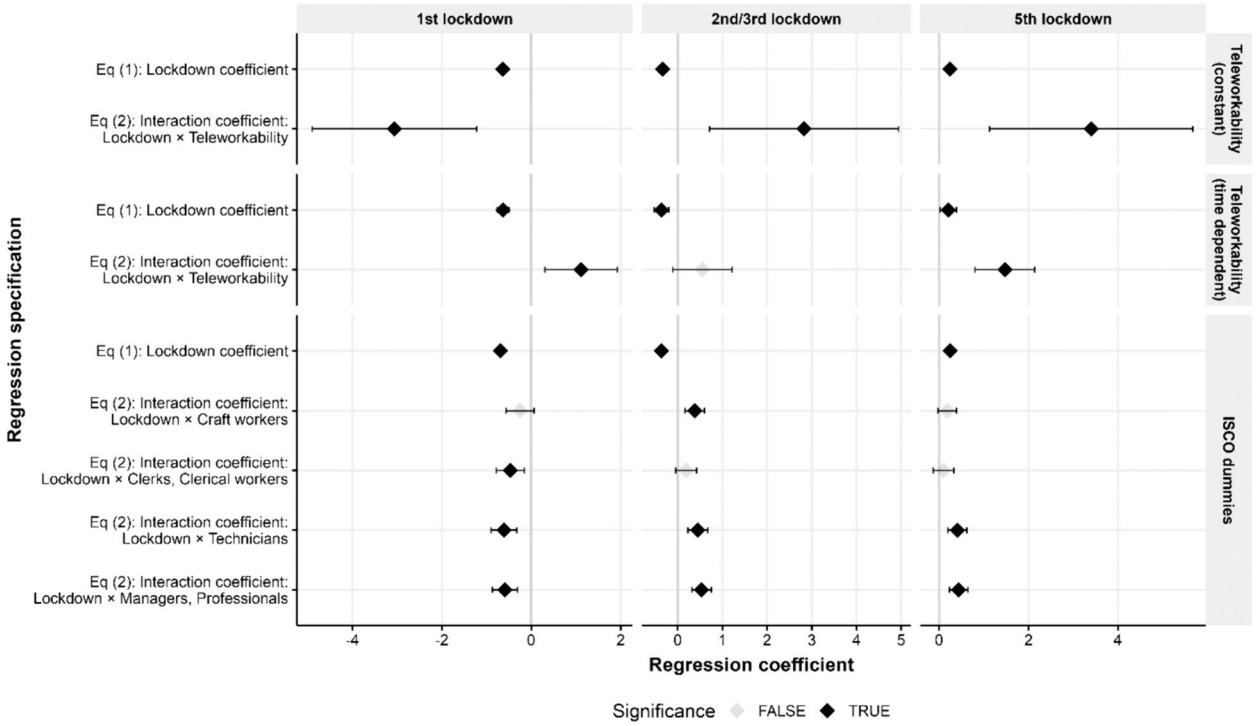

Fig. 2 Effects of complete lockdowns. Standard errors based on clustered covariance matrix estimation for panel data. A time trend and industry fixed effects are included in the estimations. Table A.2 (Supplementary Material 7) in the online appendix reports the full results. It also shows that the RMSE is relatively high for the specification with the time-variant teleworkability index, which suggests that it does not perform too well (Source: karriere.at, own calculations)

are reported in Table A.2 (Supplementary Material 7) in the online appendix.

Regarding the three lockdowns, our results from the main model (see rows 1, 3 and 5 in Fig. 2) are similar across the specifications. The coefficients of the first lockdown are all negative and highly significant, and range from −0.629 to −0.691, indicating that posting activity decreased by between 47 and 50% during the first (and most dramatic) national lockdown.[10] Negative effects are also observable for the second/third lockdown. However, here the coefficients are much lower—in the range of −0.338 and −0.365—indicating that posting activity decreased by between 29 and 31% during the second/third lockdown. By contrast, we observe positive and significant effects for the fifth lockdown: the coefficients indicate that posting activity increased by 23% to 28% during the final lockdown. The differences across the lockdowns need to be interpreted in the context of the economic responses they triggered (Baumgartner et al. 2022): the first and the second/third lockdowns were very severe, and the first resulted in the worst recession that Austria had experienced since the war, in terms of its speed and depth. Economic activity also collapsed rapidly in response to the second/third lockdown, but not as severely as in spring 2020, so that job-posting activity did not drop off too strongly. By contrast, the fifth lockdown was not only less severe, but also resulted in a slump that was less pronounced than in previous lockdowns and that quickly gave way to a rapid recovery, which suggests that the last lockdown may have been characterised by a strong mood of optimism among employers, which led to above-trend posting activity.

The results in Table A.2 (Supplementary Material 7) from the main model [see columns (1) and (3)] show that teleworkability, irrespective of whether used as a time-invariant or a time-dependent indicator, is positively associated with posting activity, indicating that more-teleworkable occupations are in higher demand, in general. Since the time-variant teleworkability index is also more variable over time—in our case, weeks—the coefficient is also substantially lower. However, in this case, the RMSE is relatively high, which suggests that it does not perform too well.

Whether teleworkable occupations also fared better during the lockdowns is tested in our interaction models (see rows 2 and 4 of Fig. 2). The results generally support

[10] In a PPML regression, a coefficient of -0.629 translates into a 47% reduction in OJPs posting (exp(−0.629) − 1) * 100 = −47%.

our hypothesis and show that more-teleworkable occupations were in greater demand than less-teleworkable occupations during all three lockdowns. There are two exceptions, though: first, the coefficient for the interaction of the first lockdown with the constant teleworkability index (see row 2) is negative, which suggests that during the first lockdown, there was less demand for more-teleworkable occupations than for less-teleworkable ones. This finding is consistent with the results of Bamieh and Ziegler (2022) for data from the job board of the Austrian Public Employment Service, but runs counter to what is typically found in the literature (Dey et al. 2020; Flisi and Santangelo 2022; Sostero et al. 2020). Second, the coefficient for the interaction of the time-dependent teleworkability index with the second/third lockdown is insignificant.

The results in Table A.2 (Supplementary Material 7) [column (5)] also show that posting activity varied across occupational groups, with significantly higher demand for all occupational groups than for manual workers (the reference category). Moreover, the results from the interaction model are compatible with the results for the constant teleworkability index, with generally negative effects for the first lockdown and positive effects for the second/third and fifth lockdowns. In addition, however, the results also show that the different occupational groups were affected differently by the three lockdowns considered (see the last four rows in Fig. 2). Specifically, during the first lockdown, posting activity was significantly lower among all occupations relative to manual workers—with the exception of craft workers (related to the low number of observations)—and of similar magnitude. The size of the coefficients suggests that the decline in posting activity was strongest among the highly skilled occupations of technicians and managers and professionals (see also Sect. 4.2.1 below). By contrast, the opposite is observable for the second/third and fifth lockdowns, when posting activity was higher—and of similar magnitude—mainly among the highly skilled and more-teleworkable occupations (see Fig. 1 above), such as technicians and managers and professionals. Hence, for the highly skilled occupations, the advantage of teleworkability was evident only from the second/third lockdown onwards.

