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OCCUPATIONAL REALLOCATION AND MISMATCH IN THE WAKE OF THE COVID-19 PANDEMIC: CROSS-COUNTRY EVIDENCE FROM AN ONLINE JOB SITE

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ABSTRACT/RÉSUMÉ

Occupational reallocation and mismatch in the wake of the COVID-19 pandemic: Cross-country evidence from an online job site

Employment has recovered strongly from the COVID-19 pandemic despite large structural changes in labour markets, such as the widespread adoption of digital business models and remote work. We analyse whether the pandemic has been associated with labour reallocation across occupations and triggered mismatches between occupational labour demand and supply using novel data on employers' job postings and jobseekers' clicks across 19 countries from the online job site Indeed. Findings indicate that, on average across countries, the pandemic triggered large and persistent reallocation of postings and clicks across occupations. Occupational mismatch initially increased but was back to pre-pandemic levels at the end of 2022 as employers and workers adjusted to structural changes. The adjustment was substantially slower in countries that resorted to short-time work schemes to preserve employment during the pandemic.

Keywords: Occupational mismatch, Reallocation, COVID-19 pandemic.

JEL classification codes: E24, J23, J24, G18.

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ABSTRACT/RÉSUMÉ

Réallocation et inadéquation professionnelles à la suite de la pandémie de COVID-19 : Preuves internationales provenant d'un site d'emploi en ligne

L'emploi s'est fortement redressé après la pandémie de COVID-19, malgré d'importants changements structurels, tels que l'adoption généralisée de modèles d'affaires numériques et du travail à distance. Nous analysons si la pandémie a été associée à une réallocation de la main-d'œuvre entre les professions et a déclenché des inadéquations entre la demande et l'offre de main-d'œuvre professionnelle en utilisant de nouvelles données sur les offres d'emploi des employeurs et les clics des demandeurs d'emploi dans 19 pays à partir du site d'emploi en ligne Indeed. Les résultats indiquent qu'en moyenne dans tous les pays, la pandémie a déclenché une réaffectation importante et persistante des offres d'emploi et des clics entre les professions. L'inadéquation professionnelle s'est initialement accrue, mais est revenue aux niveaux d'avant la pandémie fin 2022, à mesure que les employeurs et les travailleurs s'adaptaient aux changements structurels. L'ajustement a été nettement plus lent dans les pays qui ont eu recours à des mesures de chômage partiel pour préserver l'emploi pendant la pandémie.

Mots clés : Inadéquation professionnelle, réallocation, pandémie de COVID-19.

Classification JEL : E24, J23, J24, G18.

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Occupational reallocation and mismatch in the wake of the COVID-19 pandemic: Cross-country evidence from an online job site

By Gabriele Ciminelli, Antton Haramboure, Lea Samek, Cyrille Schwellnus, Allison Shrivastava and Tara Sinclair[1]

1. Introduction

1. Labour markets have rebounded strongly from the large disruptions triggered by the COVID-19 pandemic, with employment in mid-2023 well above pre-pandemic levels in most countries. At the same time, the pandemic accelerated a number of structural trends in labour markets, including expedited adoption of digital business models and remote work. The coincidence of strong labour market recovery and accelerated structural transformation suggests two potential explanations. Either the digitalisation of workplaces and the shift towards telework did not trigger a persistent reallocation of labour supply and demand across occupations, or imbalances between the supply and demand for labour across occupations (occupational mismatch) did not increase despite reallocation. This would, for instance, be the case if employers adjusted job vacancies to the new occupational structure of labour supply and/or workers adjusted job search to the new occupational structure of labour demand. Assessing the extent of occupational reallocation and mismatch in the wake of the COVID-19 pandemic may provide broader insights into labour market adjustment in the wake of reallocation shocks, as well as the role of public policies in shaping the adjustment.

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2. To analyse occupational reallocation and mismatch across countries during and after the COVID-19 pandemic, we first assemble a novel high-frequency dataset of occupational reallocation and mismatch indicators for 19 countries over the period January 2017-January 2023. The indicators are constructed using information on employers' job postings and jobseekers' clicks across 55 different occupational categories from the online job site Indeed. We then document occupational reallocation and mismatch during and after the COVID-19 pandemic. Finally, we analyse the channels underlying occupational reallocation and mismatch, as well as the role of public policies in influencing the speed and extent of labour market adjustment.

3. Our findings indicate that large and persistent occupational reallocation went hand in hand with labour market adjustment, resulting in a gradual return of occupational mismatch to pre-pandemic levels. First, the COVID-19 pandemic triggered a persistent reallocation of both labour demand (as measured by the distribution of online job postings across different job categories) and labour supply (as measured by the distribution of jobseekers' clicks). For instance, employer demand for software developers relative to overall demand was higher and for administrative assistants lower at the end of 2022 than in 2019. Second, despite persistent reallocation, occupational mismatch was back to pre-COVID levels in late 2022. Occupational mismatch surged in the initial stages of the pandemic as job postings from some occupations collapsed, but normalised thereafter as hard-hit occupations gradually recovered and postings and clicks adjusted to the post-pandemic labour market structure. For instance, interest from jobseekers for software development jobs increased and for administrative assistance jobs declined, reducing occupational mismatch. Third, the speed of adjustment was substantially lower in countries that resorted to short-time work schemes to preserve employment during the pandemic, consistent with the view that such schemes reduce employers' incentives to dismiss workers and workers' incentives to search for jobs.

4. Our paper is closely related to an emerging literature documenting occupational mismatch over the business cycle, including the COVID-19 pandemic. Pizzinelli and Shibata (2023[1]) focus on sectoral and occupational mismatch in the United States and the United Kingdom during the pandemic, mainly using survey data for vacancies and job flows. They find that mismatch rose sharply at the onset of COVID-19 but that the increase was short-lived. Gimbel and Sinclair (2020[2]) use data on jobseekers and online vacancies from Indeed to construct indicators of occupational mismatch for the United States and some English-speaking countries. They find that mismatch in the United States in 2019 was substantial, with about one-third of the labour force needing to change occupation to reduce mismatch to zero. Mismatch was declining in the years preceding the pandemic, as job vacancies in occupations that had disappeared during the 2008-09 recession were returning. This is consistent with findings from previous studies that occupational mismatch is counter-cyclical, as declines in job vacancies during recessions tend to be concentrated in specific sectors, such as construction during the 2008-09 recession, whereas the occupational distribution of labour supply tends to be more stable (Lazear and Spletzer, 2012[3]; Gimbel and Sinclair, 2020[2]).

5. The paper adds to the existing body of work as follows. First, it uses clicks on job postings as a high-frequency measure of occupational labour supply. In contrast to jobseekers' occupational background or occupation-level unemployment – which most existing studies use as measures of occupational labour supply (Forsythe et al., 2020[4]; 2022[5]; Gallant et al., 2020[6]) – clicks allow measuring the reallocation of labour supply more accurately. For instance, a jobseeker with a background in a contact-intensive occupation may be looking for work in a remote work occupation in the wake of the COVID-19 pandemic. Second, the paper constructs novel measures of occupational reallocation and mismatch for a broad set of countries spanning the period before, during and after the COVID-19 pandemic. Third, it uses the novel measures of occupational reallocation and mismatch to analyse the channels of labour market adjustment, including the role of public policies such as short-time work schemes.

6. The remainder of the paper is structured as follows. Section 2 presents the data, defines the measures of occupational reallocation and mismatch, and describes the methodology to estimate the effect of short-time work schemes. Section 3 documents occupational reallocation and mismatch across

countries during and after the pandemic and Section 4 analyses the impact of short-time work schemes. Section 5 provides a number of robustness checks and Section 6 concludes.

2. Data and methodology

7. To study occupational mismatch, we assemble a novel dataset on job advertisements and jobseekers' clicks using proprietary data from the world largest online job site Indeed. Advertisements include those posted directly on Indeed's website, as well as thousands of online job boards, career sites and recruiter listings, thus covering the near-universe of online job postings in the countries covered by the analysis. Indeed de-duplicates job offers, so that when the same job is collected from multiple sources, it is shown only once. Tests of the reliability and representativeness of Indeed job postings suggest that it is broadly comparable with official labour market data.2 Indeed also collects counts of clicks on job advertisements, with clicks not implying actual applications. In this sense, clicks should be interpreted as broad jobseekers' interest rather than the determination to apply for a job.

8. Indeed extracts key information from the postings, such as job title, posting date and other metadata using state-of-the-art text analysis algorithms, and stores them in dedicated fields. This allows us to divide job postings and clicks into 55 unique occupation categories, listed in Table A.1. Clicks encompass jobseekers who may not necessarily be qualified for the job advertisements they are clicking on. However, they have the advantage of not having to assume zero cross-occupational mobility to approximate occupational labour supply, as would, for instance, be the case of occupational background or occupation-level unemployment.

9. To estimate the impact of the COVID-19 pandemic on occupational mismatch, we complement the dataset with the stringency index of government-imposed mobility restrictions from the Oxford COVID-19 Government Response Tracker (Hale et al., 2021[7]). The index measures the extent of school, workplace and public transport closures, restrictions to public events, gatherings and internal movements, requirements to stay at home, controls of international travel and public information campaigns. The index ranges from 0 to 100, with greater values indicating more restrictive measures.

10. To analyse the role of public policies in occupational mismatch during the pandemic, we construct a measure of the existence and generosity of short-time work schemes. In short-time work schemes, workers are put on a reduced work schedule and receive partial compensation for hours not worked by the government. Short-time work schemes provide strong incentives to preserve employment matches during economic downturns. Employers usually do not have to pay any salary for the hours not worked, and workers earn a large part of their contractual salary.3

11. While several countries had short-time work schemes in place before the pandemic, new schemes were introduced and existing ones were scaled up during the pandemic. To proxy for short-time work schemes, information from Table A.2. of the OECD Employment Outlook 2021 (OECD, 2021[8]) is leveraged, which reports the replacement rate (the fraction of the salary paid by the government in the hypothetical case of a worker who is temporarily out of work). The table reports this information for two

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2 For instance, tests on the Ireland sample suggest that it is broadly comparable with the Central Statistics Office's labour market data in terms of vacancies, employment growth by county and the occupations and salaries of new hires (Adrjan and Lydon, 2023[18]).

