



BANCA D'ITALIA  
EUROSISTEMA

# Questioni di Economia e Finanza

(Occasional Papers)

Labour shortages in Italy: determinants, firms' responses  
and employment prospects

by Silvia Anna Maria Camussi, Andrea Locatelli, Graziella Mendicino  
and Francesca Modena

October 2024

Number

887





BANCA D'ITALIA  
EUROSISTEMA

# Questioni di Economia e Finanza

(Occasional Papers)

Labour shortages in Italy: determinants, firms' responses  
and employment prospects

by Silvia Anna Maria Camussi, Andrea Locatelli, Graziella Mendicino  
and Francesca Modena

Number 887 – October 2024

*The series Occasional Papers presents studies and documents on issues pertaining to the institutional tasks of the Bank of Italy and the Eurosystem. The Occasional Papers appear alongside the Working Papers series which are specifically aimed at providing original contributions to economic research.*

*The Occasional Papers include studies conducted within the Bank of Italy, sometimes in cooperation with the Eurosystem or other institutions. The views expressed in the studies are those of the authors and do not involve the responsibility of the institutions to which they belong.*

*The series is available online at [www.bancaditalia.it](http://www.bancaditalia.it).*

# **LABOUR SHORTAGES IN ITALY: DETERMINANTS, FIRMS' RESPONSES AND EMPLOYMENT PROSPECTS**

by Silvia Anna Maria Camussi\*, Andrea Locatelli\*\*,  
Graziella Mendicino\*\*\* and Francesca Modena\*\*

## **Abstract**

Italy, like other developed countries, has seen a sharp increase in labour shortages in recent years, but little is known about the underlying causes, patterns and implications.

This paper investigates various determinants of recruitment difficulties, including increased labour demand during an expansionary business cycle, changes in the skills required, demographic trends, and evolving worker preferences. The analysis reveals significant heterogeneity in labour scarcity, with the most severe shortages occurring in northern Italy, in the sectors of construction, manufacturing, and ICT, and among STEM professionals and technicians. The severity of labour shortages varies according to firm-level characteristics, with greater challenges for companies active in labour-intensive or fast-growing sectors; remote work appears to mitigate this issue.

Employers are addressing shortages with strategies such as monetary incentives, offering flexible working conditions, career development opportunities and increased job security.

Finally, we analyse the impact of labour shortages on workers' career trajectories, revealing that workers in hard-to-fill occupations tend to have better employment prospects, more stable contracts and greater regional mobility.

**JEL Classification:** J21, J63, M51.

**Keywords:** labour shortages, hiring strategies, employment prospects.

**DOI:** 10.32057/0.QEF.2024.887

---

\* Banca di Italia, ARET, Torino.

\*\* Banca d'Italia, ARET, Trento.

\*\*\* Banca d'Italia, ARET, Catanzaro.



## 1. Introduction<sup>1</sup>

Labour shortage has become a key policy issue early in the pandemic recovery because of its growing impact on the wider economy. In many EU countries, it has now reached or exceeded pre-pandemic levels: according to Eurostat data, the EU average job vacancy rate<sup>2</sup> rose from 2.2% in 2019 to 2.9% in 2023; in Italy this indicator spiked in 2023 at 2.3% (1.4% in 2019). Recent studies have analysed the causes of this phenomenon and its consequences for businesses, workers, and the economy as well.

Labour shortages can be associated to relevant effects on employees' work-life balance and on their long-term economic prospects. On one side, there may be negative impacts if labour scarcity results in increased pressure on current employees (e.g. longer working hours, skill mismatch). On the other side, working in an occupation characterized by significant recruitment difficulties may provide a competitive advantage in the labour market, potentially leading to better working conditions, economic benefits and contractual advantage. To the best of our knowledge, the empirical evidence on this issues is limited and findings are mixed, depending on the type of shortage encountered and the attributes of workers and firms (de Zeeuw and Terry, 2018; McGuinness et al., 2017; Healy et al., 2015; Fang, 2009). Hiring difficulties could have either negative effects on firms, preventing their growth and forcing them to operate below potential, or they may be performance-enhancing, leading to an improvement in the quality of jobs and the adoption of more efficient and productive technologies (Acemoglu, 2010)<sup>3</sup>. Recent empirical findings indicate the prevalence of negative effects of labour scarcity (especially high-skilled) on various aspects of firms' performance (Le Barbanchon et al., 2023; Coad et al., 2016; Toivanen and Väänänen, 2016; Horbach and Rammer, 2022; Carioli and Czarnitzki, 2023). The large array of possible implications of labour shortages makes it crucial to examine the drivers and implications of this issue. From a policy point of view, the results of this analysis may help identify potential public and private policies to deal with hiring difficulties.

The first goal of this paper is to investigate the reasons of labour shortages in Italy, analyzing both cyclical and structural determinants. We describe the geographical, occupational and sectoral patterns of labour shortages, and we characterize the firms that display the largest hiring difficulties. A second contribution is to examine the actions undertaken by employers to address labour scarcity, including both monetary and non monetary incentives that ensure better working conditions. These improvements may result from firms' initiatives to attract and retain skilled workers or may derive from a greater bargaining power of job seekers. Third, we aim to analyze individual employment trajectories comparing occupational mobility of workers employed in hard-to-fill and in non hard-to-fill jobs. In particular, we exploit rich administrative data on job contracts to examine the dynamics of job-to-job transitions, in terms of employment probability, contract type and regional mobility. This analysis adds novelty to existing research since, to the best of our knowledge, no studies have so far examined the link between labour shortages and employees' careers.

Our focus is on Italy where, in spite of a growing incidence of labour shortages in recent years,

---

<sup>1</sup>We would like to thank Giuseppe Albanese, Michele Cascarano, two anonymous referees, and all the participants to AISRE and AIEL conferences. The views expressed in the paper are those of the authors and do not necessarily reflect those of the Bank of Italy.

<sup>2</sup>The job vacancy rate measures the ratio between the number of job vacancies and the sum of the vacancies and occupied posts.

<sup>3</sup>His work shows that labour scarcity encourages technological advances if technology is strongly labour saving and will discourage them if technology is strongly labour complementary.

the empirical literature suffers from a lack of suitable data. There is limited knowledge regarding which firms are more likely to face labour scarcity and its impact on the labour market. The empirical analysis draws upon various datasets, at both the aggregate (Istat Italian Companies Census, Excelsior data) and the individual level (the Bank of Italy survey on industrial and service firms, “Invind”, and Italian administrative data on a large random sample of work relationships, “CICO”). The availability of these datasets allows us to analyze the determinants and consequences of labour shortages for different economic agents, representing an additional contribution to the literature.

Our analysis confirms that labour shortages could be shaped by a combination of cyclical drivers and structural determinants. On the one hand, recent studies have suggested that the latest sharp increase in labour scarcity is significantly influenced by cyclical factors: in an expansionary period a reduction in the unemployment rate is typically associated with an increase in firms’ time-to-hire (Causa et al., 2022; Kiss et al., 2022; Bank of Italy, 2023a). On the other hand, labour shortages also depend on long-term structural factors – e.g. a declining workforce due to demographic trends, skills shortages arising from the creation of new and more sophisticated jobs, especially in the context of the ongoing green and digital transitions (European Commission, 2023; Groiss and Sondermann, 2023) – and on shifts in worker preferences, more and more often unwilling to accept low-paying, poor-quality, or physically demanding jobs (Causa et al., 2022).

In a context of changing skills needs linked to the ongoing green and digital transitions, it is crucial to identify sectors and occupations that face higher labour scarcity. We show that hiring difficulties are more widespread in construction, manufacturing and ICT services; STEM professionals are highly sought after. We find evidence of a strong North-South divide, with firms reporting the largest hiring difficulties especially in the northern regions characterized by lower labour market slack. The extent of labour shortage also depends on firm-level characteristics.

We find that, *coeteris paribus*, firms less open to the international markets or that operate without the support of a group face pronounced recruitment difficulties.<sup>4</sup> This is especially true for expanding and labour-intensive firms; high-tech knowledge-intensive services are particularly affected. Firms in which (at least part of) the employees work from home (remote work) report a lower incidence of labour shortages. The analysis further highlights constraints on the supply of goods and services, as well as on labour turnover due to recruitment difficulties.

Firms adopt a variety of strategies to deal with labour shortage. In order to attract and retain skilled employees, they raise wages, increase workers’ autonomy, enhance benefits, and provide on-the-job training opportunities. Strategies vary according to the sector and firm size. Employers adjustments to occupational shortages may also affect employees’ occupational prospects. We find that workers in hard-to-fill jobs are more likely to remain employed, to transit towards different regions, and to stay in the same occupation.

The rest of the paper is organized as follows. Section 2 presents some evidence of labour shortages in Italy and describes the data. Section 3 analyses the possible determinants of the phenomenon, and Section 4 shows the geographical, occupational, sectoral and firms patterns of labour shortages. Section 5 discusses possible employer responses to shortages and Section 6 examines the employment prospects of workers employed in hard-to-fill jobs. Section 7 concludes.

---

<sup>4</sup>More productive firms might be able to offer better working conditions and pay higher salaries, therefore experiencing fewer hiring problems. Unfortunately, due to data limitations, it is not possible to account for these factors in our analysis, leaving room for further research.



## 2. Labour shortages in Italy: description of the phenomenon and data

Labour shortage occurs when firms cannot find suitable workers to meet their demand, given the current wage levels and working conditions. Specifically, labour shortages is related to two main conditions: first, there is a market disequilibrium between supply and demand where the number of workers that employers wish to hire exceeds the number of individuals willing to work at the prevailing wage and working conditions; second, the market adjusts slowly, with achieving equilibrium requiring a substantial period of time (Barnow, 2013).