4.2 Weekly effects estimation results

The results for the weekly effects around the two key COVID-19 containment events are shown in Fig. 3 below. The top row refers to the period around the beginning of each of the three lockdowns tested, while the bottom row refers to the end of each, when the lockdown was lifted and the economy reopened. For each event, we only show the beta coefficients of the weekly dummies as specified in Eq. (3). We report the results for three different variants of Eq. (3), which differ in the occupational variable used in the estimation: namely, a constant teleworkability index, a time-variant teleworkability index and occupational dummies.[11]

Generally, the results are similar regardless of which of the three occupational indicators is used in the estimation. However, we find very few significant coefficients for the specification with the time-dependent teleworkability indicator (which are mainly observable for the first lockdown), in which case the RMSE is also relatively high.

The results point to important differences across the three lockdowns and show that posting activity responded quite differently to the beginning and the end of each lockdown. Specifically, posting activity responded negatively to the beginning of the first lockdown: it was still above trend in the 2 weeks before the first lockdown came into effect, but it dropped below trend when the lockdown began. Posting activity declined further over the following 4 weeks into the first lockdown, before recovering somewhat (though remaining depressed). At the end of the first lockdown, posting activity was still below trend, and temporarily dipped further the week it was lifted. Subsequently, however, it did recover slowly, though it did not fully return to the trend within the 5-week time window analysed.

In line with our hypothesis, the patterns are quite different for the second/third lockdown, which saw both speedier and more symmetrical responses. First, with the announcement of the second/third lockdown, posting activity declined to below trend. Hence, we observe a strong announcement effect. However, it did not fall any further when the lockdown actually came into force. Second, posting activity remained depressed in the weeks that followed, but only started to deteriorate further 4 weeks into the second/third lockdown. Third, the end of the lockdown did not elicit any substantial response. Specifically, posting activity was already at trend level the week before the end of the lockdown was announced, and remained at trend level, with no further change thereafter.

As with the findings for the complete lockdown, the fifth lockdown was associated with positive responses. Furthermore, in line with our hypothesis, the responses were again faster and more symmetrical than during the first lockdown: in the 2 weeks leading up to the lockdown, posting activity increased steadily; it then remained constant (above trend) after the lockdown was implemented, suggesting that the lockdown may have

[11] All estimations also include a time trend and industry fixed effects, together with occupation fixed effects for the 'ISCO 1d' specification. The full results are reported in Table A.3 in the appendix.

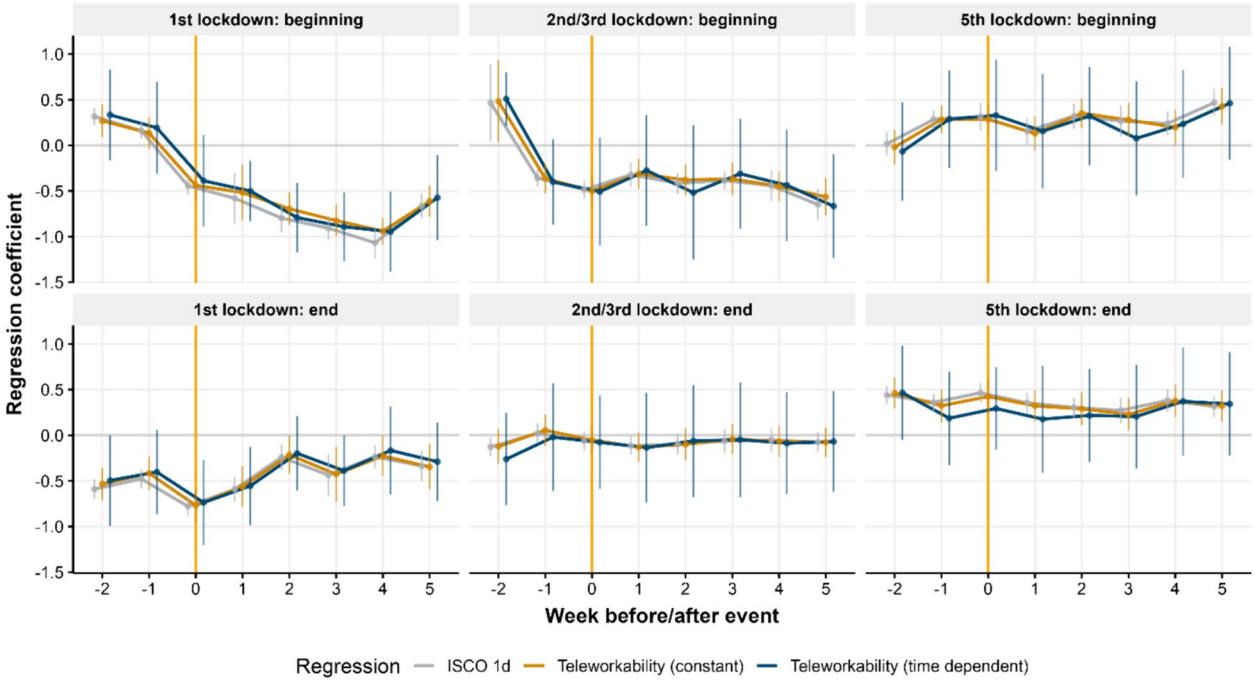

Fig. 3 Weekly effects of individual lockdowns: beginning (top row) and end (bottom row). The first lockdown started on 16 March 2020 and ended on 29 May 2020; the second and third lockdowns are taken together and started on 3 November 2020 and ended on 8 February 2021; the fifth lockdown refers to the lockdown for the unvaccinated and started on 15 November 2021 and ended on 31 January 2022. The vertical orange line refers to the tested event (i.e. the beginning or end of a lockdown). Only the beta coefficients of the weekly dummies from Eq. (3) are shown here, whereby different occupation-specific indicators were used in three different calculations: four one-digit occupational dummies (ISCO 1d), the time-invariant teleworkability index [Teleworkability (constant)], and the time-variable teleworkability index [Teleworkability (time dependent)]. A time trend and industry fixed effects are included for all estimations (together with occupation fixed effects for the'ISCO 1d' specification). The full results are reported in Table A.3 (Supplementary Material 8) in the online appendix. Error bars refer to 95% confidence intervals, which are based on clustered covariance matrix standard errors (Source: karriere.at, own calculations)

prevented a continued upward trend. The end of the fifth lockdown was again associated with above-trend posting activity. As with the end of the previous lockdown, posting activity was above trend a week before the end was announced, with no further changes after the restrictions were eventually lifted.