3 A number of countries also resorted to wage subsidy schemes during the pandemic. However, wage subsidy schemes provide weaker incentives to preserve employment, since employers receive a fixed subsidy for each employment contract, regardless of whether workers work full contractual hours or not. Unless there are additional restrictions on dismissals or the subsidy covers 100% of wages, which was uncommon during the pandemic, employers minimise labour costs by keeping the smallest number of workers needed for the firm to operate according to business needs.

points in time – May 2020 and January 2021 – for all countries in the sample. The average between these two points is taken and the start and end date of short-time work schemes in each country is recovered by referring to Calligaris et al. (2023[9]), who document the evolution of job retention schemes for a subset of the countries in our sample. Information for the remaining countries is complemented through internet searches of government documents. The extent to which countries resorted to short-time work schemes is approximated by applying the average replacement rate to all months during which the short-time work scheme was in place and setting it to 0 in all other months. The Netherlands operated a wage subsidy from March 2020 to March 2022, which mimics short-time work schemes and required firms to share some of the cost of hours not worked. Hence, it is assumed to have short-time work throughout the period of analysis. Conversely, the United States had a short-time compensation scheme with low uptake (for a number of reasons), leading to the implementation of the Paycheck Protection Program to help with loans for small and medium enterprise. Therefore, we assume a replacement rate of zero here. For details, please see Table A.2.

12. The sample includes 19 countries, namely Australia, Austria, Belgium, Canada, France, Germany, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Poland, Spain, Sweden, Switzerland, United Kingdom and the United States, and covers the period from January 2017 to January 2023 at the monthly frequency.

2.1. Methodology

13. We define reallocation of job postings and clicks relative to a base period as follows:

$$Reallocation_{ct,base}^{X} = \frac{1}{2}\sum_{i}\left|\frac{X_{c,i,t}}{X_{c,t}} - \frac{X_{c,i,base}}{X_{c,base}}\right| \quad (1)$$

where *X* denotes either job postings or clicks; *c* denotes country; *i* denotes occupation; *t* denotes month; and $\frac{X_{c,i,t}}{X_{c,t}}$ denotes the share of occupation in total job postings or clicks. Intuitively, the reallocation measure in Equation 1 can be viewed as the distance between the initial distribution of job postings or clicks and the distribution in period *t*. The resulting value can be interpreted as the share of job postings or clicks that would need to be reallocated to revert to the initial distribution of job postings or clicks.

14. Following Lazear and Spletzer (2012[3]), we define occupational mismatch as follows:

$$Mismatch_{c,t} = \frac{1}{2}\sum_{i}\left|\frac{clicks_{c,i,t}}{clicks_{c,t}} - \frac{postings_{c,i,t}}{postings_{c,t}}\right| \quad (2)$$

where notation is as in Equation 1. Intuitively, the mismatch measure in Equation 2 can be viewed as the distance between the distribution of clicks and postings. The resulting value can be interpreted as the share of clicks that would need to be reallocated to achieve identical distributions, i.e., 0 occupational mismatch.

15. Changes in mismatch relative to a base period can be decomposed as follows:

$$Mismatch_{c,t} - Mismatch_{c,2019} = \Delta Postings_{c,t,2019} + \Delta Clicks_{c,t,2019} + CoMove_{c,t,2019} \quad (3)$$

where $\Delta Postings_{c,2022Q4,2019}$ denotes the contribution to mismatch of changes in postings over 2019 to month *t* at the 2019 distribution of clicks (postings contribution); $\Delta Clicks_{c,t,2019}$ denotes the contribution to mismatch of changes in clicks over 2019 to month *t* at the 2019 distribution of postings (clicks contribution); and $CoMove_{c,t,base}$ denotes the contribution of the co-movement of the clicks and postings distributions over 2019 to month t (co-movement contribution).[4] The intuition is that changes in mismatch can be explained by (a) the distribution of postings becoming more or less similar to the initial distribution of clicks; (b) the distribution of clicks becoming more or less similar to the initial distribution of postings; or if the distribution of postings and clicks moving in the same or opposite directions.

16. We relate changes in aggregate mismatch and its components to the presence of short-time work schemes during the pandemic using the local projection method (Jordà, 2005[10]) which has been widely used as a flexible alternative to autoregressive distributed lag specifications (Auerbach and Gorodnichenko, 2012[11]; Romer and Romer, 2017[12]; Ramey and Zubairy, 2018[13]). It consists of directly obtaining the response of the dependent variable at period t+h to the shock at time t by estimating a different regression specification for each horizon. Impulse response functions (IRFs) are constructed by plotting the estimated coefficients as point estimates and their standard errors as confidence bands. More precisely, we estimate the IRF of the occupational mismatch induced by a change in the Oxford COVID-19 government response index. The estimating equation is as follows:

$$y_{c,t+h} - y_{c,t-1} = \alpha_c + \beta^h \Delta x_{c,t} + \pi^h \Delta x_{c,t} * STW_{c,t} + \omega^h STW_{c,t} + leads_{c,t,t+h} + lags_{c,t} + \varepsilon_{c,t} \quad (4)$$

where $y_{c,t}$ denotes aggregate mismatch or its components; α_c are country fixed effects; $\Delta x_{c,t}$ is the change in the Oxford COVID-19 government response index; $STW_{c,t}$ is the variable approximating the generosity of short-time work schemes; $leads$ and $lags$ denote leads and lags of all explanatory variables, where lead variables are included to take into account of shocks that happen during the horizon t+h but are not accounted by the variables at t, following Teulings and Zubanov (2013[14]); and $\varepsilon_{c,t}$ denotes the error term.[5]

17. The coefficients β^h measure the response of occupational mismatch to a change in pandemic-related mobility restrictions (pandemic shock) at time t over the t+h window in the absence of a short-time work scheme. The coefficients π^h measure the additional response in the presence of a short-time work scheme. If short-time work schemes raise the responsiveness of mismatch to the pandemic shock, the coefficients π^h would be positive. This could, for instance, be the case if workers covered by short-time work schemes have weak incentives to look for jobs in expanding occupations; or if employers resorting to short-time work schemes have little room to expand employment in occupations for which there is rising jobseeker demand.

18. To present the results, we derive IRFs showing the effect of a one standard deviation pandemic shock in the presence of a short-time work scheme with a replacement rate of 75% (about the average rate among countries with a short-time work during the pandemic) and in the absence of any short-time work scheme. We derive IRFs plotting the β^h and π^h coefficients for the point estimates and 2 standard errors for 90% confidence bands.

3. Occupational reallocation and mismatch during and after the COVID-19 pandemic

19. A first fact emerging from the descriptive analysis is that occupational reallocation in the wake of the pandemic was both large and durable (Figure 1). In the first 3 months of the pandemic (February to April 2020) about 6% of postings and clicks were reallocated across occupations. Had reallocation

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4 See Annex B for the technical details.

5 The specification contains leads of all explanatory variables from periods t to t+h $leads_{c,t,t+h} = \sum_{l=1}^{h} \beta^l \Delta x_{c,t+l} + \sum_{l=1}^{h} \pi^l (\Delta x_{c,t+l} * ST_{c,t+l}) + \sum_{l=1}^{h} \omega^l ST_{c,t+l}$ as well as four lags such as $lags_{c,t} = \sum_{l=-4}^{l=-1} \beta^l \Delta x_{c,t+l} + \sum_{l=-4}^{l=-1} \pi^l (\Delta x_{c,t+l} * ST_{c,t+l}) + \sum_{l=-4}^{l=-1} \omega^l ST_{c,t+l}$

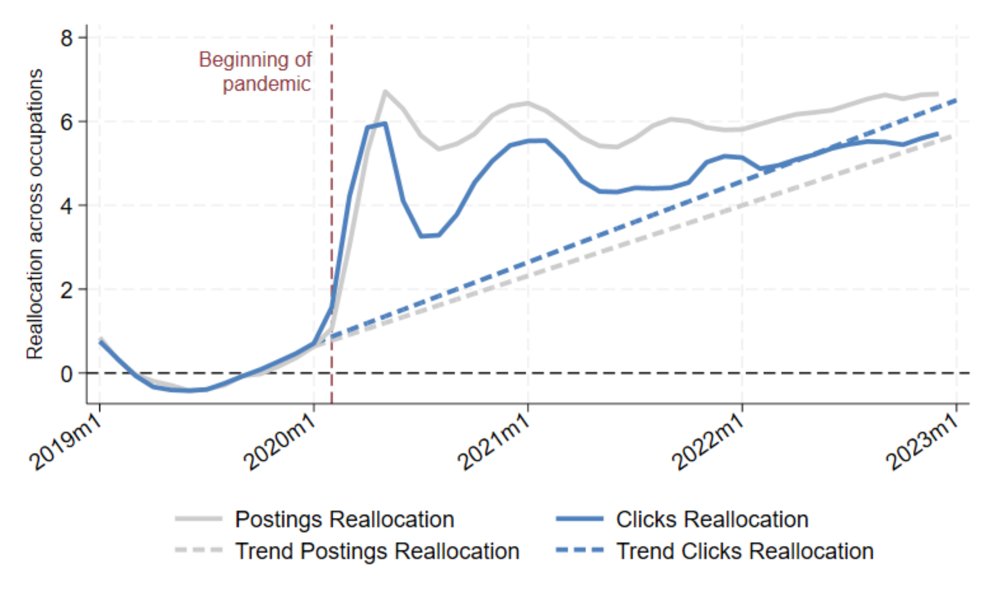
remained its pre-pandemic trend, this level of reallocation would have taken about 2 years for clicks and over 3 years for postings. The distributions of postings and clicks did not revert to the initial distributions across occupations as the pandemic receded, suggesting that the pandemic has had permanent effects on occupational labour demand and supply.

20. Food preparation, administrative assistance and sales, where postings declined, as well as software development and care occupations, where postings increased, were initially among the largest contributors to postings reallocation (Figure A.1). The declines in sales, customer service and food preparation likely reflect high contact intensity. The postings increase in software development is likely explained by the accelerated digital transition of businesses amid lockdowns, while increased pandemic healthcare needs drove higher demand for nursing. Postings shares in some occupations returned to pre-pandemic trends as the pandemic faded, but in other occupations postings shares continued to deviate significantly from pre-pandemic trends at the end of 2022. For instance, the pre-pandemic downward trend in the postings share of manufacturing appears to have reversed, with the postings share at the end of 2022 well above the pre-pandemic trend. By contrast, the pre-pandemic postings share of sales and customer service appears to have accelerated (Figure A.3).