We focus on Italy, which represent an interesting case study due to several characteristics of its labour market that may affect both labour market disequilibrium and slow adjustment. Italy has a notably low female participation rate (64.0% in 2023; 74.1% in EU average) that limits the potential pool of workers; this is also related to deep-rooted cultural dynamics that may require significant efforts to change. Additionally, Italy faces relevant demographic challenges: in 2022 the total fertility rate in Italy was 1.24 live births per woman, compared to 1.46 in the EU. This contributes to an ageing population and a shrinking workforce, which in turn leads to labour shortages as fewer young workers enter the labour market to replace those who are retiring. The quality of the labour supply could be another important issue, with concerns about the alignment of education and training with the skills demanded by employers. The mismatch between education and firms needs can further exacerbate labour shortages as employers struggle to find candidates with the required skills and competences.

Measuring occupational shortages is a challenging task: the empirical analysis faces data and methodological issues, and no single metric provides a conclusive measure of this phenomenon. Theoretically, one needs to have information on job openings and the difficulty in filling them: a larger number of vacancies than the available pool of candidates indicates a tighter labour market (Frohm, 2021; Michailat and Saez, 2022). One key indicator of labour market tightness is the vacancy rate, calculated as the ratio between the number of job vacancies and the sum of them plus the number of occupied posts. According to Eurostat data, in Italy 2.3% of jobs were vacant in the average of 2023, the highest value ever recorded (Figure 1). The vacancy rate is lower than the euro area (2.9%), driven by particularly high values in northern European countries<sup>5</sup>, but higher than other Mediterranean countries, such as Spain.

Statistics on job vacancies at a disaggregated level are difficult to collect and they are only accessible for some countries (Le Barbanchon et al., 2023; Horbach and Rammer, 2022; Carioli and Czarnitzki, 2023).

Due to the restricted availability of detailed data, many empirical analyses rely on surveys capturing firms' perceptions (e.g., Groiss and Sondermann (2023); Stevens (2007); Frohm (2021)). Potential issues with this approach include the fact that firms might exaggerate labour scarcity in their responses (Barnow, 2013), and that the self-perception of labour shortage may depend on the existing working conditions and wages of surveyed firms (Barnow, 2013; Arrow and Capron, 1959).

We explore three main surveys capturing firms' perceptions on labour scarcity. First, the Permanent census of enterprises (Istat) provides useful information on labour shortages for the years 2018 and 2022<sup>6</sup>. The questionnaire specifically asked enterprises to identify the main factors

---

<sup>5</sup>The annual vacancy rate in 2023 was 4.6% in Belgium, 4.5% in the Netherlands and 4.0% in Germany.

<sup>6</sup>The first permanent census took place in 2019 (with reference year 2018) the second one started by the end of 2022 and ended in March 2023. Each survey involved a sample of about 280,000 enterprises employing more than 3 workers (representing about 23.0-24.0% of Italian enterprises). The census provides a detailed picture of the Italian

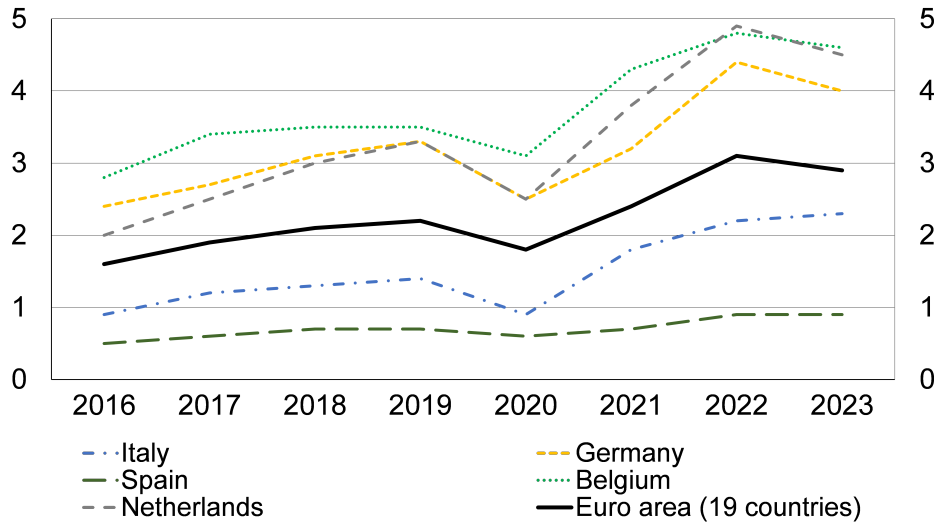


Figure 1: Average job vacancy rate. Source: Eurostat.

hindering the recruitment of human resources and to describe the practices they use to attract and/or retain qualified staff. Available data are at the sectoral, regional and firms' dimensional level. According to these data, the difficulty in finding personnel with the required technical abilities is listed among the main obstacles encountered by firms in the hiring process (Figure 2): in 2022 it was mentioned by 24.4% of companies (more than 3 percentage point compared to 2018). The difficulty in finding personnel with the necessary soft skills also hinders the recruitment process for a non-negligible share of firms (12.5% in 2022; 9.9% in 2018).

The second database we rely on is the Excelsior survey, that measures how many potential vacancies were considered difficult to fill by firms.<sup>7</sup> Data are available at the year, region, occupation<sup>8</sup> and industry level.<sup>9</sup> In Italy in 2023 up to 45% of new job vacancies were reported by firms as hard to fill, compared to nearly 26% in 2019 (see Appendix A1 for the main descriptive statistics).

---

economic system, by gathering information about emerging issues such as enterprises' organisation, competitiveness and environmental sustainability. To increase the quantity and quality of the information provided, while reducing the response burden on enterprises, the Permanent census strategy is based on the use of the statistical register of enterprises, by integrating several administrative and statistical sources, as well as a sample survey, which mainly gathers qualitative information.

<sup>7</sup>Excelsior is an information system created by Unioncamere (the Union of Italian Chambers of Commerce) designed to gather information on the labour market and training provisions in Italy and combines administrative sources and surveys of enterprises. Excelsior conducts monthly firms' surveys by means of questionnaires that collect information on recruitment strategies, challenges in finding staff, job profiles required, skills needed and other aspects related to employment and human resources. The questionnaire responses are then integrated with data from administrative sources such as Chambers of Commerce, the National Social Security Institute (INPS), the National Statistics Institute (ISTAT) and other public bodies. The integration of the survey results with administrative data is done through an autoregressive model based on the analysis of historical information. The results could be influenced by the dynamics and trends observed in the past, without being able to fully capture external factors or unforeseen events.

<sup>8</sup>Occupations are at the 2-digit Istat classification (CP 2011). Professions related to legislators, entrepreneurs and senior management (referred to CP 2011 no. 1) are excluded.

<sup>9</sup>Industries are within five macro sectors: manufacturing, construction, trade, hospitality and other services.

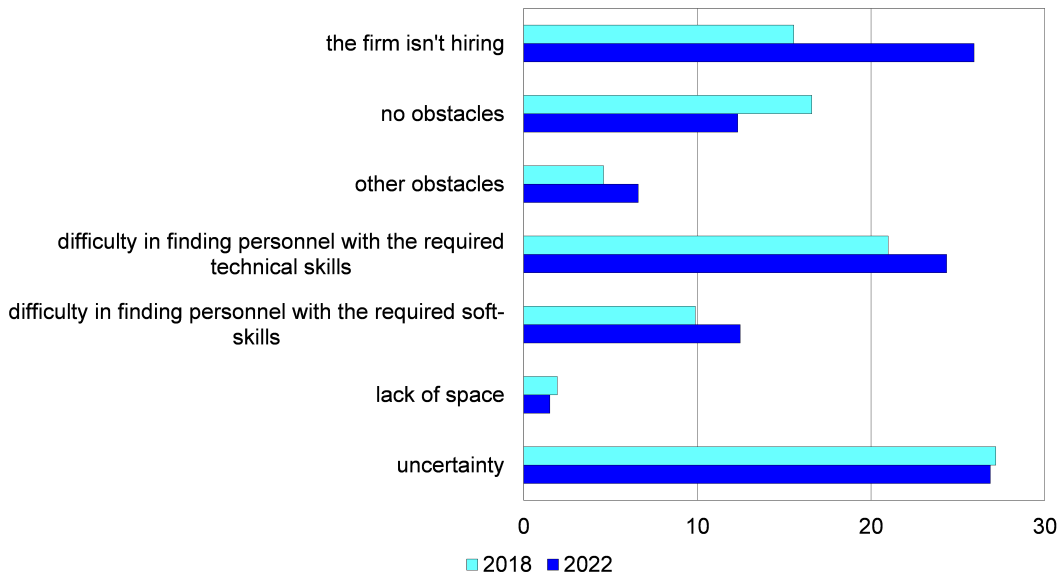


Figure 2: Obstacles in the company’s recruitment process. Source: our calculations based on Permanent Census of enterprises data, Istat.

The latter sources of information we have used on labour shortages is the Survey of industrial and service firms (Invind) conducted by the Bank of Italy since the 1970s, which includes data on a broad array of firm-level characteristics. In this work we focus on the period between 2019 (the year before the outbreak of the COVID-19 pandemic) and 2022 (the latest available year). Survey data referring to one year are collected through interviews conducted between February and May of the following year. The Invind survey covers firms with at least 20 workers,<sup>10</sup> which is a relatively large figure for the Italian economy, characterized by a small average firm size. Our analysis focuses on a specific question asking respondents whether a shortage of workforce affected their company between September of the previous year and the interview date. This question was introduced in the surveys conducted in 2022 and 2023. Possible answers include “no”, “yes, a little”, “yes, quite”, and “yes, a lot”. We group them two by two in order to obtain a binary variable equal to 1 for the two latter answers and to 0 otherwise<sup>11</sup>: about 17% of respondents reported a shortage of workforce in the last quarter of 2022 and the first few months of 2023 (over 3 percentage points more than in the previous year). Henceforth we focus on the most recent survey (see Section 4.1).