4.2.1 Results by occupation

The results for the weekly effects of the three lockdown events on each of the five occupational groups considered are shown in Fig. 4 below. The results refer to a specification which includes the time-dependent teleworkability index (in addition to a time trend and industry fixed effects).[12]

Figure 4 points to interesting occupation-specific responses across lockdown events. For instance, posting activity responded most strongly for the highly skilled occupations of technicians and managers and professionals: postings fell well below trend at the start of the first lockdown and continued to decline in the weeks that followed. When the first lockdown was lifted, however, posting activity was slow to recover, and was still below trend 5 weeks after the lockdown was lifted. By contrast, posting activity for craft workers and for clerks responded with a delay and only fell below the trend 2 to 3 weeks into the first lockdown; meanwhile, for manual workers there was no reaction and posting activity remained at trend level throughout. For manual workers, the unchanged posting activity in the first weeks into the lockdown, together with the limited overall decline in posting activity during the entire lockdown (see above), seems to be related to their importance in those essential sectors of the economy that continued operating. Moreover, unlike for technicians and managers and professionals, posting activity for those three occupational groups—craft workers, clerks and manual

[12] Since the underlying estimations are carried out separately for each occupational group, we can neither include occupational fixed effects nor the time invariant teleworkability indicator which is constant within an occupational group and thus collinear with the intercept. Thus, we include the time-dependent teleworkability indicator. The full results are available in Table A.4 in the appendix.

workers—recovered rapidly and returned to trend levels within 1 to 2 weeks following lifting of the lockdown.

Concerning the second/third lockdown, the above-mentioned announcement effect is visible across all occupations, but it was significant only for technicians, and managers and professionals. Hence, as in the first lockdown, posting activity for the highly skilled occupations initially responded most strongly and with the greatest speed—indeed faster than during the first lockdown. Overall, however, posting activity dropped most for manual workers and clerks: the week the lockdown started, posting activity was below trend for all occupations, with the largest decline among manual workers and clerks. In the following 5 weeks, posting activity remained below trend for all occupations, and fell further towards the end of the 5-week period, with the largest drop for manual workers and clerks overall. The stronger decline in posting activity among clerks appears to be related to the absence of winter tourism and the limited Christmas activity due to the lockdown at the end of the year. However, for all occupations except clerks, posting activity immediately returned to trend level with the announcement of the end of the lockdown, and remained at trend level in the following weeks, indicating a much faster response than during the first lockdown. For clerks, posting activity was depressed and was still below trend even 5 weeks after the lockdown was lifted.

As regards the fifth lockdown, posting activity again responded much quicker than during the first lockdown: it was above trend for craft workers, technicians, and managers and professionals from the week of the announcement to 5 weeks into the lockdown, with signs of a further increase in the 5th week. By contrast, posting activity for clerks did not respond at all, but remained at trend level throughout the 7-week period studied, while posting activity for manual workers returned to trend level when the beginning of the lockdown was announced and remained at trend level in the following weeks. At the end of the fifth lockdown, posting activity was similar and already above trend across all occupations in the week before the end of the lockdown was announced, with no changes thereafter (though it was relatively volatile for manual workers).

4.2.2 Industry-specific results

The results for the weekly effects of the three tested lockdown events on each of the 14 industries considered are shown in Fig. 5a and b below.[13] For the sake of brevity, we mention only the most interesting findings. The results refer to a specification which includes occupational fixed effects, in addition to a time trend; this produces the lowest RMSE scores.

In most industries, posting activity was above trend before the start of the first lockdown, but then dropped below trend in the week the lockdown began. The most pronounced drop can be observed in leisure and hospitality (which includes accommodation and food services and arts, entertainment and recreation), where posting activity dropped further in the following 3 weeks, before starting to pick up somewhat. Nonetheless, it remained far below trend in the 5-week window studied. This drastic and sustained drop in posting activity was the result of mandatory closures and widespread travel restrictions and bans, which hit the industry particularly hard, as reported in other studies (Koren 2020). A more pronounced drop is also observable in other industries, such as public services and utilities, wholesale and retail trade, logistics, transport and traffic, and energy and environmental technology, which were also affected by mandatory closures and travel restrictions. In all industries, posting activity was below trend in the week that saw the lifting of the first lockdown, and remained below trend in the 5-week window studied. By contrast, the IT, internet and telecommunications industry stands out from the rest: posting activity there remained above trend almost throughout the first lockdown period analysed. This is related to the fact that COVID-19 led to a surge in e-commerce and an acceleration of the digital transformation, as businesses and consumers increasingly 'went digital', providing and purchasing more goods and services online. Many workers also started to work from home.[14] Hence, businesses increasingly sought IT experts to meet emerging digital challenges and to implement new digital solutions.

In all industries, posting activity was below trend even before the second/third lockdown was announced, and remained below trend for the 5 weeks thereafter. A notable exception is again the IT, internet and telecommunications industry, where posting activity started well above trend, but then fell to below trend when the lockdown began. It also remained far below trend for the 5 weeks thereafter. The sharp drop in job postings in the IT industry indicates that either the digital transformation was already sufficiently advanced in most businesses (so that the demand for IT experts declined again) or that businesses anticipated the second/third lockdown and brought forward their hiring activities. Posting activity across industries responded differently to the end of the

[13] The full results are reported in Table A.5 in the appendix.

[14] Before the onset of the pandemic, telework was not too widespread in Austria but it increased from around 10% in 2019 to around 18% in 2020, putting Austria in fourth place among all EU27 countries (see Eurostat: lfsa_ehomp).