21. On the clicks side, the largest contributions to reallocation are from increased clicks on software development, education and information design, and fewer clicks on sales, administrative assistance and manufacturing jobs (Figure A.2). The share of clicks on software development, education and information design jobs progressively increased over 2020-22, deviating significantly from the pre-pandemic trend (Figure A.4). The negative deviation of clicks shares of sales, manufacturing, and administrative assistance from pre-pandemic trends may reflect permanent shifts in job preferences by low- and middle-qualified workers in the wake of pandemic-related labour market disruptions.

Figure 1. Rapid and durable reallocation of job postings and clicks in the wake of the pandemic

Clicks and postings reallocation as defined in Equation 1 (in %), 2019=0

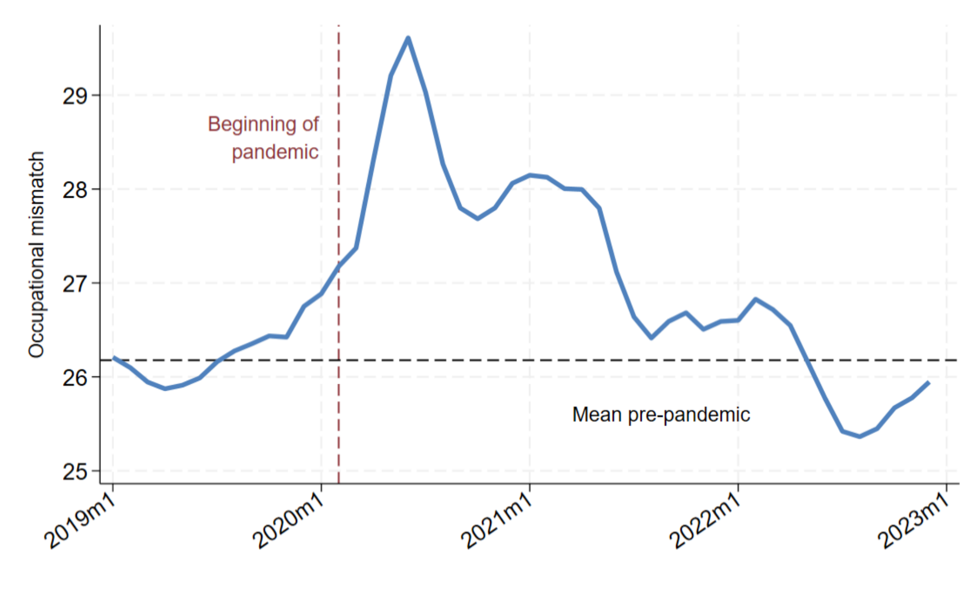


Note: This chart shows the 3-month moving average of reallocation of clicks and postings as defined in Equation 1 relative to the average occupational distributions in 2019, with average reallocation in 2019 re-scaled to 0. The trends in postings and clicks reallocation represent the cumulative reallocation had the speed of reallocation remained similar to its 2018 and 2019 level after the onset of the pandemic. It is obtained by applying the average reallocation computed for the year 2018 and 2019 relative to the average occupational distribution in 2017.
Source: OECD, Indeed.

22. A second striking fact from the descriptive analysis is that, despite the large and durable occupational reallocation of postings and clicks, mismatch has returned to its pre-pandemic level (Figure 2). In the initial stages of the pandemic, mismatch increased from about 26% to about 29% (about a 10% increase), implying that the initial reallocation of postings did not match the reallocation of clicks. However, as the pandemic faded, occupational mismatch gradually declined, even though the structure of job postings and clicks remained significantly different from the initial distribution of postings and clicks. This mainly reflects shifts in the structure of job postings towards the initial structure of clicks and the co-movement of postings and clicks (Figure A.5). Postings in some occupations with large initial excess labour demand, as measured by excess postings – such as loading and stocking, food services and cleaning – contracted (Figure A.6). In parallel, postings in some occupations with large initial excess labour supply, as measured by excess clicks – such as management, installation and maintenance, and retail – expanded. The co-movement of clicks and postings also contributed to the return of occupational mismatch to its pre-pandemic level, suggesting a significant degree of labour market flexibility. Jobseeker interest tended to expand by more in occupations where growth in job postings was largest, including software development and nursing. Shifts in the structure clicks towards the initial structure of postings played a negligible role.

Figure 2. Occupational mismatch initially soared but has returned to pre-pandemic levels

Occupational mismatch as defined in Equation 2 (in %)



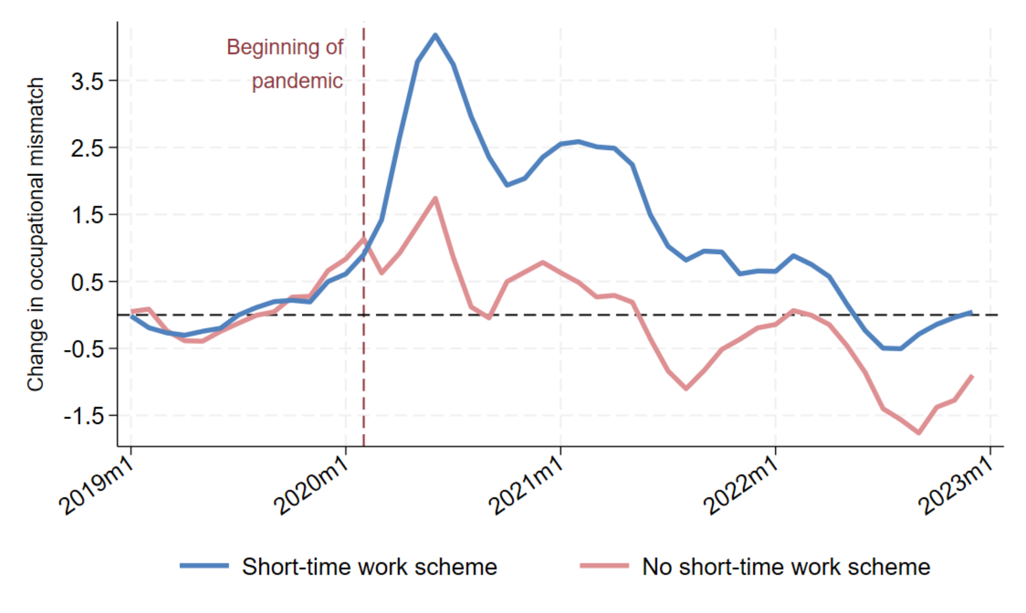
Note: This figure plots 3-month moving averages of occupational mismatch from January 2019 to January 2023. Occupational mismatch is first computed at the country-month level and then averaged across countries.
Source: OECD, Indeed.

23. A third fact emerging from the descriptive analysis is that the initial increase in occupational mismatch during the pandemic tended to be larger and the subsequent return to the pre-pandemic level to be shorter in countries where short-time work schemes were in place (Figure 3). Short-term work schemes allow employers to reduce working time while only paying a part of the hours not worked, allowing them to hold on to workers until economic activity picks up. Workers' salaries are reduced less than in proportion to working time, as the government partly compensates the hours not worked. In the case of temporary economic downturns, short-time work schemes can preserve job matches that may be unprofitable in the short-term but viable in the medium term, thereby preventing the inefficient loss of firm-specific skills. But

short-time work schemes tend to reduce incentives for employers to dismiss workers and for workers to look for a new job during economic downturns (Giupponi, Landais and Lapeyre, 2022[15]). In the case of downturns that involve significant amounts of reallocation of economic activity and labour demand – as was the case in the wake of the COVID-19 pandemic (Figure 1) – this can lead to mismatch in the labour market. Businesses in expanding sectors may face difficulties in finding workers as businesses in contracting sectors hold on to them.

Figure 3. Occupational mismatch rose by more in countries with short-time work schemes

Change in occupational mismatch relative to average of 2019 (in % points)



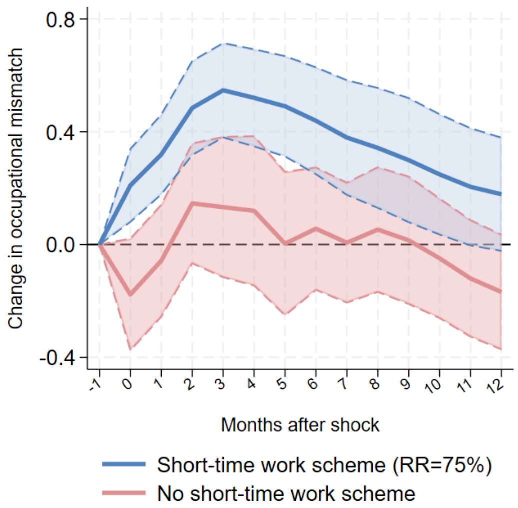
Note: This plot shows occupational mismatch relative to its average in 2019, separately for countries with and without short-time work schemes in April 2020.
Source: OECD and Indeed.

4. The impact of short-time work and wage subsidy schemes on occupational mismatch

24. The effect the pandemic shock on occupational mismatch was larger and more persistent in countries with short-time work schemes (Figure 4). In the absence of short-time work schemes, the pandemic shock had no statistically significant impact on occupational mismatch. By contrast, in the presence of a short-time work scheme with a replacement rate of 75%, a 1 standard deviation increase in the government mobility restrictions index raised occupational mismatch by about 0.6 percentage points after 3 months. Considering that the average increase in the mobility restrictions index between February and April 2020 across countries was about 2 standard deviations, the pandemic shock initially raised occupational mismatch by about of 1.2 percentage points (about a 5% increase). The upward effect of the pandemic shock persists for about one year before becoming statistically insignificant, suggesting that short-time work schemes significantly slowed down labour market adjustment.