The various measures used to assess labour shortages from different sources provide complementary perspectives on the phenomenon. While each may highlight different aspects of the problem, together they point to a significant escalation of recruitment challenges, a tightening labour market and increased difficulty in finding suitable employees. This convergence of data underlines the urgency of addressing labour market imbalances and implementing effective strategies to alleviate recruitment constraints. Further analyses are reported in Section 4, where we describe

<sup>10</sup>The survey covers some 4,000 firms per year. Sample size is about 3,200 in 2019 because the corresponding survey was conducted in early 2020, at the outbreak of the COVID-19 pandemic.

<sup>11</sup>This choice is motivated by the fact that interviewers and interviewed firms may find it hard to distinguish between similar answers, e.g. “no” and “yes, a little”. Results of the multivariate analysis, available upon request, remain basically unchanged if we use a binary variable equal to 0 if firms answer “no” and 1 if they answer “yes”.

the differences in labour shortages between regions, sectors and firms.

### 3. Determinants of labour shortages

Labour shortages can result from several causes. It is a complex phenomenon, characterised by a number of interconnected elements, each playing a role in different aspects of the problem. The drivers of labour scarcity may be related to quantitative or qualitative aspects: the former refers to insufficient labour supply in certain segments of the labour market or in certain geographical locations, the latter occurs when demand and supply of labour are fairly balanced but there is still a high proportion of unfilled vacancies and a high unemployment rate due, e.g., to skill mismatch (Reymen et al., 2015; European Commission, 2023). In this section, we explore some of the possible determinants as a preliminary effort to understand the complex challenges associated with labour shortages. Specifically, we examine factors such as excess labour demand during an expansionary business cycle as well as changes in required skills. Additionally, we consider supply-related factors, including population decrease impacting the labour force, or changes in workers' preferences.

*Expansionary business cycle* – First, potential reasons for hiring difficulties might be ascribed to increased demand for specific goods or services, or to overall economic growth. This may result in a temporary shortage of labour, as vacancies react faster than unemployment. For instance, many developed countries witnessed a sharp increase in labour shortages as the economy and labour market recovered from the COVID-19 pandemic. In 2022, Italy also experienced an increase in employment and labour force participation and a reduction in unemployment that fell to historically low levels, driven by GDP growth and the associated expansion of the business cycle in the post-pandemic recovery. This led to an increase in firms' time-to-hire as companies experienced more difficulty in finding new people to hire.

The Beveridge curve is a graphical representation of the relationship between the unemployment rate and the job vacancy rate to assess the efficiency of labour market matching. Indeed, the curve is associated with two fundamental concepts: labour market tension and market efficiency. Tightness in the labour market, defined as the ratio of vacancies to unemployment, captures the movements along the curve. Supply and demand matching efficiency refers to the amount of people finding employment against a given value of the ratio of vacancies to unemployment and is captured by the shifts of the curve (European Central Bank, 2019). The Beveridge curve for Italy shows a movement along the curve<sup>12</sup>, with an increase in vacancies against a fall in the unemployment rate (Figure 3): this suggests that the efficiency of labour market matching has not deteriorated in recent years (European Commission, 2023; Blanchard et al., 2022).

While there is currently no evidence of increasing structural mismatch, monitoring the Beveridge curve over time and analyzing more granular mismatch indicators can provide insights into the phenomenon. High and persistent levels of labour shortages signal underlying long-term structural drivers that interact with cyclical factors (European Commission, 2023). In a context where demographic trends are leading to a declining working age population, and economies rely to a greater extent on skilled labour (in the context of the green and digital transitions), understanding the structural causes of labour shortages becomes crucial.

*Training and skills* – There is a growing concern that a mismatch exists between industry needs

---

<sup>12</sup>In 2020 trend was affected by the temporary shock related to the pandemic.

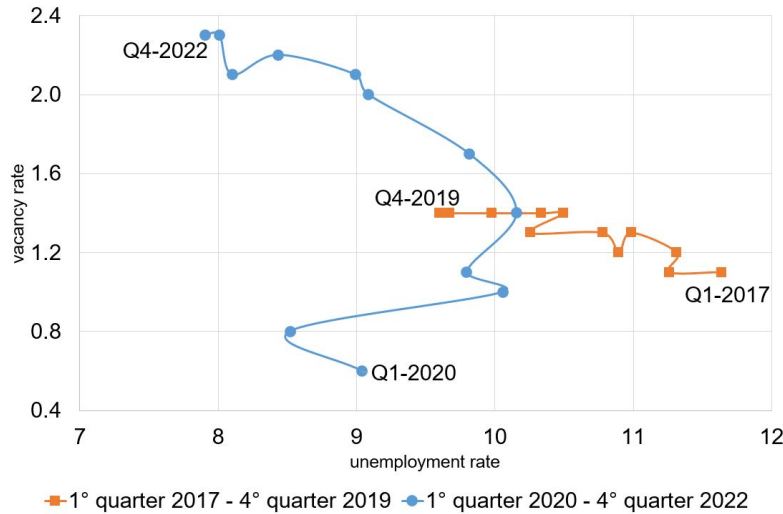


Figure 3: The Beveridge curve. Source: our calculations based on Istat (“Posti vacanti nelle imprese dell’industria e dei servizi” and LFS). The curve in 2020 needs to be treated with caution given the impact of the COVID-19 pandemic.

and educational offerings, especially in a context of rapid technological advancements (Carioli and Czarnitzki, 2023; Barnow, 2013).

According to Excelsior data, although the increase in hiring difficulties reported by Italian firms occurred at all levels of education, labour shortages appear to be more pronounced in occupations that require vocational programmes, both secondary and post-secondary education (professional skills), and university degrees (Figure 4, panel a), especially in engineering and science faculties (STEM<sup>13</sup>; Figure 4, panel b).

As regard professional skills, vocational education and training (VET) can improve the transition from school to work and increase the employability of young people by better matching the skills they acquire with the needs of the economy. In 2022-23, planned hiring by companies requiring vocational training accounted for almost 40% of all planned recruitment, up from 30% in 2019. However, the difficulty of finding such candidates rose to almost 50%, up from just below 30% in 2019, making this category the most difficult to recruit for jobs requiring post-secondary or tertiary education.

Concerning post-secondary education, in Italy in 2021, 26.8% of the population aged 30-34 had a tertiary degree, a significantly lower percentage compared to the EU average<sup>14</sup> (41.9%; Eurostat data). Distinguishing by educational level, only a small proportion of graduates attended post-secondary vocational programmes (1.8%, 11.7% in the EU average; Figure 5, panel a). These programmes, introduced by relatively recent legislation, combine school-based and work-based learning and primarily focus on developing professional specializations at the post-secondary level to meet the demands of both public and private sector labour markets. Currently, the proportion of recruits with this specific type of training remains relatively low compared to those with other educational backgrounds. However, this could change in the coming years.

Italy exhibits a lower proficiency in STEM fields as well. In 2021 graduates from a STEM

<sup>13</sup>According to Eurostat, STEM fields are classified as ISCED-F 05 (natural sciences, mathematics and statistics), 06 (information and communication technologies) or 07 (engineering, manufacturing and construction).

<sup>14</sup>We consider European Union - 27 countries.

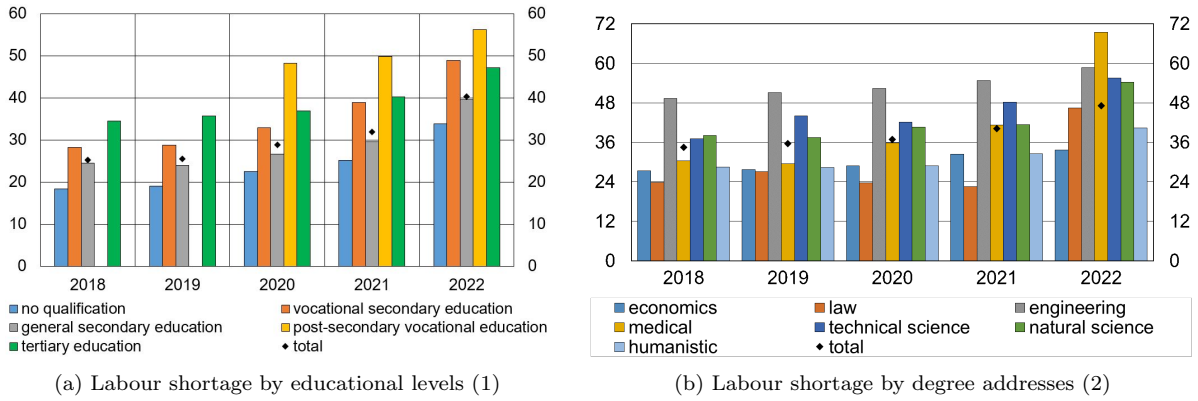


Figure 4: Labour shortage by educational level. Source: our calculations based on Excelsior data. We only consider data on typical employment contracts, excluding data on atypical contracts. (1) We consider the classification of qualifications adopted by Excelsior which others to the general secondary education, includes also vocational secondary education (“Istituti professionali”), post-secondary vocational education (ITS) and university (tertiary education). Data on ITS is only available from the 2020 survey. (2) Total labour shortage refers only to that for professions requiring a university degree.