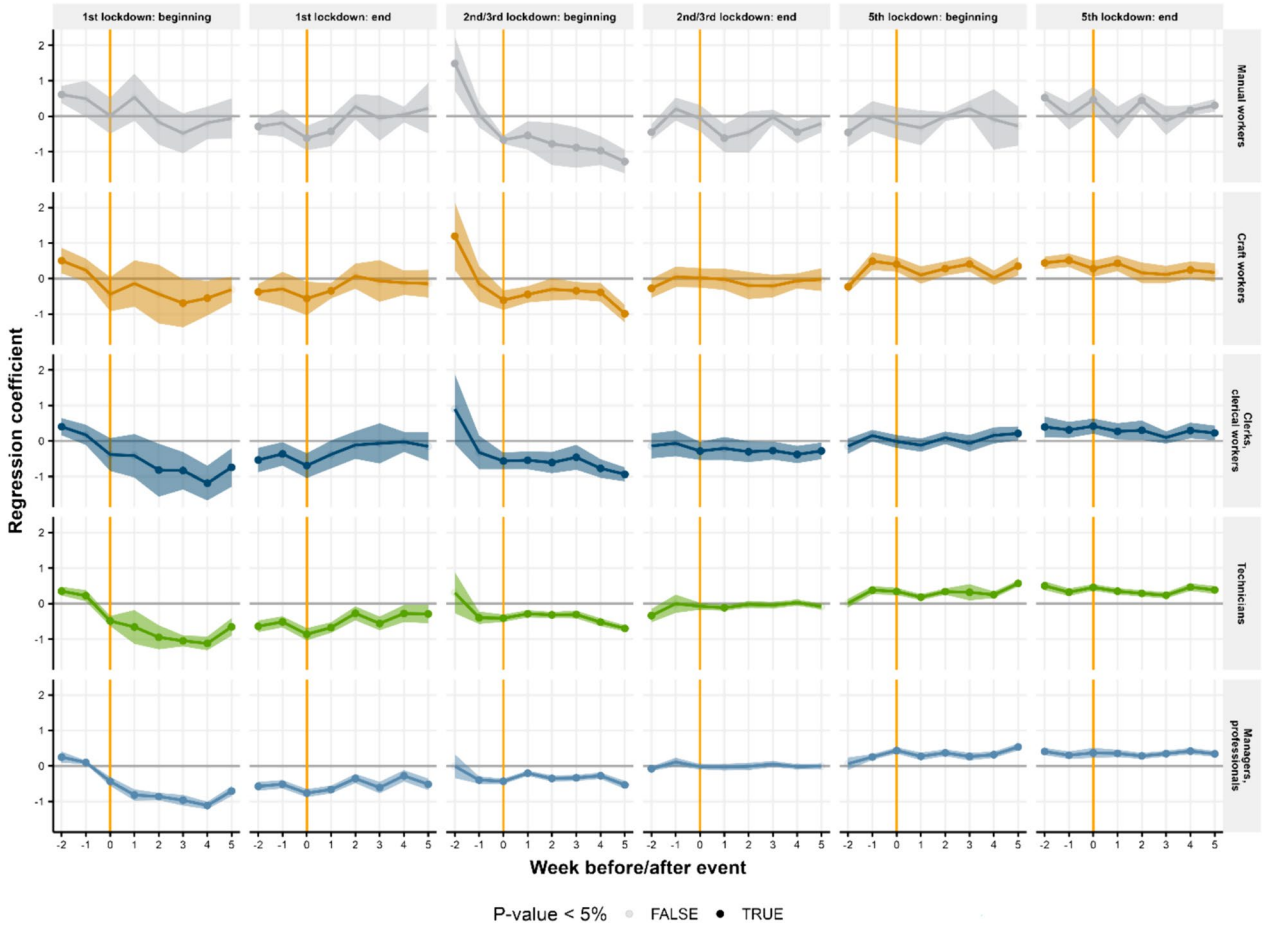

Fig. 4 Weekly effects of individual lockdown events (beginning and end), by occupational group. The first lockdown started on 16 March 2020 and ended on 29 May 2020; the second and third lockdowns are taken together and started on 3 November 2020 and ended on 8 February 2021; the fifth lockdown refers to the lockdown for the unvaccinated and started on 15 November 2021 and ended on 31 January 2022. The five occupational groups are defined as follows (based on the ISCO-08 classification): managers, professionals [managers (ISCO-08: 1), professionals (ISCO-08: 2)]; technicians [technicians and associate professionals (ISCO-08: 3)]; clerks, clerical workers[clerical support workers (ISCO-08: 4) and services and sales workers (ISCO-08: 5)]; craft workers [skilled agricultural, forestry and fishery workers (ISCO-08: 6) and craft and related trades workers (ISCO-08: 7)]; and manual workers [plant and machine operators and assemblers (ISCO-08: 8) and elementary occupations (ISCO-08: 9)]. The vertical orange line refers to the tested event (i.e. the beginning or end of a lockdown). Only the beta coefficients of the weekly dummies from Eq. (3) are shown here. The time dependent teleworkability index, a time trend and industry fixed effects are included in the estimations. The full results are reported in Table A.4 (Supplementary Material 9) in the online appendix. Error bars refer to 95% confidence intervals, which are based on clustered covariance matrix standard errors (Source: karriere.at, own calculations)

second/third lockdown. Specifically, in several industries, posting activity was below trend before the second/third lockdown was lifted, but quickly returned to trend level, largely in the week when the lockdown was eventually lifted. However, in some industries—the leisure and hospitality industry, as well as the IT, internet and telecommunications industry—posting activity remained far below trend for the 5 weeks thereafter. By contrast, posting activity in the consulting services industry barely responded to the end of the lockdown, and remained slightly above trend throughout the entire 7-week window around the end of the lockdown (though not always significant).

In most industries, posting activity was above trend before the start of the fifth lockdown and remained above trend thereafter. A further upward trend is observable in some industries, such as the public services and utilities industry, the wholesale and retail trade industry (from week 2 onwards), and the health and social services industry. Particularly noteworthy are leisure and hospitality and the IT, internet and telecommunications industry: whereas both previous lockdowns (beginning

and end) had hit the leisure and hospitality industry particularly badly, the start of the last lockdown had no significant effect. Meanwhile, in the IT, internet and telecommunications industry, a negative effect was also observable for the fifth lockdown, but the coefficients were all insignificant (except for one), pointing to a return to trend level. Generally, posting activity around the end of the fifth lockdown was very similar to posting activity around its beginning: in all industries, it was already above trend before the end of the fifth lockdown, and remained above trend thereafter. The strongest above-trend posting activity was seen in the public services and utilities industry.

4.2.3 Effects by NUTS 1 region

Figure 6 shows the results for the weekly effects of the three lockdown events considered, for each of the four NUTS 1 regions: North, East, South and West. As above, the results refer to a specification that includes occupational fixed effects—in addition to a time trend and industry fixed effects—since this produces the lowest RMSE scores.[15]

The results for the first lockdown indicate similar sluggish response patterns across all regions. Posting activity barely responded to the announcement of the lockdown, but then dropped to below trend when the lockdown started and declined further over the next 4 weeks, before improving somewhat during the 5th week of lockdown. Overall, however, the negative response was strongest in the Eastern region. The end of the first lockdown also led to similar responses across regions, with below-trend posting activity prior to the end, and a slow but steady recovery over the subsequent weeks. However, in none of the regions did it fully catch up with trend activity within the 5-week time window analysed.

Rather similar patterns across the regions are also observable for the second/third lockdown. However, the responses were generally quicker. Specifically, there was a strong announcement effect in all regions, though it was most pronounced in the Southern region. The actual start of the lockdown failed to elicit any further drop in posting activity, which remained fairly stable (at below trend) over the following weeks, before dropping in the 5th week of the lockdown. This pattern is mainly observable for the Northern and Eastern regions. In the Southern and Western regions, posting activity had already started to decline somewhat earlier. The results for the end of the second/third lockdown suggest that posting activity was already at trend level before the end of the lockdown was announced. The only notable exception was the Western region, where posting activity remained below trend even after the lockdown was lifted. The stronger overall decline and slower recovery in the Western region is related to the importance of tourism in the region: it was hit particularly hard by this lockdown, which shut down most of its winter tourist season.

The fifth lockdown resulted in somewhat different responses in posting activity in the four regions. Generally, posting activity was above trend from the time of the announcement, and remained above trend thereafter. In the Northern and Eastern regions, posting activity remained stable (at above trend) over the following weeks, before increasing in the 5th week of lockdown. Conversely, in the Southern region, posting activity continued to increase over the 5 weeks following the end of lockdown. A similar upward trend is also observable in

(See figure on next page.)