Figure 4. Short-time work schemes are associated with an increase in occupational mismatch

Effect of a 1 standard deviation increase in the government mobility restriction index on occupational mismatch (in % points)

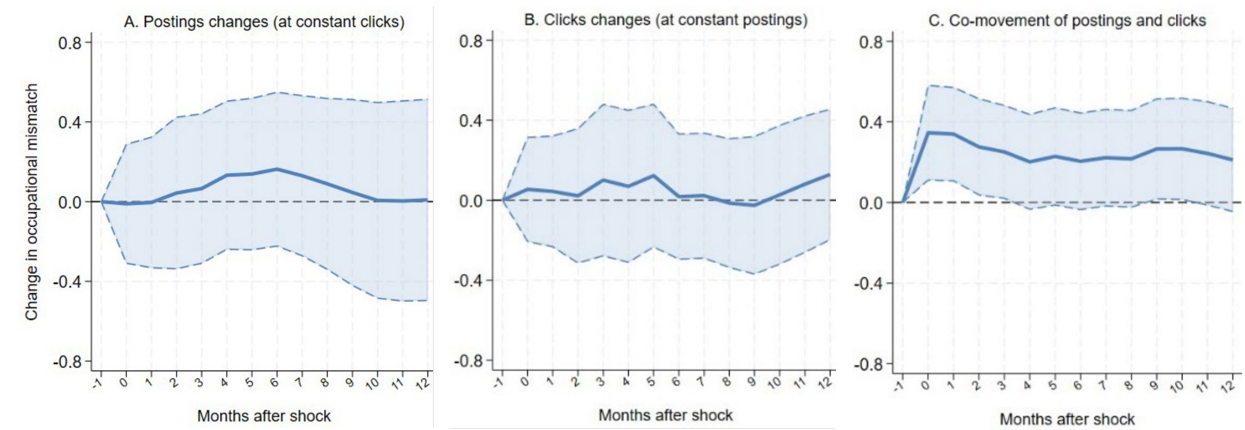


Note: The lines represent the IRF of occupational mismatch to a one-standard deviation in the COVID-19 government restriction index, with the dotted lines representing the 90% confidence interval and assuming a 75% replacement rate of short-time work schemes.
Source: OECD and Indeed.

25. The difference in the response of occupational mismatch to the pandemic shock between countries with and without short-time work schemes is entirely explained by differences in the extent of co-movements between postings and clicks (Figure 5). The contributions of postings changes (at the occupational structure of clicks in 2019) and clicks changes (at the occupational structure of postings in 2019) were very similar across countries with and without short-time work schemes. This suggests that short-time work schemes did not change employers' and workers' incentives to adjust to occupational mismatches existing before the onset of the pandemic. However, postings and clicks changes co-moved to a much smaller extent in countries with short-time work schemes than in countries that resorted to other labour market policies to protect workers from income losses, such as expanded unemployment insurance or job subsidies. This suggests that short-time work schemes reduced employers' incentives to respond, shifting worker preferences while also reducing workers' incentives to respond to changes in occupational labour demand.

Figure 5. Lower co-movement of clicks and postings in countries with short-time work schemes

Effect of a 1 standard deviation increase in the government mobility restriction index on occupational mismatch, difference between countries with and without a short-time work scheme (in % points)

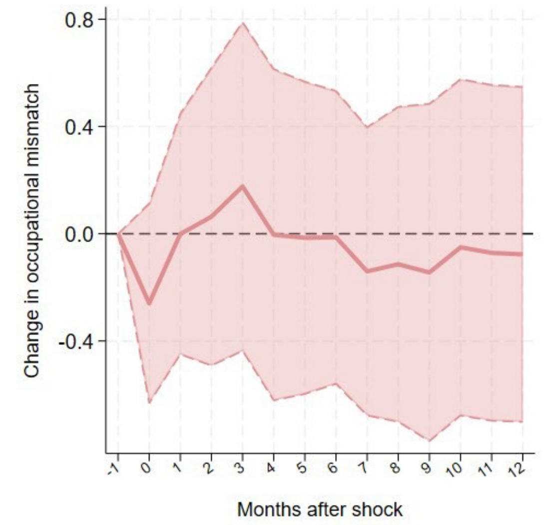


Note: Based on Equation 4 with the three components of the decomposition in Equation 3 as dependent variable. The lines represent the difference in the IRF of occupational mismatch (short-term work scheme vis-à-vis no short-term work scheme in place) to a one-standard deviation in the COVID-19 government restriction index, with the dotted lines representing the 90% confidence interval and assuming a 75% replacement rate of short-time work schemes.
Source: OECD and Indeed.

26. Countries that resorted to wage subsidy schemes (the list of countries is available in Table A.3) experienced no statistically significant increases in occupational mismatch following government-imposed mobility restrictions (Figure 6). Several countries, which did not resort to short-time work schemes to preserve employment during the pandemic, set up wage subsidy schemes. These schemes typically paid a fixed subsidy for each worker employed by covered businesses, irrespective of whether workers were working full contractual hours or put on a reduced work schedule. The main analysis above does not distinguish between countries that did not put in place any job preservation scheme and countries that resorted to wage subsidy schemes, assuming that wage subsidy schemes provided for weaker incentives to reduce working time and preserve employment. Employers could benefit from the wage subsidy while maintaining full contractual hours for retained workers while dismissing those who become redundant. The absence of any statistically significant increase in occupational mismatch in response to government-imposed mobility restrictions validates the empirical choice to treat short-time work schemes separately from wage subsidy schemes.

Figure 6. Wage subsidy schemes are not associated with increases in occupational mismatch

Effect of a 1 standard deviation increase in government mobility restriction index on occupational mismatch (in % points)



Note: The lines show the response of the occupational mismatch to a one-standard deviation in the COVID-19 government restriction index when a wage subsidy scheme is in place, with the dotted lines representing the 90% confidence band and assuming a 75% replacement rate.
Source: OECD, Indeed.

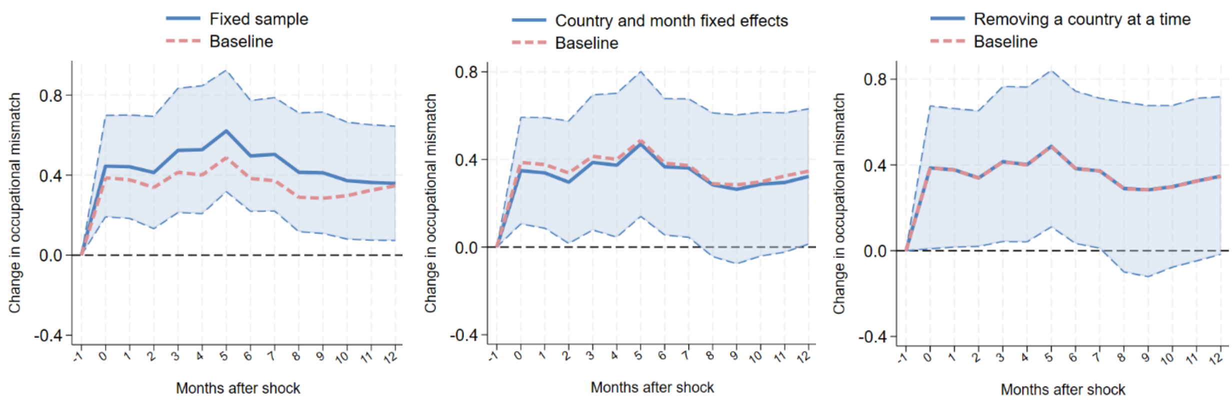
5. Robustness checks

27. A range of robustness checks confirm our finding that the pandemic had a larger and more persistent impact on occupational mismatch in countries with short-time work schemes than elsewhere.

28. Our baseline specification uses the full sample period (January 2017-January 2023) to estimate the response of occupational mismatch to mobility restrictions for up to 12 months after the initial shock. This leads to small differences in the sample used to estimate the response at different horizons. The reason is that only shocks to mobility restrictions up to January 2022 can be used to estimate the response 12 months ahead, but all shocks up to January 2023 can be used to estimate the instantaneous response. Small differences in the sample may impact the shape of our estimated impulse-response function. We address this potential source of error by restricting our estimation sample to January 2017-January 2022, allowing for a 12-month horizon for each data point. Our results are basically unchanged (Figure 7, first Panel), with the difference between countries with short-time work schemes and those without now statistically significant over the entire 12-months horizon.

Figure 7. Results are robust to alternative sample and specification

Effect of a 1 standard deviation increase in the government mobility restriction index on occupational mismatch, difference between countries with and without a short-time work scheme (in % points)



Note: Based on Equation 4 and assuming a 75% replacement rate of short-time work schemes. Panel A restricts the sample to observations up to January 2022; Panel B controls for calendar month fixed effects; Panel C drops one country at a time from the sample. The lines represent the difference in the IRF of occupational mismatch (short-term work scheme vis-à-vis no short-term work scheme in place) to a one-standard deviation in the COVID-19 government restriction index, with the blue dotted lines representing the 90% confidence interval of the robustness checks.
Source: OECD, Indeed.

29. We also check the robustness of our baseline results by including calendar month controls on top of the baseline country-fixed effects additionally to control for possible seasonality in occupational labour demand and supply. The resulting point estimates align closely with those from the baseline analysis (Figure 7, second Panel). To ensure that our results are not driven by a single country we drop one country at a time from our baseline estimation sample. Again, the resulting point estimates are almost identical to the baseline estimates, suggesting that no single country drives the difference between countries with and without short-time work schemes (Figure 7, third Panel).

30. Finally, we check whether the larger and more persistent response of occupational mismatch to mobility restrictions in countries with short-time work schemes than elsewhere captures other labour market characteristics omitted from the estimation. For instance, the generosity of short-time work schemes during the pandemic could be correlated with the stringency of employment protection, which may in turn impact occupational reallocation. To explore this hypothesis, we replace our indicator of short-time work schemes with the synthetic OECD employment protection indicator for regular workers (OECD, 2020[16]). The results, which are available from the authors upon request, indicate that the response of occupational mismatch to mobility restrictions was not statistically significantly associated with the stringency of employment protection suggesting that our results on short-time work do not simply reflect broader differences in labour market regulation across countries.[6]

6. Concluding remarks

31. This paper documents a significant reallocation of labour demand and supply across occupations in the wake of the pandemic. Both online job postings and jobseekers' clicks persistently shifted away from

6 Including both short-time work and employment protection-related variables saturates the model due to the large number of lags and leads, resulting in imprecise point estimates. Results are available upon request.

customer-facing occupations, such as sales and administrative assistance, to care and education occupations as well as software development. The reallocation of job postings and clicks that took place in the first 3 months of the pandemic was large, amounting to the total reallocation observed over the previous 4 years.

32. Despite large and persistent reallocation of job postings and clicks, occupational mismatch gradually returned to its pre-pandemic level. Prior to the pandemic, in the average country, 26% of clicks or postings would have had to be reallocated to eliminate occupational mismatch. In the first few months of the pandemic in early 2020, occupational mismatch surged by about 3 percentage points (approximately 10%), as jobs in some occupations disappeared and others expanded rapidly. For instance, jobseekers' clicks did not immediately respond to the collapse in postings in food preparation and retail, and to the rapid expansion in care occupations and software development. However, over the following two years, workers gradually adapted to the structural change in employer demand, and employers adapted to workers' post-pandemic job preferences.