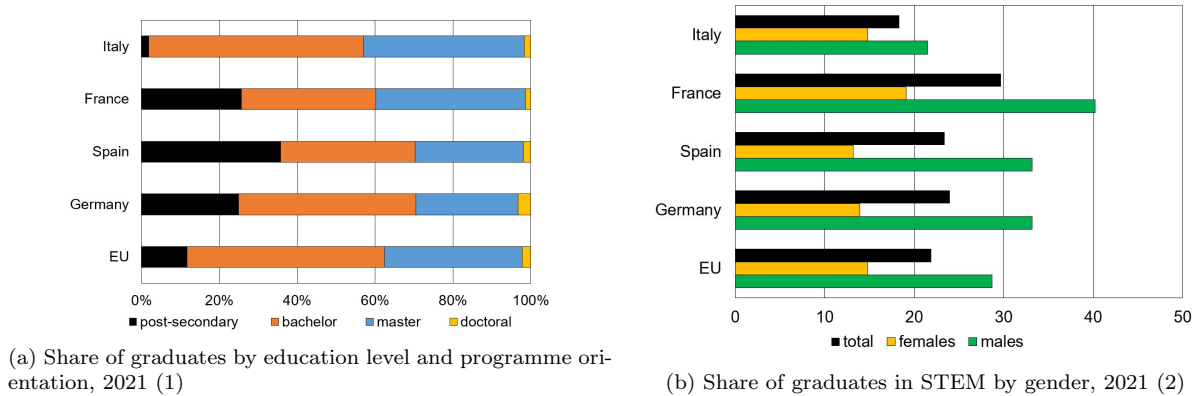
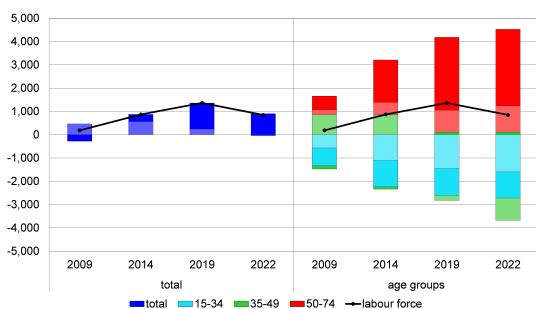


Figure 5: Graduates by country and educational level. Source: Eurostat (panel a, educ\_uoe\_grad0; panel b educ\_uoe\_grad04). The EU average refers to EU - 27 countries. (1) “Post-secondary” includes “Post-secondary non-tertiary education” and “Short-cycle tertiary education” as defined in the International Standard Classification of Education (ISCED 2011). (2) STEM refers to tertiary education, in science, math., computing, engineering, manufacturing, construction. Shares are calculated as graduates per 1000 of population aged 20-29.

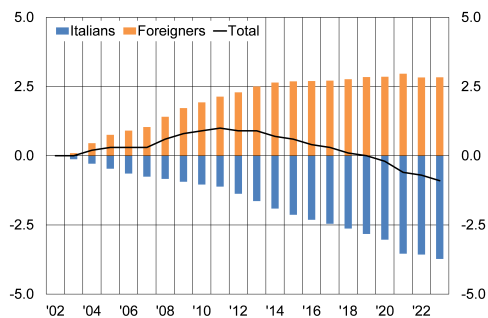
degree were 18.3 per 1,000 of population aged 20-29, highlighting a lower stock compared to the European average of 21.9 per 1,000 of population (Figure 5, panel b). Skill shortages may be exacerbated by gender segregation: only 14.8 per 1,000 of females aged 20-29 had a STEM degree (21.5 for males). This limits the pool of people available to fill new vacancies, possibly making skilled labour shortages more persistent.

The relevant gap in vocational training and STEM programmes may entail future challenges of skills mismatch, in times of rising demand for these qualifications due to the digital transitions.

*Population trends* – Labour shortage may result from demographic change if there is no compensation by increased immigration or a higher willingness to participate in the labour market (Horbach and Rammer, 2022). Demographic trends have been particularly pronounced in Italy: among European countries, Italy features the highest old-age dependency ratio (37.5% in 2022 and 43.7% in 2030 according to Eurostat projections; the EU average is equal to 33.0% in 2022 and to 38.0% in 2030) and the highest share of population aged 65 and over (23.8%; 21.1% in



(a) Labour force, by age (thousands)



(b) Resident population, by citizenship (millions)

Figure 6: Labour force and population. Panel a – Source: Istat, LFS. Contribution of age groups to the variation in the workforce compared to 2004. In the graph, the fully filled area of each histogram represents the contribution arising from the change in the participation rate, once the variation in the number of residents (total and in each age group) is taken into account. The cross-hatched areas represent the contribution arising from the change in the number of residents (total and in each age group), holding the participation rate constant at 2004 levels. Panel b – Source: calculations based on Istat, resident population. Variation of the population aged 15-64 since 2002.

the EU). Italy exhibits the highest population median age among European countries: 48 years in 2022 (from 36.9 in 1990), 44.4 years in the EU average (Eurostat data).<sup>15</sup> Between 2019 and 2022 Italian working age population (15 to 64 years old) decreased by nearly 800,000 units and labour force by about 500,000 units.

In the medium term, the effects of population decrease has been mitigated by the rise in the labour market participation and the increase in net migration. In Italy, holding the population constant, the workforce would have experienced growth over the last two decades, in particular due to increased participation of the elderly workforce influenced by retirement reforms (Figure 6, panel a). Furthermore, according to Istat data, net migration flows have been increasing over the years. These flows contracted significantly during the pandemic (about 50,000 people on average per year in 2020-21) but returned in 2022 to levels similar to those before COVID-19 (close to 110,000 people). Nevertheless, especially in more recent years, they were not enough to offset the contraction in the Italian population (Figure 6, panel b). Moreover, managing migration flows will require well-designed training and integration policies, which are crucial for absorbing migrants into the social fabric and production system (Bank of Italy, 2023b).

Overall, based on Istat’s demographic projections, by the year 2040, Italy’s resident population will decline by 2.5 million units, and that between age 15–64 by 5.5 million with respect to 2022. These demographic trends may further reduce the size of the labour force, and therefore the pool of potential workers.

*Changing preferences* – The growing challenge of hiring employees – even for occupations that do not require any qualifications – also suggests that the rise in labour shortages may, in part, be attributed to shifts in job preferences among some workers, generating a mismatch between individual’s aspirations and available job opportunities (Duval et al., 2022). Indeed, some workers may no longer accept low wages and poor or strenuous working conditions<sup>16</sup> (Causa et al., 2022), preferring instead jobs that are more easily teleworkable and involve fewer health risks, for example.

<sup>15</sup>We consider European Union - 27 countries.

<sup>16</sup>These factors also depend on the labor market conditions and the overall economic situation of those entering the labor market, not necessarily on their preferences.

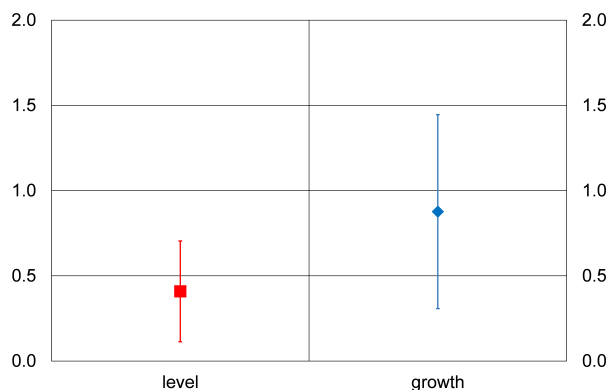


Figure 7: Accident rate. Source: our calculations on INAIL and Excelsior. This figure presents, respectively, the effect of accident rate on hiring difficulties for years 2019-2022, and the effect of the accident rate in 2019 on the growth of hiring difficulties between 2019 and 2022. Each regression includes dummies for the type of occupations and region fixed effects (plus year fixed effects in the first model).

Workers in occupations characterised by persistent labour shortages and high levels of job strain are more likely to express concerns about their health and safety being put at risk by their work. Based on Eurostat data for 2021 (the most recent available), Italy had a workplace accident rate of 2.7%, above the EU-27 average of 1.7%. In particular, the construction sector recorded the higher accident rates, followed by mining and quarrying and agriculture. To delve into various occupations, we used data on accidents obtained from INAIL (the Italian National Institute for Insurance against Accidents at Work) and we calculated an occupation-specific accident rate.<sup>17</sup> Table A4 shows the most dangerous occupations in 2022: the injury-index is rather high for unskilled professions in manufacturing and construction but also in trade and service. Also workers in human health, drivers, metalworkers and craftsmen suffer more accidents at work. These professions are also those often associated with greater recruitment difficulties. Considering the data provided by Excelsior, there seems to be a positive correlation between the two phenomena: occupations with higher levels of risk seem to be linked to greater labour shortage over the four-year period, both in terms of level and growth (Figure 7). The highly aggregated nature of the data and the potential omitted variable bias preclude a causal interpretation of these results, so it is prudent to approach them with caution. Nevertheless, albeit weak, these correlations align with theoretical expectations regarding workers’ reduced willingness to undertake hazardous jobs<sup>18</sup> and thus the potential contribution to the labour shortage.

#### 4. Heterogeneity in labour shortages across firms

Labour scarcity may considerably vary across segments of the labour market. Shortages of specific types of labour may differ in the presence of industry-specific skills (Stevens, 2007), and occupational scarcity could be limited to a few labour markets or regions of the country (Barnow,

<sup>17</sup>The accident rate is calculated by the number of injuries at work on the number of employees as calculated from the Istat LFS, by occupations categorised according to the 2-digit CP2011 classification. Data are available for the period 2019-2022. It is not possible to eliminate the public sector and to purify the data from commuting accidents.

<sup>18</sup>“3Ds jobs” is an American neologism derived from an Asian concept and refers to certain types of work often performed by unionised workers. The term originated from the Japanese term 3K (Connell, 1993) and has since become widely used, particularly in reference to work done by migrant workers.