Fig. 5 **a** Weekly effects of individual lockdown events (beginning and end), by industry. The first lockdown started on 16 March 2020 and ended on 29 May 2020; the second and third lockdowns are taken together and started on 3 November 2020 and ended on 8 February 2021; the fifth lockdown refers to the lockdown for the unvaccinated and started on 15 November 2021 and ended on 31 January 2022. The vertical orange line refers to the tested event (i.e. the beginning or end of a lockdown). Only the beta coefficients of the weekly dummies from Eq. (3) are shown here. Occupational fixed effects, a time trend and industry fixed effects are included in the estimations. The full results are reported in Table A.5 (Supplementary Material 10) in the appendix. Error bars refer to 95% confidence intervals, which are based on clustered covariance matrix standard errors. Source: karriere.at, own calculations. **b** Weekly effects of individual lockdown events (beginning and end), by industry. The first lockdown started on 16 March 2020 and ended on 29 May 2020; the second and third lockdowns are taken together and started on 3 November 2020 and ended on 8 February 2021; the fifth lockdown refers to the lockdown for the unvaccinated and started on 15 November 2021 and ended on 31 January 2022. The vertical orange line refers to the tested event (i.e. the beginning or end of a lockdown). Only the beta coefficients of the weekly dummies from Eq. (3) are shown here. Occupational fixed effects, a time trend and industry fixed effects are included in the estimations. The full results are reported in Table A.5 (Supplementary Material 10) in the online appendix. Error bars refer to 95% confidence intervals, which are based on clustered covariance matrix standard errors (Source: karriere.at, own calculations)

[15] The full results are reported in Table A.6 in the appendix.

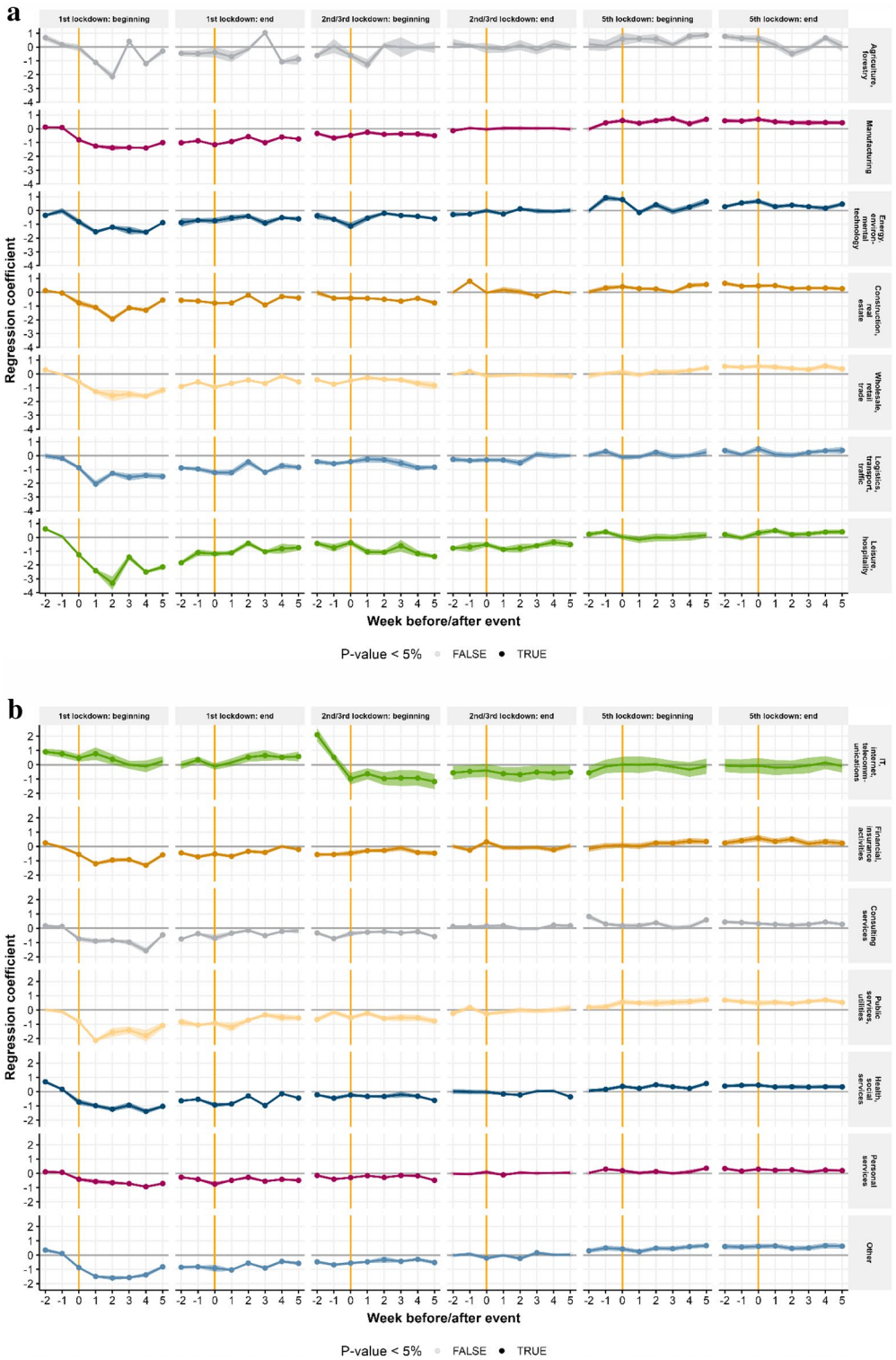

Fig. 5 (See legend on previous page.)

the Western region, but with a slight delay. The end of the last lockdown is also associated with above-trend posting activity in all regions. But while posting activity followed a moderate U-shaped pattern in the Northern region and a sideways movement in the Eastern region, it showed a downward trend in the Western and Southern regions.