33. Labour market adjustment, as measured by the return of occupational mismatch to it pre-crisis level, was slower in countries that resorted to short-time work schemes during the pandemic. This was not due to differences in the severity of the pandemic across countries, since our estimation results suggest that the response of occupational mismatch to government mobility restrictions was larger and more persistent in countries with short-time work schemes than in countries that resorted to other policies to protect workers' incomes or preserve employment. In particular, we find that occupational mismatch did not increase in response to increases in government-imposed mobility restrictions in countries that resorted to wage subsidy schemes to support businesses and workers during the pandemic. We interpret our results as being consistent with the view that short-time work schemes can slow the adjustment of the labour market in the wake of shocks that cause a significant degree of occupational reallocation. While short-time work schemes may preserve viable job matches when shocks are temporary and cause little reallocation, their design needs to balance job preservation with appropriate incentives to reallocate workers from declining to expanding occupations.

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Annex A. Additional material

Table A.1. Indeed occupation classification

Indeed's occupation classification		
accounting	food preparation & service	mining
administrative assistance	hospitality & tourism	nursing
agriculture & forestry	human resources	personal care & home health
architecture	industrial engineering	pharmacy
arts & entertainment	information design & documentation	physicians & surgeons
aviation	installation & maintenance	production & manufacturing
banking & finance	insurance	project management
beauty & wellness	it operations & helpdesk	real estate
chemical engineering	legal	retail
childcare	loading & stocking	sales
civil engineering	logistic support	scientific research & development
cleaning & sanitation	management	security & public safety
community & social service	marketing	social science
construction	mathematics	software development
customer service	mechanical engineering	sports
dental	media & communications	therapy
driving	medical information	veterinary
education & instruction	medical technician	
electrical engineering	military	

Note: List of occupations available in Indeed and covered in the analysis.

Table A.2. List of countries with short-time work schemes

Acronym	Full name	Time frame	RR at the avg. wage	Applied RR
AT	Austria	Jan 2019 – Jan 2023	May 2020 80% Jan 2021 *same*	80%
BE	Belgium	Jan 2019 – Jan 2023	May 2020 50% Jan 2021 *same*	50%
CH	Switzerland	Jan 2019 – Jan 2023	May 2020 80% Jan 2021 *same*	80%
DE	Germany	Jan 2019 – Jan 2023	May 2020 60% Jan 2021 *same*	60%
ES	Spain	Jan 2019 – Jan 2023	May 2020 48% Jan 2021 *same*	48%
FR	France	Jan 2019 – Jan 2023	May 2020 70% May 2020 70%	70%
GB	Great Britain	Mar 2020 – Sept 2021	May 2020 74% Jan 2021 74%	74%
IL	Israel	Mar 2020 – Jun 2021	May 2020 53% Jan 2021 *same*	53%
IT	Italy	Jan 2019 – Jan 2023	May 2020 46% Jan 2021 *same*	46%
JP	Japan	Jan 2019 – Jan 2023	May 2020 60% Jan 2021 *same*	60%
LU	Luxembourg	Jan 2019 – Jan 2023	May 2020 80% Jan 2021 *same*	80%
NL†	Netherlands	Jan 2019 – Mar 2020 & Apr 2022 – Jan 2023	May 2020 100% Jan 2021 100%	100%
SE	Sweden	Jan 2019 – Jan 2023	May 2020 85% Jan 2021 *same*	85%
US*	United States		May 2020 123% Jan 2021 78%	0%

Note: List of countries available in Indeed, with a short-time work scheme in place and covered in the analysis. Information on short-time work schemes is obtained from Table 2.A.2. in the OECD Employment Outlook 2021 (OECD, 2021[8]).

† As the wage subsidy operated Mar 2020 – Mar 2022 in the NL mimics short-time work schemes that require firms to share some of the cost of hours not worked, it is assumed to have short-time work throughout the period of analysis.

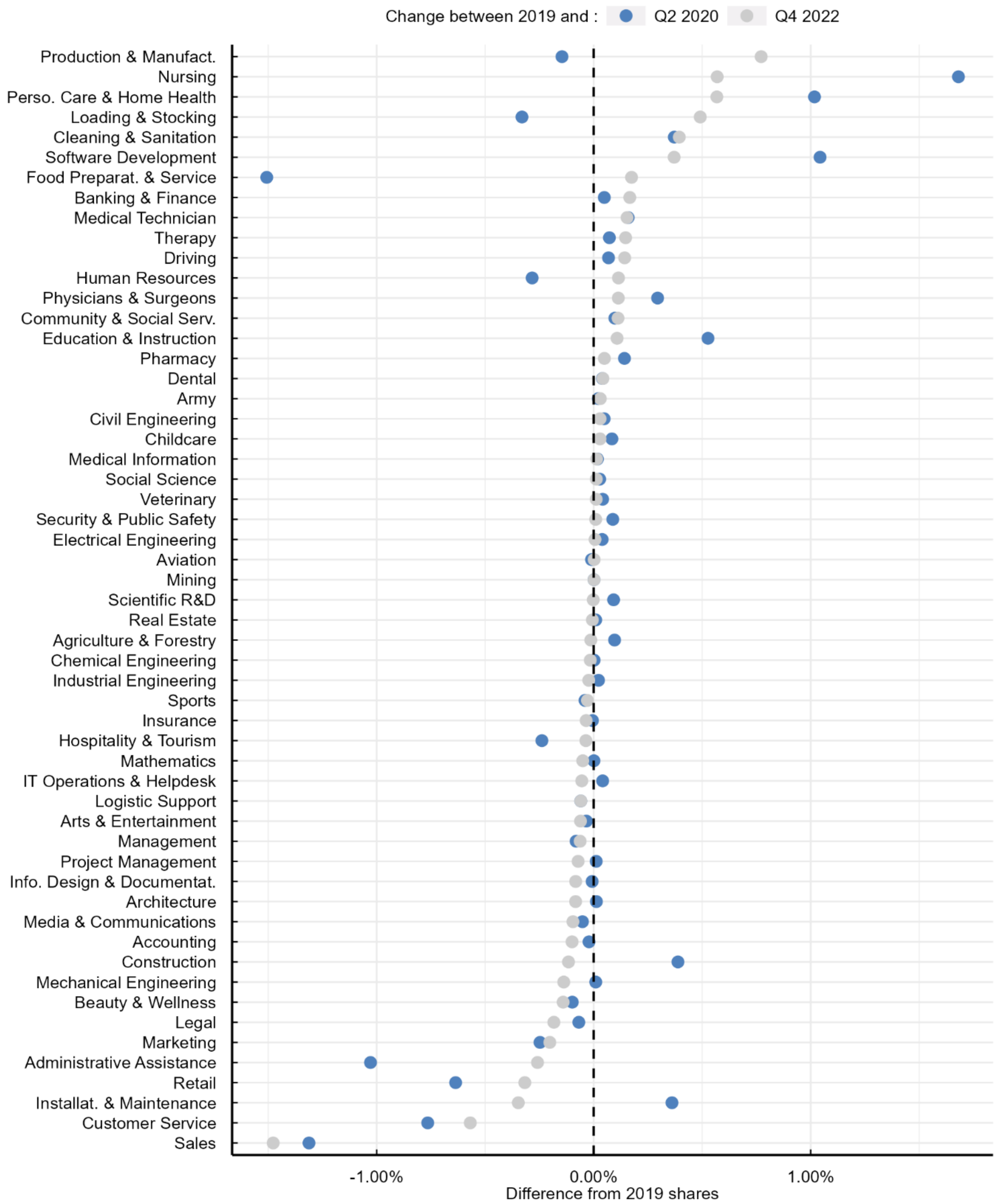
*The US had a short-time compensation scheme with low uptake and a Paycheck Protection Program to help with loans for small and medium enterprises; hence, we assumed a RR of zero.

Table A.3. List of countries with wage subsidy schemes

Acronym	Full name	Time frame	RR at the avg. wage	Applied RR
AU	Australia	Apr 2020 – Apr 2021	May 2020 41% Jan 2021 27%	34%
CA	Canada	Mar 2020 – Apr 2022	May 2020 75% Jan 2021 56%	65.5%
IE	Ireland	Jan 2019 – Jan 2023	May 2020 37% Jan 2021 37%	37%
NL	Netherlands	Mar 2020 – Mar 2022	May 2020 100% Jan 2021 100%	100%
PL	Poland	Jan 2019 – Jan 2023	May 2020 53% Jan 2021 *same*	53%