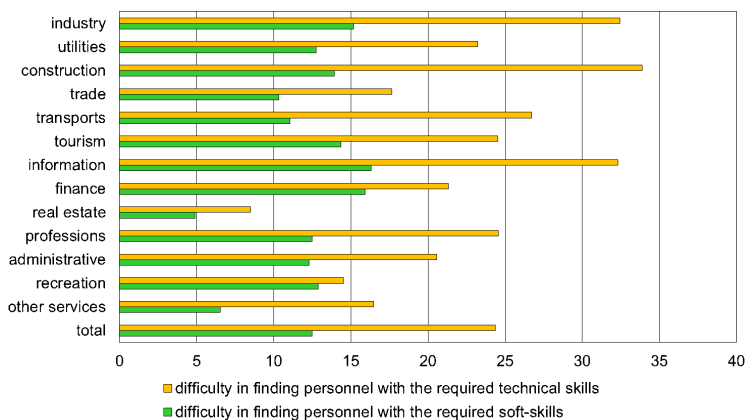


Figure 8: Recruitment difficulties. Source: our calculations on Permanent Census of enterprises data, Istat. Shares of firms mentioning lack of technical abilities or soft-skills as an obstacle to hiring. Year: 2022 Note: Sectors include the following NACE Rev. 2 level 1 codes. See footnote 19 for details.

2013). Therefore aggregate measures hide a great heterogeneity among sectors, occupations, geographical areas and other firm characteristics, such as size, which we explore in this section.

In this subsection we report some several univariate descriptive statistics to investigate the heterogeneity across firms using data from the Permanent census of enterprises and Excelsior data.

*Sector heterogeneity* – Labour shortages are more widespread in the industrial sector and in services with a higher knowledge content. In particular, Census data show the difficulty in finding workers with the required technical skills involved one firm out of three in construction, manufacturing and ICT services, while the lack of candidates with soft skills affected one in six companies in ICT, in financial services and manufacturing (Figure 8).<sup>19</sup>

Heterogeneity across sectors is also confirmed by Excelsior data which captures information on the share of potential hiring that is expected to be difficult to fill over total potential hiring.<sup>20</sup> In 2022, 40% of expected new contracts showed recruitment challenges (25.6% in 2019), with the highest level in the construction sector (53% of expected new hires) and the lowest level in trade (33%).

*Occupational heterogeneity* – Sectoral differences are closely linked to the specific skills sought by companies in the various occupations. In particular, Excelsior data highlights persistent labour shortages for ICT and STEM professionals and technicians, as well as construction workers and

<sup>19</sup>Sectors reported in Figure 8 include the following NACE Rev. 2 level 1 codes: industry = B (Mining and Quarrying) + C (Manufacturing); utilities =D (Electricity, Gas, Steam and Air Conditioning Supply) + E (Water Supply; Sewerage, Waste Management and Remediation Activities); construction = F (Construction); trade =G (Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles); transports = H (Transportation and Storage); tourism = I (Accommodation and Food Service Activities); information = J (Information and Communication); finance = K (Financial and Insurance Activities); real estate = L (Real Estate Activities); professions =M (Professional, Scientific and Technical Activities); administrative = N (Administrative and Support Service Activities); recreation s. = R (Arts, Entertainment and Recreation); other services = S (Other Service Activities).

<sup>20</sup>It is important to note that the Excelsior data are based on companies' expected hiring rather than the actual job advertisements published. This could entail a potential risk of bias or incompleteness in the answers provided by the firms, affecting the precision and accuracy of the information collected.

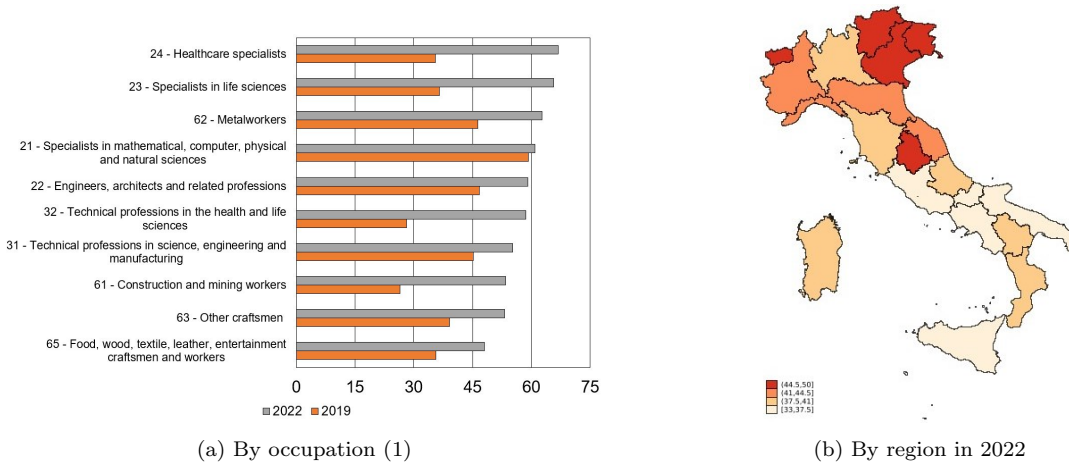


Figure 9: Share of hard-to-fill jobs. Source: our calculations based on Excelsior data. We only consider data on typical employment contracts, excluding data on atypical contract. (1): Occupations are classified according to the ISTAT’s CP2011 coding system at 2-digit.

craftsmen. Concurrently, there appears to be growing hiring difficulty in health-related professions in more recent times (Figure 9, panel a and Table A2). Population ageing may also exacerbate the difficulties in recruiting health professionals, both because of the increased prevalence of chronic diseases and age-related health conditions, and because of the need to maintain and replace an ageing health workforce.

The green and digital transitions are likely to exacerbate these current shortages. Until now, the role of the workforce in facilitating the green transition has been relatively modest. This is likely attributable to the limited shifts in occupational composition towards greener jobs while the emphasis has been placed on an increased efficiency, particularly concerning a greener input mix in energy production (Basso et al., 2023a). Demand conditions might soon change due to policies focused on reducing emissions, potentially boosting job growth across various sectors and professions. The digital transition is also contributing to labour shortages among ICT professionals. Eurostat reports show a significant increase in demand for ICT jobs in Italy and the EU-27 between 2011 and 2021, with projections indicating continued growth. The shortage could be compounded by lower digital skills among women, older people, and those with less education (European Commission, 2023).

*Regional heterogeneity* – Finally, we focus on the regional dimension of labour scarcity. Italy exhibits significant geographical heterogeneity in economic conditions and educational levels (Accetturo et al., 2022), coupled with limited population mobility (Ciani et al., 2017). Excelsior data for 2022 reveals notable hiring difficulties in Northern regions (Figure 9, panel b). In particular, the province of Bolzano exhibits the highest share of hard-to-fill jobs (53%), followed by the province of Trento, Umbria and Friuli Venezia Giulia (47%; Table A3). This result shows that labour shortages are greater in regions with higher economic growth and lower unemployment rates<sup>21</sup>; indeed, regional GDP and unemployment rates can be seen as examples of both cyclical

<sup>21</sup>Unemployment rates provide a direct measure of the number of people who are actively seeking work but remain unemployed: a low unemployment rate indicates a smaller pool of available workers and thus contributes more to labour shortages.

and structural variables that exacerbate recruitment difficulties (Groiss and Sondermann, 2023).

#### 4.1. *Firms' analysis on granular data*

We now look at labour shortage heterogeneity from a more granular perspective, i.e. at the firm level, in an attempt to characterize the firms that display the largest hiring difficulties. In order to do so, we resort to Invind data.

Several characteristics of a firm may be linked to their difficulties in fulfilling their labour demand needs. Firms belonging to a group may be supported by their group's HR functions in their hiring process and they may as well exploit competencies or skills available elsewhere within the group. Companies open to larger, international markets may be more prone to hire from abroad, making it easier to find the desired skills when local markets are too tight. Hiring difficulties may be particularly severe for firms experiencing significant growth and those belonging to sectors of economic activity that are expanding rapidly (Le Barbanchon et al., 2023). In this Section, we explore these dimensions in turn. Figure 10 collects the graphical evidence of the heterogeneity we find among different types of firms (univariate analysis), while Table 2 reports the results from a multivariate analysis in which we include firm-level observable characteristics (including size, age, and sector in all models).

Exporting firms, particularly those with a higher export share, more open to the international markets, typically report fewer issues relating to labour shortages. Exporting companies are typically more productive and therefore able to pay higher wages than non-exporting ones (Melitz, 2003; Bernard et al., 2007); this could make them more desirable employers, facing fewer shortages. Firms belonging to a group face lower labour scarcity, possibly because they can find the required workforce or competences within the group, or with the support of their group in the hiring process. Results in Table 2 show the probability to incur labour shortages faced by exporting firms is lower by about 10 percentage points<sup>22</sup> compared to the rest of the sample; these values are rather large, given an overall share of firms reporting labour shortages of about 17%. Being part of a group reduces firms' labour shortages by almost 4 percentage points.

Our analysis shows that firm's size does not significantly impact hiring difficulties (even within sector).<sup>23</sup> In order to explain this evidence, it is important to notice that two countervailing mechanisms might be at play. On one hand, larger companies might have difficulty finding people with the required skills. On the other hand, smaller firms might struggle to find workers altogether due to the worse conditions they are able to offer. Unfortunately, due to data limitations, we cannot distinguish between these two different channels in our analysis.

We then explore the extent to which hiring difficulties affect firms facing different growth rates, either in their own business or within their sector of economic activity.<sup>24</sup> We compute the growth rate of firm revenues in the three years prior to the survey, and we group firms with a decline (strong or moderate), stability, or growth (moderate or strong). Although Figure 10 shows that companies expanding their activity –more likely trying to hire new workers– display the largest labour shortages, these differences are not statistically significant. Moreover, we find that labour shortage is significantly more severe for firms in expanding sectors: results in Table 2 point to a 6 percentage points higher share of firm experiencing labour shortages in expanding sectors

---

<sup>22</sup>The estimate refers to firms in the top half of the distribution of export shares (higher than zero), which is equal to 36% in our sample (the mean is equal to 40%).