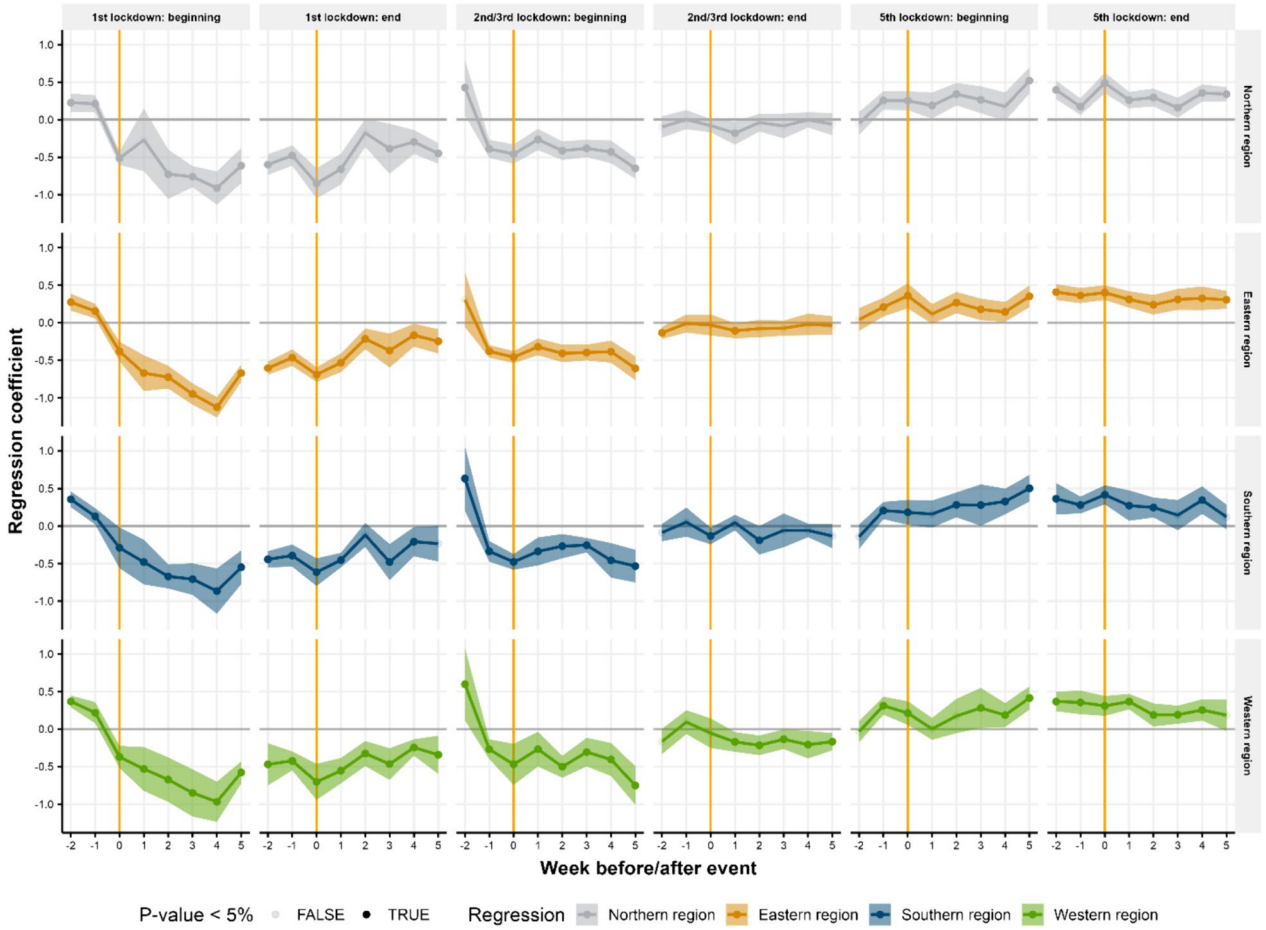

Fig. 6 Weekly effects of individual lockdown events (beginning and end), by NUTS 1 region. The first lockdown started on 16 March 2020 and ended on 29 May 2020; the second and third lockdowns are taken together and started on 3 November 2020 and ended on 8 February 2021; the fifth lockdown refers to the lockdown for the unvaccinated and started on 15 November 2021 and ended on 31 January 2022. 'Northern region' refers to Upper Austria; 'Eastern region' to the capital city Vienna, Lower Austria and Burgenland; 'Southern region' to Styria and Carinthia; and 'Western region' to Salzburg, Tyrol and Vorarlberg. The vertical orange line refers to the tested event (i.e. the beginning or end of a lockdown). Only the beta coefficients of the weekly dummies from Eq. (3) are shown here. Occupational fixed effects, a time trend and industry fixed effects are included in the estimations. The full results are reported in Table A.6 (Supplementary Material 11) in the online appendix. Error bars refer to 95% confidence intervals, which are based on clustered covariance matrix standard errors (Source: karriere.at, own calculations)

4.3 Effect of the vaccination roll-out programme

Tables A.7 and A.8 (Supplementary Material 12 and 13) in the online appendix provide the results for the effect of the vaccination roll-out programme on posting activity—both the complete effects (for the whole lockdown period) and the weekly estimations. Since the vaccinations mainly became available from early 2021 onwards, we focus on the second/third and fifth lockdowns, but expand the time window to account for their slow roll-out and uptake. In the analysis, we also test for non-linearity in the vaccination roll-out programme by including a squared term of the (log of the) share of the vaccinated in a region, in addition to the (log of the) share of the vaccinated in the same region. The presence of a potential minimum or maximum has important implications for both health and labour market policy. In both tables, column (1) refers to the main model, while column (3) refers to the interaction model, including interaction terms between the share of people in the population of the NUTS 1 region with two doses, and the dummies for the second/third and fifth lockdowns. In addition, non-linearity in the main model and the interaction model is reported in columns (2) and (4), respectively. The results for the weekly estimations are also shown in Fig. 7 below, with the top panel showing the coefficients of the weekly dummies and the bottom panel showing the coefficients of the weekly interaction terms. The log of the share of the vaccinated has been centred to ease interpretation.

Generally, the results show that posting activity was significantly higher in those regions where the share of persons who had had two COVID-19 vaccine doses was greater [see column (1) in Tables A.7 and A.8 (Supplementary Material 12 and 13)], underscoring the fact that the COVID-19 vaccines had a positive employment effect. Specifically, the coefficients suggest that an increase in the share of vaccinated persons in a region by 1% was associated with a 7% rise in posting activity.

Moreover, the results from the interaction model of the complete lockdown estimations point to a differentiated effect of vaccinations during the lockdowns [see column (3) in Table A.7 (Supplementary Material 12)]. The positive coefficients suggest that those regions with a higher share of vaccinated persons also had stronger posting activity during the lockdowns. This is particularly the case for the second/third lockdown, while the effect is only marginally significant for the fifth lockdown.

The results of the weekly lockdown estimations [see the top panel in Fig. 7 or column (1) in Table A.8 (Supplementary Material 13) in the online appendix] point to similar adjustment patterns as in Fig. 3 [and column (3) in Table A.3], where the results for the fifth lockdown are most reliable, due to the stronger vaccination uptake in 2021. Hence, even after controlling for vaccination uptake in the population, in addition to a time trend and occupational, industry and regional effects, the positive responses during the fifth lockdown persist. This suggests that the above-trend posting activities observable during the fifth lockdown were independent of either occupational differences (related to differences in teleworkability, for instance) or the uptake of vaccinations, and were more likely a reflection of a strong mood of optimism among employers and early hiring activities in anticipation of the end of the COVID-19 pandemic and in preparation for a quick recovery, as seen after the end of previous lockdowns.

Moreover, the findings from the interaction model of the weekly lockdown estimations also show that the coefficients for both lockdowns are mostly positive but consistently insignificant [see the bottom panel in Fig. 7 or column (3) in Table A.8 (Supplementary Material 13) in the online appendix]. This suggests that the share of the vaccinated made no difference in terms of posting activity in any of the individual lockdown weeks, and could not generate additional demand for new hires.