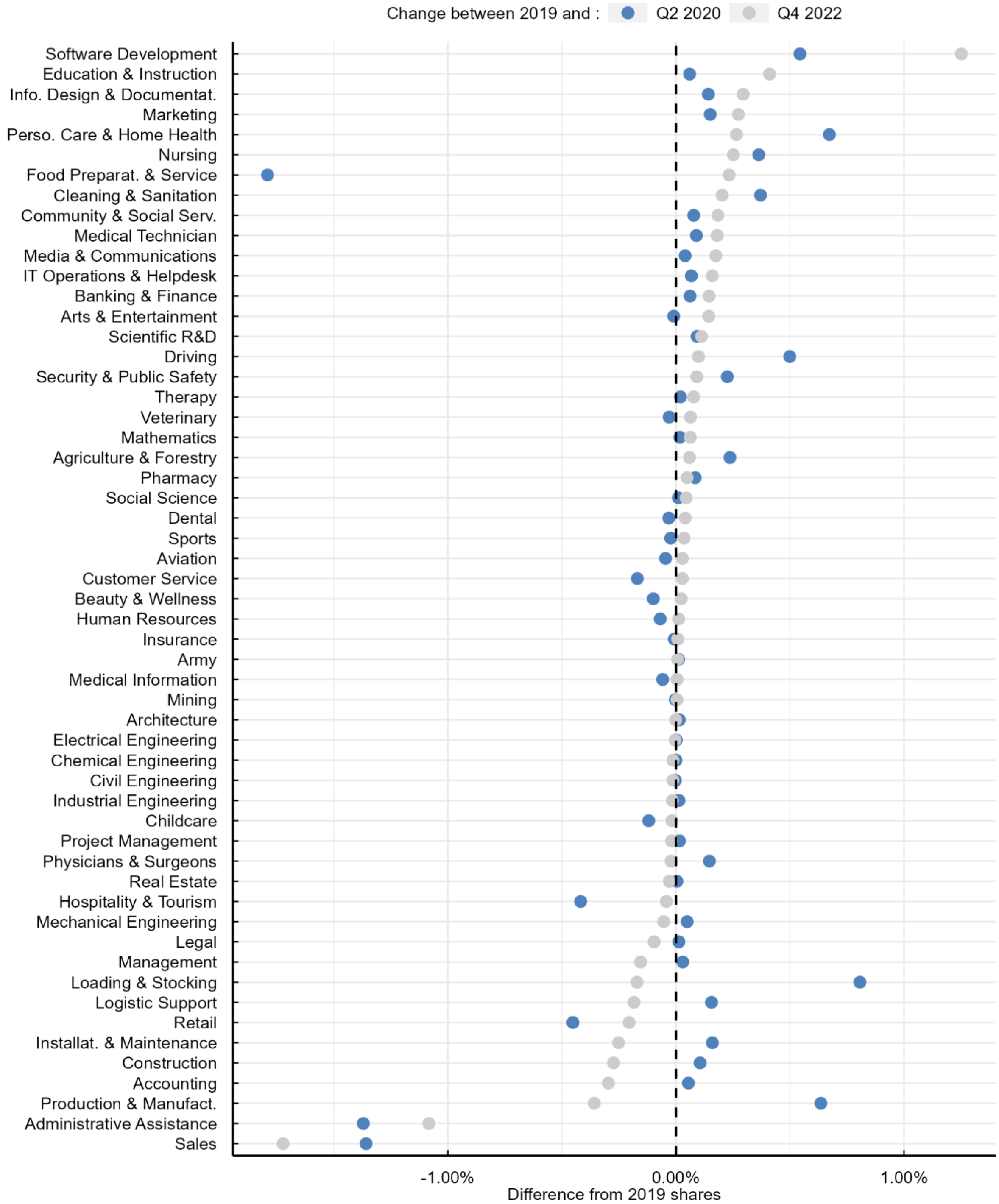
Note: List of countries available in Indeed, with a wage subsidy in place and covered in the analysis. Information on wage subsidy schemes is obtained from Annex Table A.2. in the OECD Employment Outlook 2021 (OECD, 2021[8]).

Figure A.1. Share of postings by occupation as a share of total postings, Q4 2022 compared to 2019



Note: The share of postings by occupation as a share of total postings is first computed for each country and occupation before the pandemic (in 2019), at the peak of the pandemic (Q2 2020) and after the pandemic (Q4 2022). Second, the difference between the posting shares between Q2 2020 and 2019 (blue point) and between Q4 2022 and 2019 (grey point) are computed at the country level, before averaging these differences across countries.
Source: OECD and Indeed.

Figure A.2. Share of clicks by occupation as a share of total clicks, Q4 2022 compared to 2019

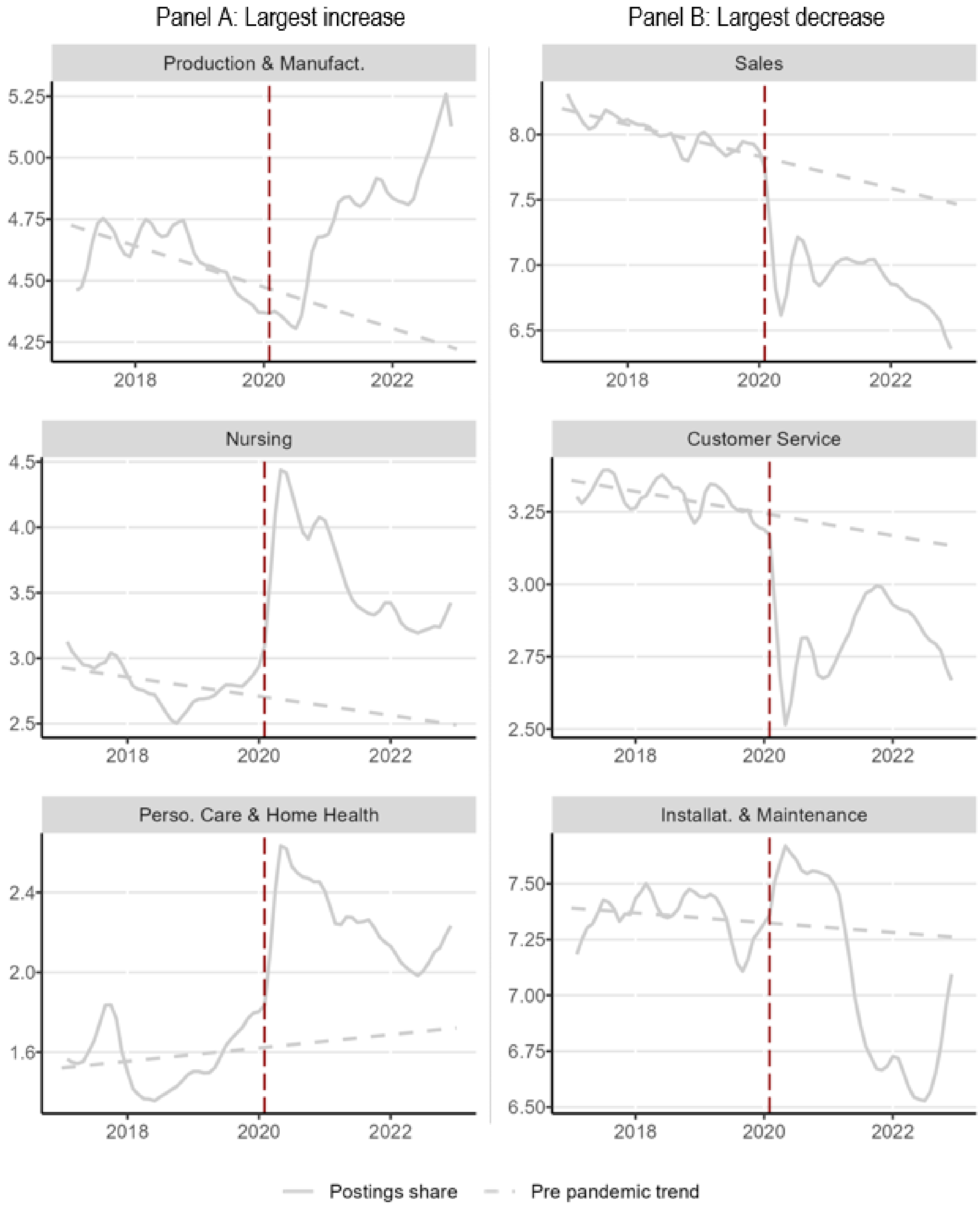


Note: The share of clicks by occupation as a share of total clicks is first computed for each country and occupation before the pandemic (in 2019), at the peak of the pandemic (Q2 2020) and after the pandemic (Q4 2022). Second, the difference between the clicks shares between Q2 2020 and 2019 (blue point) and between Q4 2022 and 2019 (grey point) are computed at the country level, before averaging these differences across countries.

Source: OECD and Indeed.

Figure A.3. The pandemic impacted long-term posting trends in sales and manufacturing

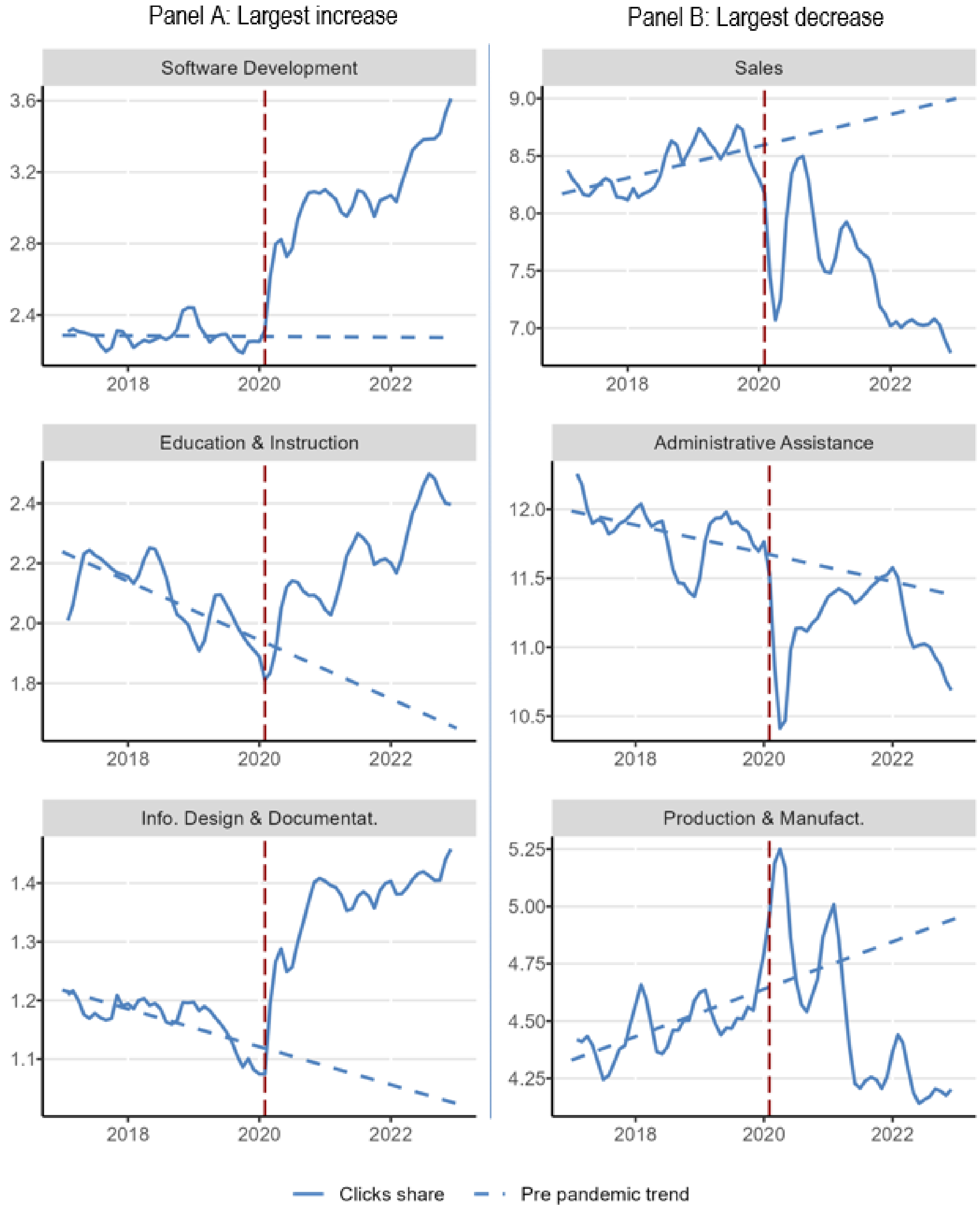
Share of postings, occupations with the largest increases (left) and decreases (right) over 2019-22 Q4, %



Note: The figure represents the share of postings for the 3 occupations with the largest increases (left) and decreases (right) between 2019 and 2022 Q4. The share of postings is averaged across the 19 countries of the sample. The trend (dotted line) is determined by fitting an OLS regression to the pre-pandemic observations.
Source: OECD, Indeed.