<sup>23</sup>The Invind survey covers firms with at least 20 workers.

<sup>24</sup>We call “expanding sectors” those whose share of value added increased between 2007–2019. Value added is computed according to the economic accounts of the Italian national statistical institute (Istat).

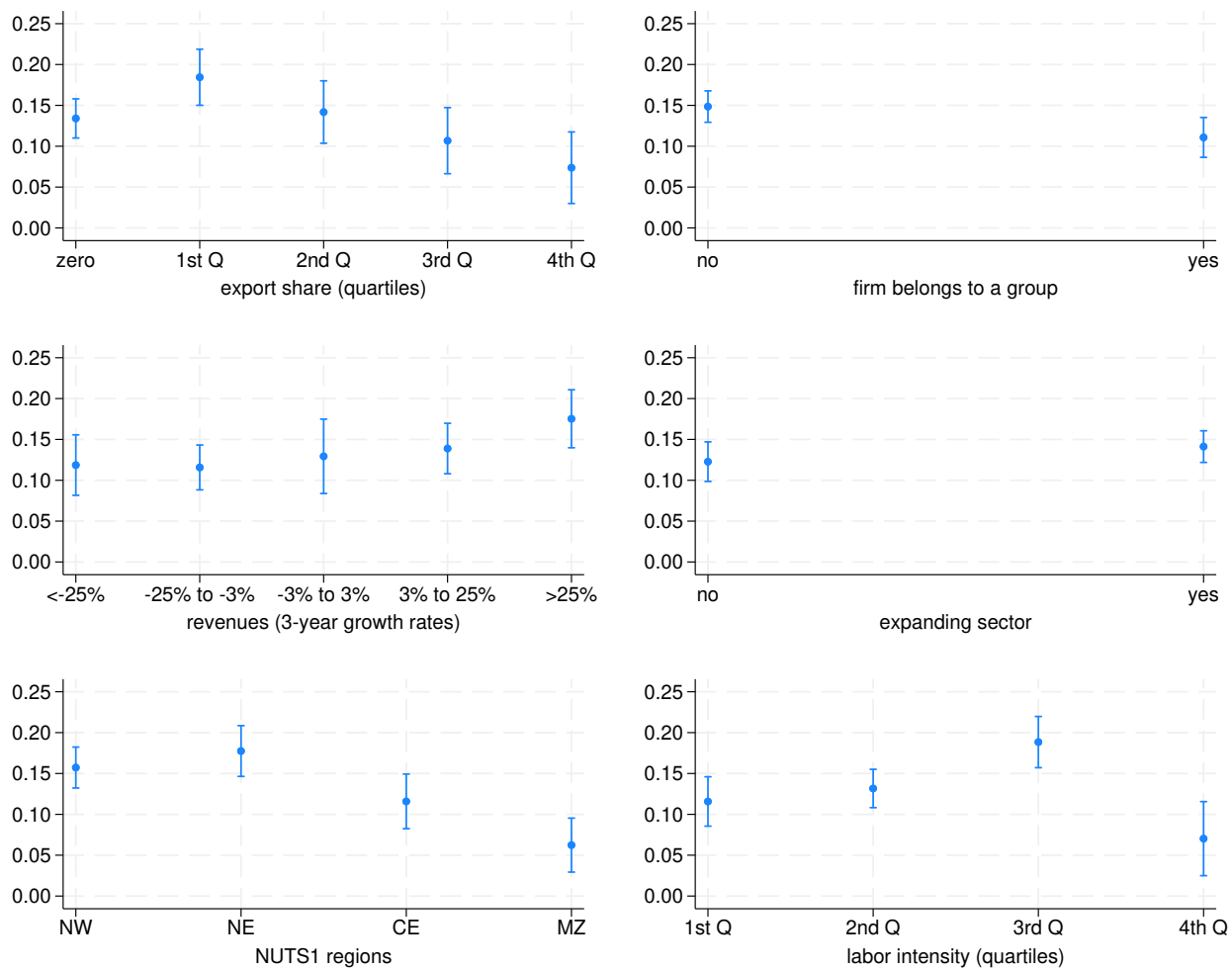


Figure 10: Heterogeneity in firm hiring difficulties. Source: Bank of Italy (Invind Survey), Cerved Group and INPS. Share of firms with labour shortages among firms with different characteristics. Sample restricted as in Table 2. The figure further plots 95% confidence intervals.

compared to the rest of the economy. Further, as noted in Section 4, we document a large North-South divide: controlling for the available employers’ characteristics, the share of firms reporting hiring difficulties in the Center and South –where unemployment rates are higher– is about 6 and 13 percentage points lower than that observed in the North of Italy (Table 2).

As the degree of hiring difficulties may vary according to how much firms rely on labour, we compute a measure of labour intensity defined as the ratio between the labour input (number of employees recorded by INPS, the National institute for social security) and the capital stock (total book value of tangible and intangible assets) of each firm, and we attribute each company to the corresponding quartile of the distribution, computed for year 2019 by aggregate sectors.<sup>25</sup> Our analysis shows that the issue of labour shortage displays an inverted-U share in labour intensity. We observe, however, that the estimated coefficient is not statistically significant for firms located in the top quartile of the distribution: we conjecture that these firms exhibit a notably high ratio of employees to assets, implying a potentially greater capacity for adjustment through internal labour markets. They may also rely heavily on expanding the utilization of overtime (wherein existing employees work additional hours), or on restructuring the work processes to engage their workers from diverse occupations, possibly reducing any mismatch between workers and tasks, while attempting to fulfill new positions.

Invid data also include information regarding the use of remote work among participating firms.<sup>26</sup> About 60% of firms reportedly had no workers working from home; among those with a positive share of workers working remotely, the median share was as low as 5%, corresponding to a very sporadic use of this flexibility tool. We pool together firms above this threshold (firms using remote work), and we compare them to those below it (firms not using remote work). Estimates in model 5 of table 2 suggest that working from home decreases significantly, by about 5 percentage points, the probability of a firm experiencing labour shortages.

Technological advancement is key in promoting economic growth. At the same time, firms need to hire workers with a significant amount of human capital in order to fully exploit the potential of innovation. In some cases, innovation and automation may even replace workers, at a time of a significant technological transition, which is now underway. Distinguishing manufacturing and services sectors by degree of technology intensity based on the corresponding OECD classification<sup>27</sup>, our analysis highlights heterogeneity in the incidence of reported labour shortages among both manufacturing and service firms (Figure 11). In particular, manufacturing firms with the highest grade of technology intensity display the lowest hiring difficulties, compared to medium- and low-tech firms; among services, the fraction of high-tech knowledge-intensive firms<sup>28</sup> reporting hiring difficulties (about 20%) is higher by about 10 percentage points than among the remaining

---

<sup>25</sup>We group sectors of economic activity from Cerved group data into the following categories: primary, energy, utilities, manufacturing, construction and real estate, trade, transportation, hospitality, business services, and other services.

<sup>26</sup>This information is available for a slightly smaller subset of firms, see model 5 in table 2; our favourite specification is model 4, based on which we restrict the sample for this section of the paper.

<sup>27</sup>The Organization for Economic Cooperation and Development (OECD) provides a classification of services by degree of knowledge intensity, distinguishing between non knowledge intensive services and knowledge intensive services (abbreviated as KIS), further grouped into “High-tech knowledge-intensive services”, “Knowledge-intensive market services” and “Knowledge-intensive financial services” (the latter are not covered in the Invid survey). The OECD further provides a classification of manufacturing sectors by degree of technology intensity, which may be either high, medium-high, medium-low or low. A full list of sectors by degree of knowledge- and technology intensity can be found in Istat’s Glossary.

<sup>28</sup>They include: postal services, ICT services, and scientific R&D.

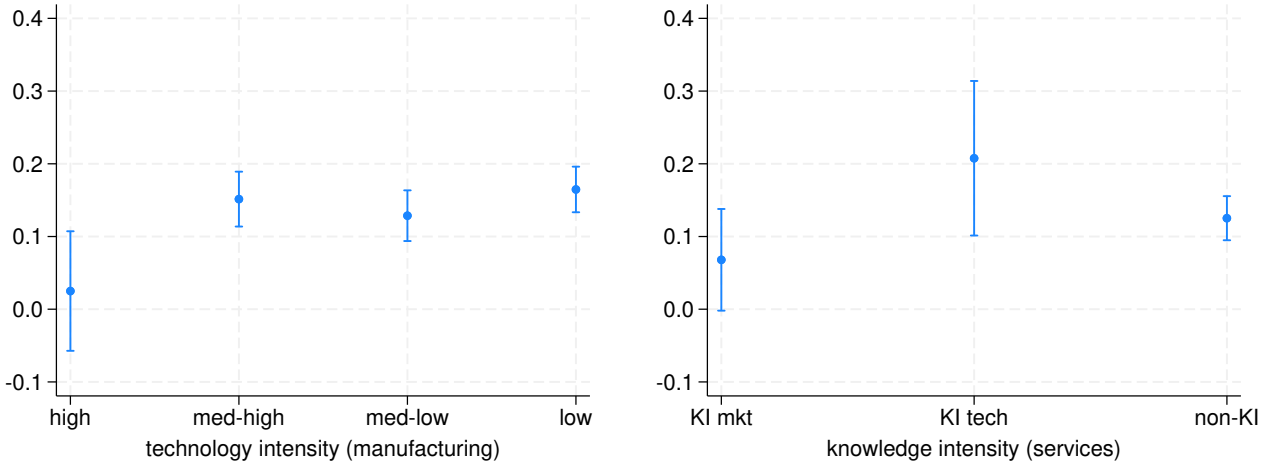


Figure 11: Firm hiring difficulties by knowledge or technology intensity. Source: Bank of Italy (Invind Survey) and Cerved Group. Share of firms with labour shortages among manufacturing firms with different technology intensity (panel a) and service firms with different values of knowledge intensity (panel b), according to the OECD classification. See footnote 27 for further details. Sample restricted as in Table 2. The figure further plots 95% confidence intervals.

companies (although differences are just marginally significant).