Finally, the results for the non-linear models [see column (2) in Tables A.7 and A.8 (Supplementary Material

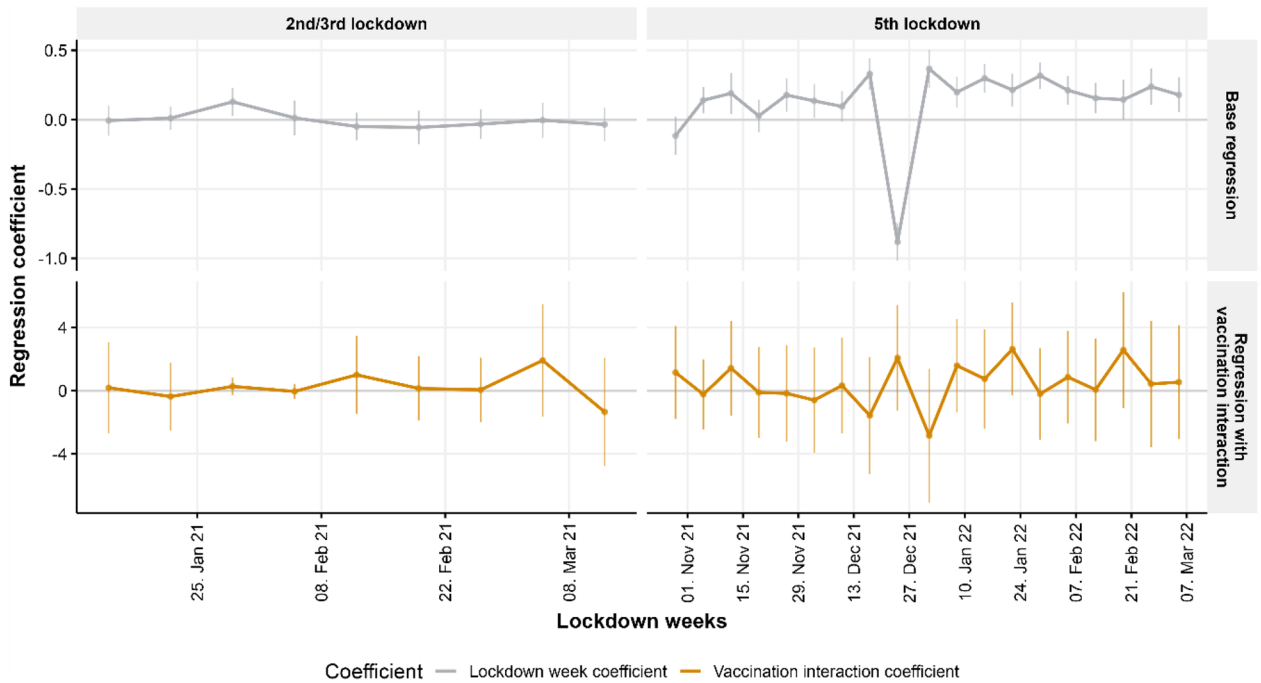

Fig. 7 Weekly lockdown effects (top panel) and vaccination interactions (bottom panel). The second and third lockdowns are taken together, starting on 3 November 2020 and ending on 8 February 2021; the fifth lockdown refers to the lockdown for the unvaccinated and started on 15 November 2021 and ended on 31 January 2022. Only the beta coefficients of the weekly dummies from Eq. (3) are shown here. Occupational fixed effects, a time trend and industry fixed effects are included in the estimations. The full results are reported in Table A.8 (Supplementary Material 13) in the online appendix. Error bars refer to 95% confidence intervals, which are based on clustered covariance matrix standard errors (Source: karriere.at, own calculations)

12 and 13)] indicate non-linearities in the share of vaccinated persons in a region. However, the estimated turning point is at around 1.1% to 1.8%, which is very near to the minimum of the range of the share of vaccinated persons, so there is insufficient evidence of a U-shaped relationship. This also applies to the results for the interaction models [see column (4) in Tables A.7 and A.8 (Supplementary Material 12 and 13)], where there is evidence of non-linearity only during the second/third lockdown. However, the estimated turning point is again very close to zero, indicating insufficient evidence of a lockdown-specific U-shaped relationship in the share of vaccinated persons.

5 Summary and conclusion

This paper has analysed changes in the speed of labour demand for new hires in response to lockdowns that were repeatedly put in place to contain the spread of the COVID-19 pandemic. It tested whether the uncertainty-reducing effect of similar lockdowns in quick succession increased the responsiveness of the labour market, allowing for faster adjustments, both at the beginning and at the end of subsequent lockdowns.

It used a unique dataset of online job-posting data, and applied an event study approach to six COVID-19 events in Austria, namely the start of three national lockdowns and their subsequent lifting between 2020 and 2022: (i) the *first* and most dramatic national lockdown (16 March 2020 to 29 May 2020); (ii) the *second and third* national lockdowns together (which were only separated by 2 days) (3 November 2020 to 8 February 2021); and (iii) the *fifth* strict national lockdown for the unvaccinated (15 November 2021 to 31 January 2022). It looked at the 2 weeks before and the 5 weeks after each event in order to identify a potential announcement effect, as well as immediate and lagged implementation effects on labour demand; and it analysed differences across occupations, industries and regions. Furthermore, given the importance of progress in vaccination for labour market recovery, the analysis looked at vaccine roll-out as an additional COVID-19 containment measure, with 2021 as the main roll-out period.

Our results indicate quite different responses to the various lockdowns and related events. On average, job-posting activity declined by between 47 and 50% during the first lockdown and by between 29 and 31% during the second/third lockdown; but it increased by 23% to 28% during the final lockdown. The differences across lockdowns are related to the nature of the lockdowns and the different economic responses each of them triggered (Baumgartner et al. 2022). The relatively modest slump and quick recovery associated with the last lockdown prompted above-trend posting activity.

In line with our hypothesis, the findings of the event study analysis point to faster and more symmetrical responses over later lockdowns. Specifically, posting activity responded sluggishly to the first lockdown: it dropped below trend at the start of the first lockdown and declined further over the next 4 weeks, before recovering somewhat. Posting activity recovered slowly after the lockdown was lifted, but failed to return to trend within the subsequent 5 weeks. Conversely, posting activity already dropped substantially below trend with the announcement of the second/third lockdown, with signs of a further decline 5 weeks into the lockdown. The end of lockdown did not elicit any substantial response, with posting activity already back at trend level the week before it was announced. Both the beginning and the end of the fifth lockdown saw above-trend posting activity in the week before the announcements were made, and there was little change thereafter.

Furthermore, the results show that teleworkability is important: more-teleworkable occupations fared better during the lockdowns in terms of higher demand. This was true for all but the first lockdown, during which more-teleworkable occupations—especially technicians, and managers and professionals—were less in demand than less-teleworkable occupations. This contrasts with what is typically found in the literature (Chetty et al. 2023; Flisi and Santangelo 2022; Sostero et al. 2020) and highlights the fact that more-teleworkable and highly skilled occupations were generally shielded no better from the negative effects of the lockdowns.

While there is little difference across regions, responses to the various events differ by occupation and industry. For instance, for the highly skilled occupations of technicians, managers and professionals, posting activity declined most rapidly and most sharply with the start of the first lockdown, and recovered the least after it was lifted; however, it fell to below trend level at the time of the announcement of the start of the second/third lockdown and immediately returned to trend level with the announcement of its end; it moved to above trend level with the announcement of the fifth lockdown and was already above trend level even before the end was announced. By contrast, for manual workers posting activity barely responded to either the start or the end of the first lockdown, which was probably related to the importance of such workers in those essential sectors that continued operations; however, it dropped sharply at the beginning of the second/third lockdown, before immediately returning to trend level with the announcement of its end. It returned to—and subsequently remained at—trend level at the time of the announcement of the fifth lockdown and showed more erratic responses at its end.