Figure A.4. The pandemic impacted long-term trends in clicks for several occupations

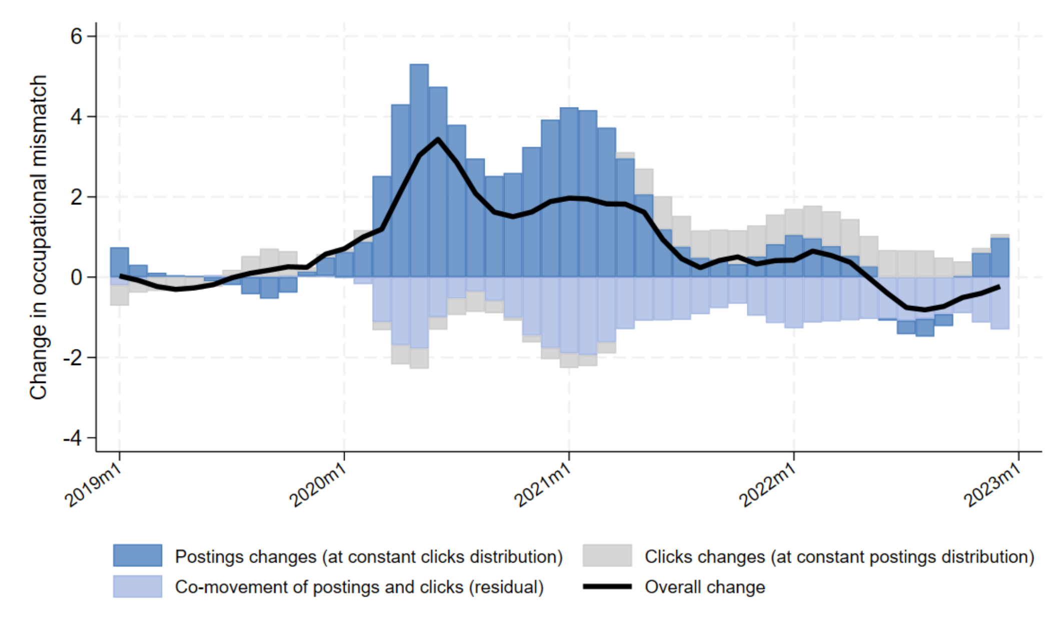
Share of clicks, occupations with the largest increases (left) and decreases (right) over 2019-22 Q4, %



Note: The figure represents the share of clicks for the 3 occupations with the largest increases (left) and decreases (right) between 2019 and 2022 Q4. The share of postings is averaged across the 19 countries of the sample. The trend (dotted line) is determined by fitting an OLS regression to the pre-pandemic observations.
Source: OECD, Indeed.

Figure A.5. Contributions to changes in occupational mismatch

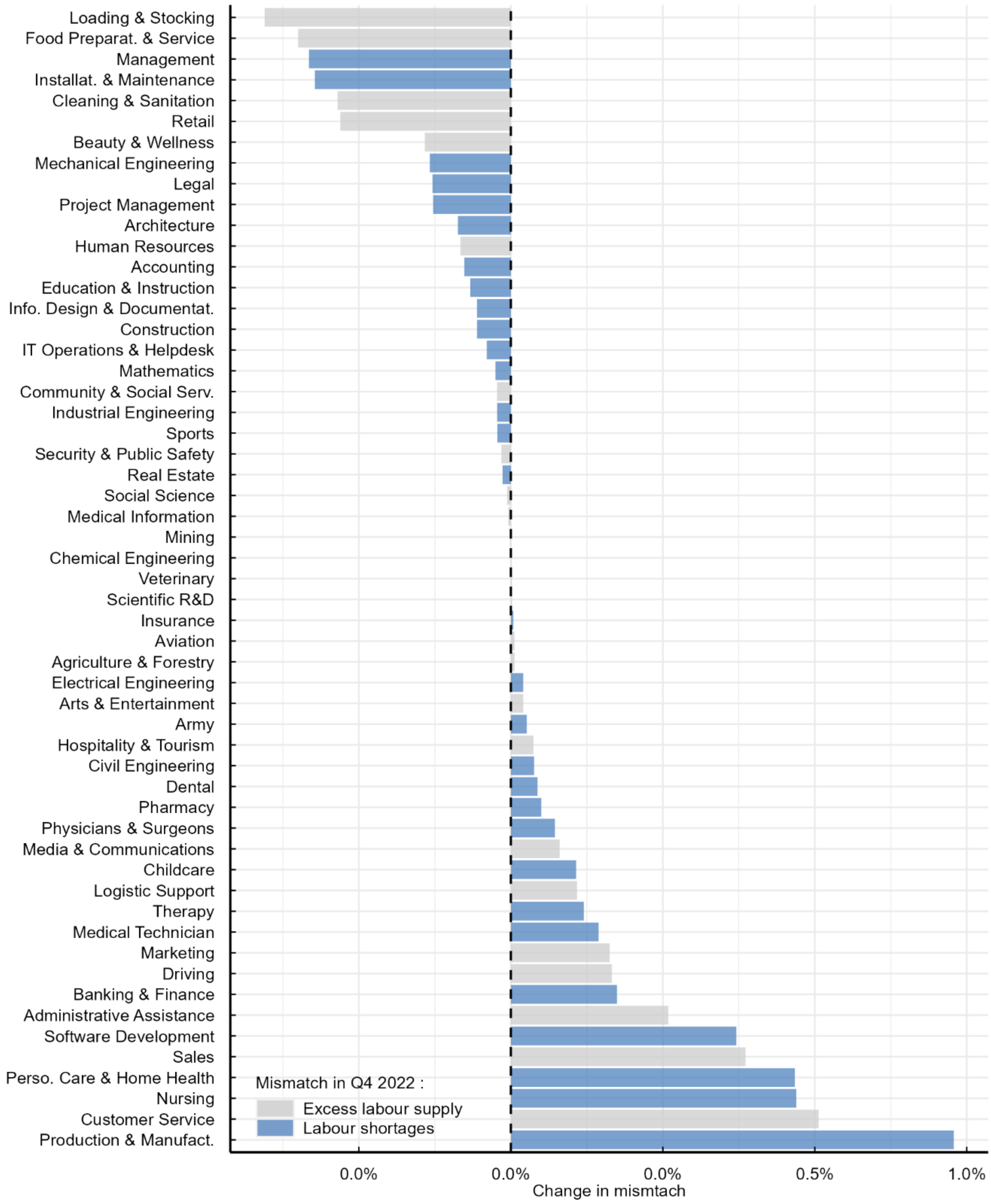
Change in occupational mismatch relative to average of 2019 based on Equation 3 (in % points)



Note: The figure plots the 3 components of the decomposition of changes in occupational mismatch in Equation 3.
Source: OECD, Indeed.

Figure A.6. Contribution of postings changes to changes in occupational mismatch

Changes in occupational mismatch assuming occupational structure of clicks in 2019