We conclude this section asking to what extent hiring difficulties hinder firms activity, in particular for what concerns their ability to deliver their goods and services in time (Table 3) and the turnover rates of their workforce (Table 4). We find that labour shortages are associated with a higher probability (by 4 percentage points) of delaying the provision of firms’ goods or services, pointing to the fundamental importance of the labour input in their production process, and with negative effects on both hiring and separation rates (computed as a fraction of total employment; -7 percentage points in each case). While the negative correlation with hiring rates provides some evidence that hiring difficulties lead firms to reduce recruitment, the negative correlation with separation rates suggests an important margin of adjustment within firms’ internal labour markets (Le Barbanchon et al., 2023), confirming the relevance of labour hoarding as a firm’s strategy in the face of hiring difficulties (Leduc and Oliveira, 2023).

All in all, the evidence collected in this Section suggests that firms’ difficulties in fulfilling their labour needs stem from a combination of demand- and supply-side factors, or similarly of firm-level and aggregate factors. In fact, on the one hand, firms experiencing a period of growth and especially those active in a growing sector, tend to present more wide-spread issues of labour shortages compared to the remaining companies. On the other hand, firms belonging to a group and more open to international markets, typically report fewer concerns on this issues compared to those more dependent on domestic demand of goods and local supply of labour. Remote work may help reduce labour shortage issues.

## 5. Employer response to shortage

Human capital is a crucial input for enhancing firms’ competitiveness and challenges in recruitment pose a critical issue for employers’ performance. Firms may adopt different strategies

to overcome skill scarcity, depending on the type of shortage encountered and other attributes of the firm. This section discusses some of the practices that firms are likely to take to deal with labour shortages, based on Istat Census data.

First, it's important to acknowledge that not all companies take action in response to hiring challenges. According to Istat data, in Italy in 2022 32.7% of companies opted for no specific practices, a decrease of 11 percentage points compared to 2018. This decision is more prevalent among traditional services and small-sized firms. For these businesses, the financial burden associated with implementing an action may be too substantial to afford. When examining firms' strategies to attract and retain skilled employees, the most common approach is salary increase, adopted by approximately one-third of firms in 2022 (Figure 12). Using data aggregated at the sectoral level, we observe a positive correlation between the share of firms that increase wages to address hiring problems and the degree of difficulty in finding workers with the required technical skills. Conversely, the relationship between the share of companies using no practices and the labour shortage indicator is negative (Figure 13).

Recent studies supports our findings that economic incentives are effective strategies. Groiss and Sondermann (2023) find that firms with higher shortages pay a wage growth premium to keep and attract workers, increasingly so if they face excess demand. Le Barbanchon et al. (2023) show that firms partially adjust to hiring difficulties by raising salaries of new hires, but only when tightness is due to higher competition for workers on the labour market. Similarly, de Zeeuw and Terry (2018) find that firms are more likely to increase wages in response to hiring difficulties when they are due to too few applicants or increased competition from other employers; when a shortage of labour arises from the lack of soft or job-specific skills, education, or experience, firms are more likely to reorganize current employee responsibilities, relax job requirements, or provide additional training. This evidence indicates the potential for alternative, non monetary, strategies.

According to Istat data, other common practices to deal with labour shortages include: enhancing the degree of autonomy of workers (mentioned by 20% of the firms), granting company benefits (15%) or giving on-the-job training opportunities (12%). The use of actions to overcome hiring difficulties is heterogeneous across sectors and varies by firm size (Table 1): in general, larger firms, industrial companies and knowledge intensive business services use a wider set of responses which include not only economic incentives but also non-wage compensation.

The literature examines the role of training when companies face difficulties in finding potentially suitable workers. In such cases, firms may adjust downward their hiring standards in terms of experience requirements (Le Barbanchon et al., 2023); to address diminished qualifications, they can provide training on the job, particularly in the form of firm-specific training, to enhance human capital. This can mitigate the risk of potential employee turnover by aligning acquired skills with the specific needs of the firm, thereby increasing the likelihood of employee retention (Barron et al., 1997; Zweimüller and Winter-Ebmer, 2003).

In response to labour shortages firms may also increase recruiting efforts. The use of the informal channels for recruitment purpose (e.g. personal knowledge, recommendations from people close to the company) is quite common in Italy: according to Istat data, in 2018, 27% of companies relied exclusively on this channel and around 50% of firms used this procedure in conjunction with other search channels (such as active search, collaboration with entities authorized to carry out intermediation activities, employment agencies). Personal connections as an entry channel are more relevant for low knowledge intensive services and for the construction sector. To enhance their ability to fill job vacancies, firms have the option to use different recruitment channels, including traditional media advertisements, optimizing their website, and engaging with social media platforms. Moreover, employers could expand the recruiting area, increasing the geographical scope

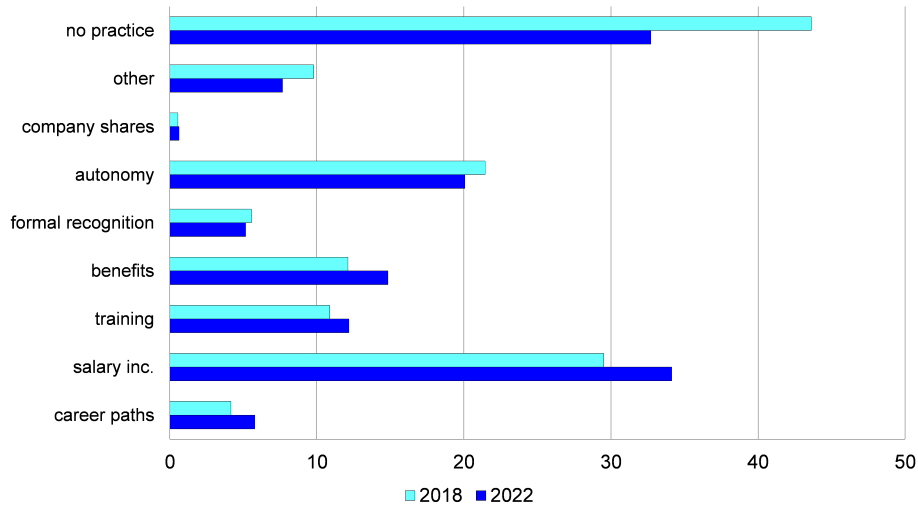


Figure 12: Firm strategies to attract and retain qualified personnel. Source: our calculations based on Companies Census data, Istat. Shares of firms with at least 10 employees using each strategy to attract or retain qualified personnel (including firms that do not report hiring difficulties). Firms can use more than one strategy. Note: career paths =definition of accelerated career paths; salary inc. = possibility of wage increase; training = incentives for self-training and professional growth activities, even external to the company; benefits = access to company benefits (company car, personal insurance, etc.); formal recognition = formal recognition of the work carried out and the results obtained (e.g. specific products or patents); autonomy = increasing degrees of autonomy at work in relation to specific skills or tasks; company shares = sale of company shares, partnerships, etc.

of their recruiting efforts, or leveraging networking to connect with potential candidates.

Other possible strategies mentioned by the literature are the following. Firms may deal with the problem of filling vacancies by relying on internal workers. For example, employers may increase the use of overtime, having current employees work more hours, leading to adverse effects on them. This action is more likely to be used when the problem is expected to be temporary. Leduc and Oliveira (2023) find evidence that firms deal with hiring difficulties by changing the number of hours for current workers in response to varying demand for goods and services in the wake of the pandemic. Moreover, it is sometimes possible to restructure the work to make use of workers in other occupations (Fang, 2009; Healy et al., 2015). Nevertheless, while it is often possible to reassign some tasks from lower-skilled to higher-skilled workers, the reverse transition is rarely feasible (Barnow, 2013).

The recent development of computer-based technologies and artificial intelligence permit machines and computers to perform more sophisticated tasks and to substitute workers under certain circumstances. However, technology can not only substitute for human labour but also can complement it, requiring more skilled workers (Acemoglu and Johnson, 2023).

## 6. Employment prospects of workers employed in a hard-to-fill job

In the following section we study the effects of labour shortages in terms of employees' working conditions. Unfortunately, available data do not contain information on wages, benefits, time schedules or participation to on-the-job training programmes. Therefore, we focus on other relevant aspects. In particular, we analyse whether workers employed in hard-to-fill jobs have higher employment opportunities, greater mobility and less discontinuous careers. We first present the data used and some preliminary statistics. Our empirical analysis draws upon two different sources:



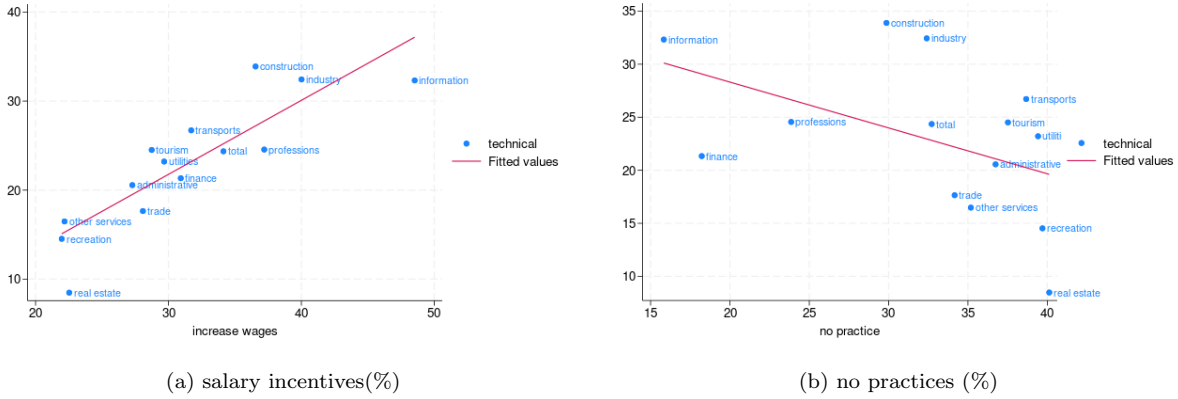


Figure 13: Firm strategies and difficulty to find personnel with the required technical skills. Source: our calculations based on Permanent Census of enterprises data, Istat. Year: 2022.

administrative micro-level data on work relationships that have undergone a labour contract event combined with Excelsior data on labour shortages.