The most notable effects are observable in leisure and hospitality (which includes accommodation and food services, and arts, entertainment and recreation) and in the IT, internet and telecommunications industry. Overall, as expected, leisure and hospitality saw the largest declines and the slowest recoveries in posting activity, suggesting that that sector will take longer to rebound and fully recover. Specifically, it experienced a strong decline in posting activity at the beginning of the first lockdown, due to the mandatory closures and the widespread travel restrictions and bans that hit this industry particularly hard. Recovery was then roughly as slow as in all other industries after the lockdown was lifted. Likewise, due to similar lockdown measures, posting activity fell to (and remained at) below trend at the start of the second/third lockdown and remained well below trend for the 5 weeks after it was lifted. Conversely, whereas the start of the fifth lockdown had no significant effect, posting activity was slightly above trend at the end of that lockdown and remained slightly above trend thereafter.

By contrast, the IT, internet and telecommunications industry showed posting activity developing in the opposite direction to the other industries. Specifically, posting activity remained above trend for almost the entire first lockdown period. This is related to the fact that COVID-19 led to a surge in e-commerce and an acceleration of the digital transformation, with many people starting to work from home; this prompted businesses to increasingly seek IT experts to meet the emerging digital challenges and to implement new digital solutions. Posting activity started far above trend, but then fell to below trend when the second/third lockdown began, and remained far below trend for the 5 weeks thereafter; this suggests either that the digital transformation was already sufficiently advanced in most businesses (so that demand for IT experts declined again) or that businesses anticipated the second/third lockdown and brought their hiring activities forward. Similarly, posting activity remained far below trend for the 5 weeks after the lockdown was lifted. A negative but insignificant effect is also observable for the fifth lockdown, indicating that the COVID-19-induced digital transformation was already complete, since the demand for IT experts was back to trend level.

Finally, as concerns vaccine roll-out, the results indicate that posting activity was significantly higher in regions with a greater share of persons who had received two doses of a COVID-19 vaccine. In particular, our estimations suggest that a 1% increase in the log of the share of the vaccinated is associated with a 7% increase in posting activity. However, there is little robust evidence of a differentiated effect during the lockdowns. We also find insufficient evidence of a U-shaped relationship, either generally or with specific reference to the lockdowns.

Overall, our findings point to the importance of studying repeated lockdowns—something that the literature has failed to address, due to its narrow focus on the first lockdown (and in many cases even just the *beginning* of the first lockdown). In line with this literature, our results indicate a rather sluggish response to both the beginning and the end of the first lockdown, with a slow decline at the beginning and a very slow recovery after it was lifted. However, our study of repeated lockdowns shows that the demand for new hires responded more quickly to both the beginning and the end of subsequent lockdowns, suggesting that uncertainty-reducing learning effects allowed for faster adjustment to similar shocks. This is an important and positive finding, since large pandemics like COVID-19 are increasingly likely (Marani et al. 2021), making repeated lockdown-like measures more probable. Of particular importance in this context is the quicker—at times even instantaneous—recovery (i.e. return to trend level as soon as the announcement was made of the end of the lockdown) during subsequent lockdowns, which allows for more rapid overall recovery.

Importantly, we also find that vaccination is a critical factor in labour market recovery (Kiss et al. 2022; Mosbah and Dharmapala 2022) and is associated with stronger posting activity. This underscores the point that, as well as having a protective effect against serious illness and death (Zheng et al. 2022), vaccination also affects demand for new hires, making it an important policy tool from a labour market perspective, too. However, our results also show that vaccination made no difference to posting activity during the lockdowns. This was particularly true of the fifth lockdown, which differentiated by vaccination status and allowed for meaningful empirical analysis, thanks to the adequate vaccination uptake in the population. This finding has important policy implications, as it suggests that the vaccination roll-out—which, like the lockdowns, also aimed at protecting the population—had no additional demand-enhancing effect on new hires (over and above the lockdowns). Moreover, we do not find sufficient evidence of a turning point in the effect of vaccination on the demand for new hires. Hence, there is no evidence for the importance of a minimum or optimal vaccination policy (in terms of a minimum share of the vaccinated to be exceeded or a maximum share to be reached/not exceeded) in labour market recovery.

Like other studies, our analysis also shows that there are winners and losers from lockdowns. However, our analysis of a series of lockdowns shows that this is often only temporary and can even shift between lockdowns.

For instance, we find that the highly skilled—and more-teleworkable—occupations of technicians, managers and professionals experienced the strongest positive and negative responses. Thus, contrary to what is typically found in the literature, the crisis also adversely affected the highly skilled, at least temporarily and only during the first lockdown, while the advantage of teleworkability only kicked in during the subsequent lockdowns. Furthermore, we find persistent above-trend posting activity in the IT, internet and telecommunications industry, but this was only observed during the first lockdown; it subsequently reversed and then returned to trend level during the last lockdown. Hence, the very positive job-posting activity of the first lockdown was not repeated during subsequent lockdowns.

Finally, our results likewise suggest that lockdowns may be felt longer in some industries than in others. Specifically, leisure and hospitality not only saw the largest declines, but also the slowest recoveries in posting activity, suggesting that it may take longer for that industry to rebound and recover fully. This is a key industry for Austria, especially in its Western provinces, and requires policy intervention to help encourage new hiring, especially against the backdrop of simultaneous labour shortages in the industry (Dornmayr and Riepl 2022), which were exacerbated during and after the COVID-19 pandemic by the non-return of foreign workers, on whom the industry is heavily dependent, and by workers who 'left' the industry permanently during the pandemic, due to uncertain employment and income prospects.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12651-024-00376-9.

Supplementary Material 1.
Supplementary Material 2.
Supplementary Material 3.
Supplementary Material 4.
Supplementary Material 5.
Supplementary Material 6.
Supplementary Material 7.
Supplementary Material 8.
Supplementary Material 9.
Supplementary Material 10.
Supplementary Material 11.
Supplementary Material 12.
Supplementary Material 13.

Acknowledgements
Support provided by the Austrian Science Fund for this research is gratefully acknowledged. We also thank Michael Landesmann and Georg Fischer for helpful comments and discussions.

Author contributions
S.L and O.R. designed the study; O.R. analysed the data; S.L. gave feedback on results and suggested methodological adjustments; S.L and O.R wrote the paper.

Funding
Research for this paper was financed by the Austrian Science Fund (Project No. P 35180-G).

Data availability
The data that support the findings of this study are available from karriere.at, but restrictions apply to the availability of these data, which were used under licence for the current study and so are not publicly available. The data are, however, available from the authors upon reasonable request and with the permission of karriere.at.

Code availability
The codes for all analyses reported in this paper are available on request.

Declarations

Competing interests
The authors declare no competing interests.

Received: 20 December 2023 Accepted: 22 July 2024
Published online: 16 August 2024

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