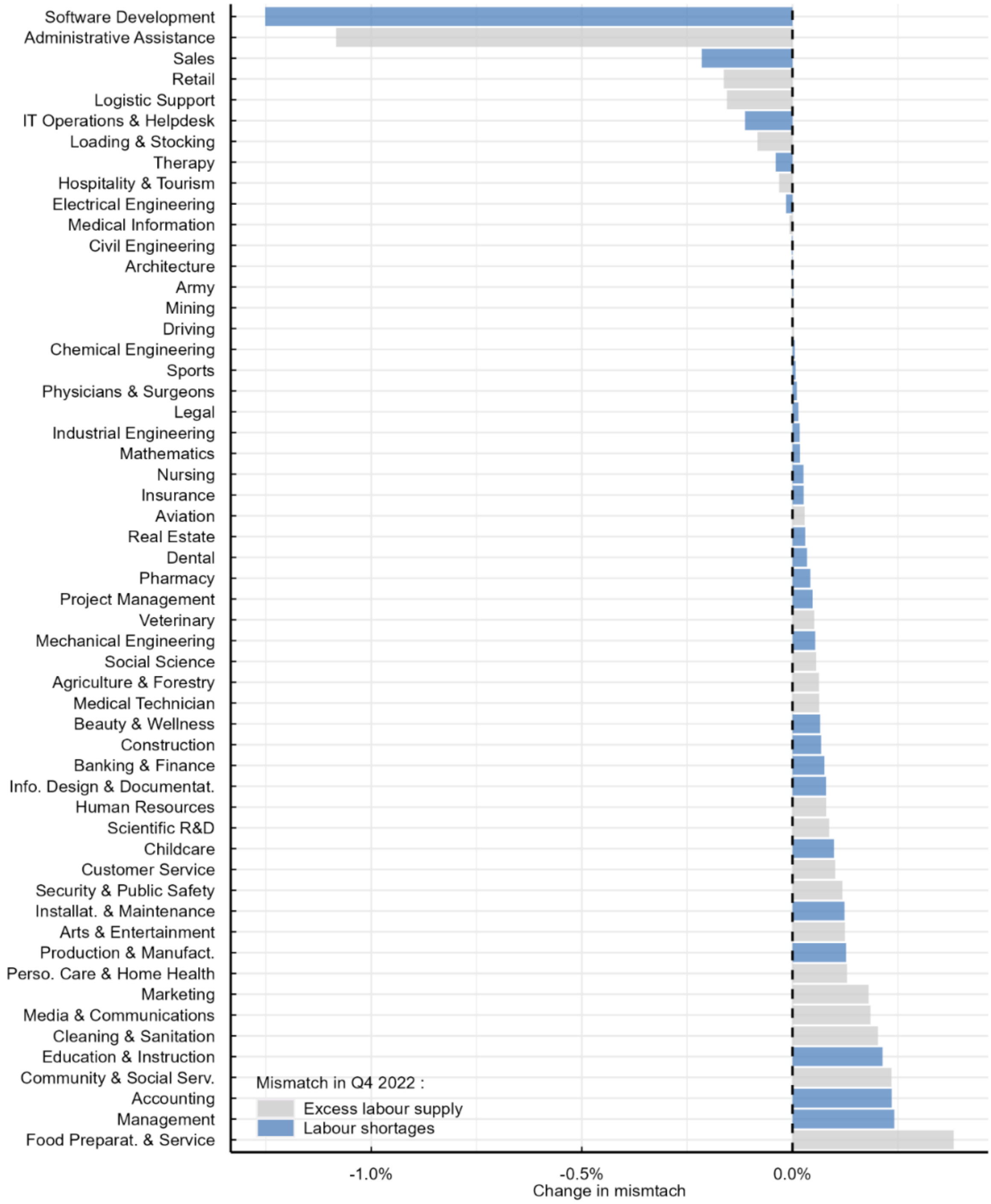


Note: The bars show the postings contribution in Equation 3. Formally: $\frac{1}{C}\sum_c\left(\left|\frac{p_{i,Q4\,2022}}{P_{Q4\,2022}} - \frac{c_{i,2019}}{C_{2019}}\right|\right) - \frac{1}{C}\sum_c\left(\left|\frac{p_{i;2019}}{P_{2019}} - \frac{c_{i,2019}}{C_{i,2019}}\right|\right)$. The colour coding indicates whether contributions are driven by changes in labour shortages or changes in excess labour supply.

Source: OECD, Indeed.

Figure A.7. Contribution of clicks changes to changes in occupational mismatch

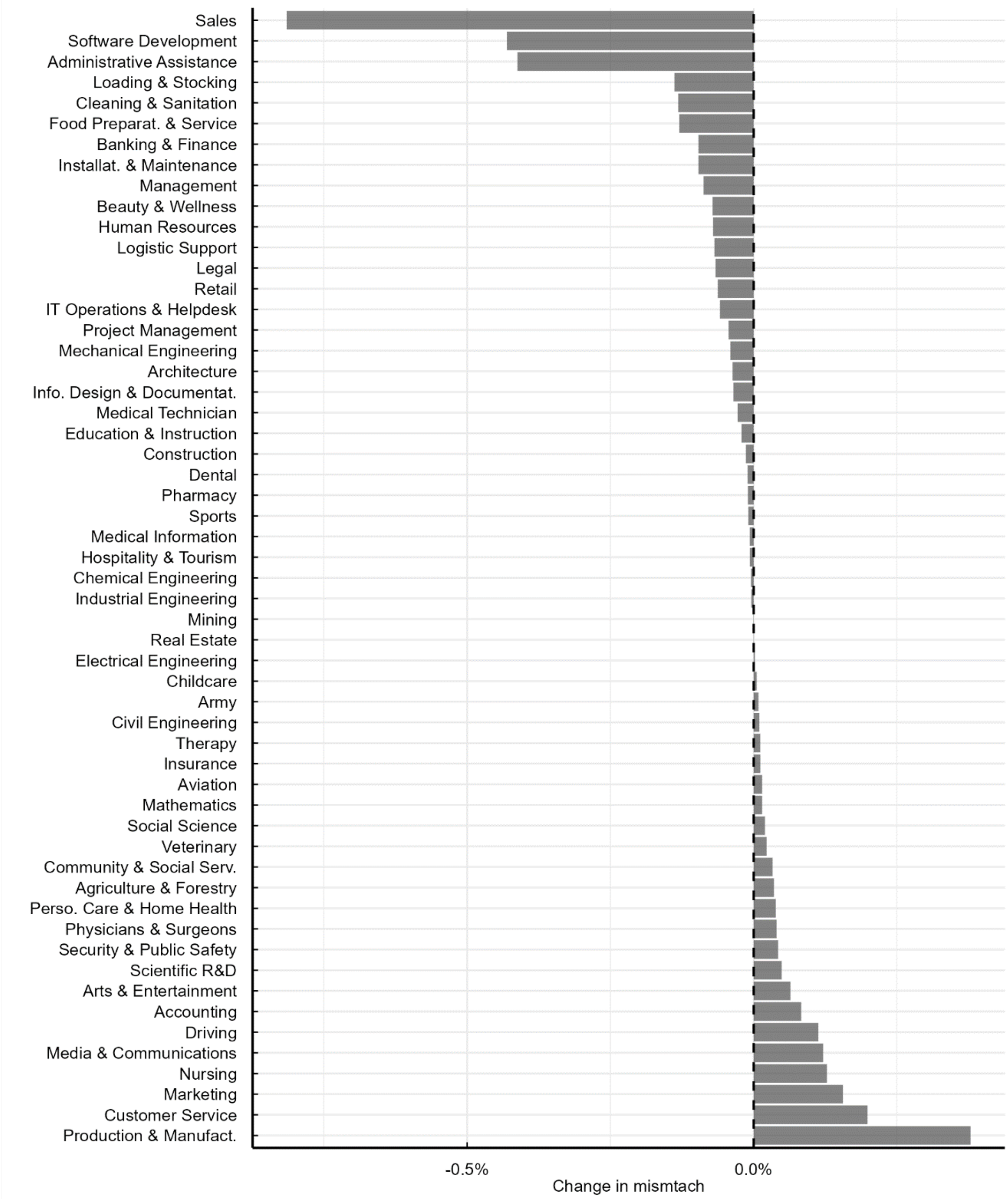
Changes in occupational mismatch assuming occupational structure of postings in 2019



Note: The bars show clicks contribution in Equation 3. Formally: $\frac{1}{C}\sum_c(\left|\frac{p_{i;2019}}{P_{2019}} - \frac{c_{i,Q4\,2022}}{C_{Q4\,2022}}\right|) - \frac{1}{C}\sum_c(\left|\frac{p_{i;2019}}{P_{2019}} - \frac{c_{i,2019}}{C_{i,2019}}\right|)$. The colour coding indicates whether contributions are driven by changes in labour shortages or changes in excess labour supply.
Source: OECD, Indeed.

Figure A.8. Contribution of co-movement of postings and clicks to changes in occupational mismatch

Co-movement of postings and clicks, based on Equation 3, 2022 Q4 – 2019



Note: The bars show the contribution of each occupation to the co-movement component in Equation (3). Formally: $\frac{1}{C}\sum_c(\left|\frac{p_{i;Q4\,2022}}{P_{Q4\,2022}} - \frac{c_{i,Q4\,2022}}{C_{Q4\,2022}}\right|) - \frac{1}{C}\sum_c(\frac{1}{2}\left|\frac{p_{i;2019}}{P_{2019}} - \frac{c_{i,Q4\,2022}}{C_{Q4\,2022}}\right|) - \frac{1}{C}\sum_c(\frac{1}{2}\left|\frac{p_{i,Q4\,2022}}{P_{Q4\,2022}} - \frac{c_{i,2019}}{C_{2019}}\right|)$. The colour coding indicates whether contributions are driven by changes in labour shortages or changes in excess labour supply.

Source: OECD, Indeed.

Annex B. Mismatch decomposition

We define occupational mismatch as follows:

$$Mismatch_{c,t} = \frac{1}{2}\sum_i \left| \frac{clicks_{c,i,t}}{clicks_{c,t}} - \frac{postings_{c,i,t}}{postings_{c,t}} \right|$$

where notation is as in Equation 1. Intuitively, the mismatch measure in Equation 2 can be viewed as the distance between the distribution of clicks and postings. The resulting value can be interpreted as the share of clicks that would need to be reallocated to achieve identical distributions, i.e., 0 occupational mismatch.

Changes in mismatch relative to the base period 2019 can be decomposed as follows:

$$Mismatch_{c,t} - Mismatch_{c,2019} = \Delta Postings_{c,t,2019} + \Delta Clicks_{c,t,2019} + CoMove_{c,t,2019}$$

where

$$\Delta Postings_{c,t,2019} = \frac{1}{2}\left(\sum_{i=o}^{I} \left| \frac{p_{\ i,t}}{P_t} - \frac{c_{\ i,2019}}{C_{2019}} \right| - \sum_{i=o}^{I} \left| \frac{p_{\ i,2019}}{P_{2019}} - \frac{c_{\ i,2019}}{C_{2019}} \right| \right)$$
$$= \frac{1}{2}\left(\sum_{i=o}^{I} \left| \frac{p_{\ i,t}}{P_t} - \frac{c_{\ i,2019}}{C_{2019}} \right| - mismatch_{2019} \right)$$

where $½\sum_{i=o}^{I} \left| \frac{p_{\ i,t}}{P_t} - \frac{c_{\ i,2019}}{C_{2019}} \right|$ can be interpreted as the counterfactual mismatch in t1 had the distribution of clicks remained the same as in the base period 2019 and

$$\Delta Clicks_{c,t,2019} = \frac{1}{2}\left(\sum_{i=o}^{I} \left| \frac{p_{\ i,2019}}{P_{2019}} - \frac{c_{\ i,t}}{C_t} \right| - \sum_{i=o}^{I} \left| \frac{p_{\ i,2019}}{P_{2019}} - \frac{c_{\ i,2019}}{C_{2019}} \right| \right)$$
$$= \frac{1}{2}\left(\sum_{i=o}^{I} \left| \frac{p_{\ i,2019}}{P_{2019}} - \frac{c_{\ i,t}}{C_t} \right| - mismatch_{2019} \right)$$

where $½\sum_{i=o}^{I} \left| \frac{p_{\ i,2019}}{P_{2019}} - \frac{c_{\ i,t}}{C_t} \right|$ can be interpreted as the counterfactual mismatch in t1 had the distribution of posts remained the same as in the base period 2019 and

$$CoMove_{c,t,2019} = Mismatch_{c,t} - Mismatch_{c,2019} - \Delta Postings_{c,t,2019} - \Delta Clicks_{c,t,2019}$$

measuring the co-movement of clicks and posts.