### 6.1. Data

We exploit data from CICO (Campione Integrato delle Comunicazioni Obbligatorie, or Integrated Sample of Compulsory Notifications), a unique dataset that contains administrative records on job contracts for a large random sample of Italian employees. This administrative system collects mandatory notifications that employers submit to the Italian Ministry of Labour when they activate, terminate, or convert a contract. The Ministry releases a sample of micro-data on all individuals born in specific dates (namely, on the 1st, 9th, 10th and 11th of each month and year birth dates), so that we observe more than 13% of the population of employees. We follow the entire working history of these employees, including ins and outs of existing positions, until they definitively leave the labour market; by the same token, new cohorts are added through individuals born in the four relevant birth dates (Basso et al., 2023b). Data are available for the period between 2009 and 2022.

For each contract, data record the start and the end dates, the type of contract, the date of any conversion to an open-ended contract, the reason for contract ending. We have also information on the firm's characteristics (location, industry<sup>29</sup>) and on workers' characteristics (occupation, age, gender, nationality, education). The richness and the administrative nature of our data constitute relevant advantages with respect to other sources. We focus on permanent, fixed-term and apprentices contracts<sup>30</sup> in the non-agricultural private sector; we exclude the public sector workers, those in the agricultural sector, job on call and domestic workers. However, when we test the probability of job transitions, we keep all sectors as possible destination to capture workers' employment status properly.

We use two versions of the CICO dataset. For descriptive analysis we use a cross-sectional database in which each observation correspond to a different contract<sup>31</sup>; descriptive statistics are

<sup>29</sup>Industry is classified according to the Italian national statistical institute (ISTAT) ATECO 2007 codes (the Italian counterpart of NACE Rev.2).

<sup>30</sup>In the rest of the paper, we will refer to permanent or open-ended contracts, as well as to fixed-term or temporary contracts interchangeably.

<sup>31</sup>For workers holding multiple contracts in overlapping periods, we assume that the main contract is the one

reported in section 6.2. For the empirical analysis we rely on the panel structure of the database. We convert contract-level data into a longitudinal dataset in which we follow individuals over time, recording their employment status month by month (Sestito and Viviano, 2018; Basso et al., 2021, 2023b).<sup>32</sup> The unit of analysis is the individual observed at a monthly frequency and we track his/her monthly employment status, sector, type of contract, occupation, firm and region of work. In particular we consider an individual as employed in a given year-month if he/she worked at least a day in that period and as non-employed otherwise; we keep one observation per worker in each month, corresponding to the main job contract, defined as the one with the longest duration or the one that is still active in December 2022 (Basso et al., 2021, 2023b).

We combine the CICO data with Excelsior data on hard-to-fill jobs for the period 2017-2022.<sup>33</sup> We construct an index  $HF_{rost}$ , at the region ( $r$ ), occupation ( $o$ ), sector ( $s$ ) and year ( $t$ ) level, that ranges from zero (no firms report difficulties in filling a particular type of vacancy) to 100 (all vacancies are considered difficult to fill; see Section 2). The main descriptive statistics are presented in Appendix A1. We then define the dummy hard-to-fill occupations ( $dHF_{rost}$ ) equal to one if  $HF_{rost}$  is in the least quartile of the national distribution of the index across all the period considered; as shown in Table 5 these occupations are STEM specialists and technicians, engineers, specialist in life science, workers in the construction and in manufacturing of metal products.

## 6.2. Descriptive statistics

Before moving on to the empirical analysis, we check the main summary statistics of workers in hard-to-fill jobs compared to the others: the demographic characteristics of the two groups are different, with a higher proportion among hard-to-fill jobs of male, Italian, highly educated<sup>34</sup> and older workers (Figure 14). These differences could be due to a composition effect related to the characteristics of the hardest to fill jobs, which are often in sectors where, for example, women are less represented or in high-skilled occupations characterised by a shortage of supply.

Looking at the employment prospects of these workers, Figure 15 shows the probability of being employed 12 months after having a fixed-term contract: as expected, workers in hard-to-fill jobs are more likely to be employed with both a permanent and a temporary contract. Figure 16 reports the share of people who found a job after the separation: for workers who have lost their jobs (either through resignation or dismissal), the unconditional probability of re-employment is significantly higher if they were employed in a hard-to-fill occupation than for the others. This evidence may also suggest that these employees are more likely to move from one job to another, possibly experiencing better working conditions in their new positions.

## 6.3. Empirical strategy and results

In this section, we extend the analysis on all worker employment prospects looking at transitions across employment statuses, various contract types, and geographical regions. We adopt a more formal conditional estimation that controls for a number of observable characteristics of the workers, relying on the individual level panel dimension. We estimate the following linear model:

---

that has the longest total duration.

<sup>32</sup>We do not observe people who have never get an employment.

<sup>33</sup>We consider fixed-term, open-ended, apprenticeship and on-call contracts.

<sup>34</sup>We consider the workers' highest education level across contracts, because in some cases, education is present for one contract but not for another.

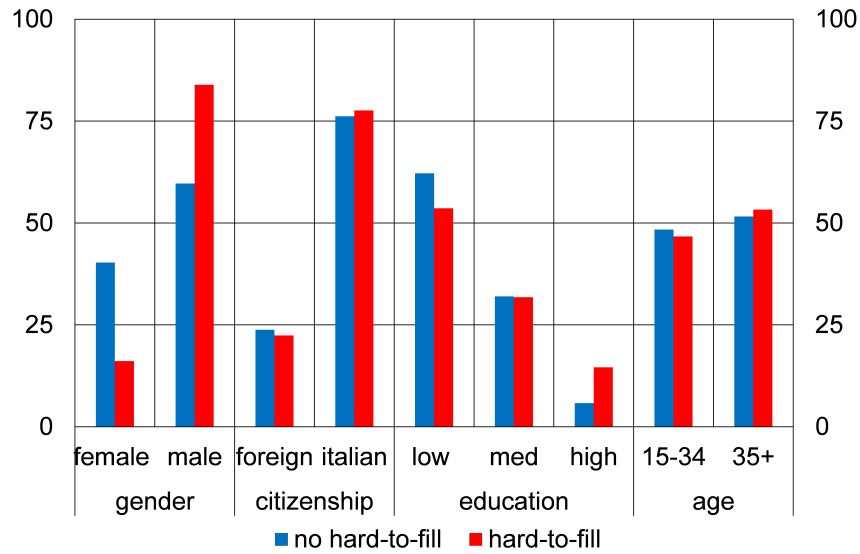


Figure 14: Workers’ characteristics by hard-to-fill occupations (%). Source: our calculations based on Excelsior and CICO data. The figure shows the workers’ characteristics in the hard-to-fill ( $dHF_{rost}=1$ ) and non hard-to-fill jobs ( $dHF_{rost}=0$ ). Histograms by each group of characteristics (gender, citizenship, education, age) sum to 100.

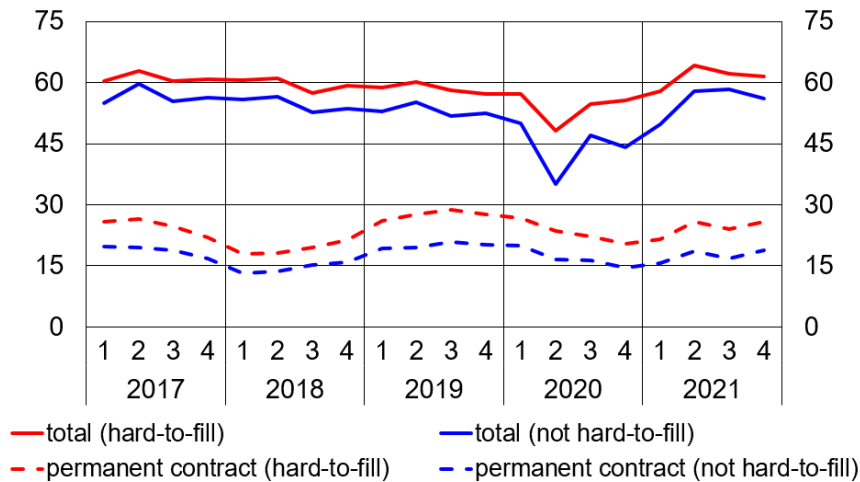


Figure 15: Probability of being employed 12 months after signing a fixed-term contract. Source: our calculations based on Excelsior and CICO data. Jobs are classified into “hard to fill” and “not hard to fill” categories on the basis of the distribution of the “hard to fill” indicator. In particular, all occupations for which the degree of labour shortage is above the 75th percentile of the indicator distribution are classified as “hard-to-fill”. The solid lines show the probability of being employed 12 months after starting a fixed-term contract. The dashed lines show the probability of being employed on a permanent contract 12 months after starting a fixed-term contract. Estimates excluding the effects of the socio-demographic characteristics of the worker and the economic activity of the enterprise. Moving averages.

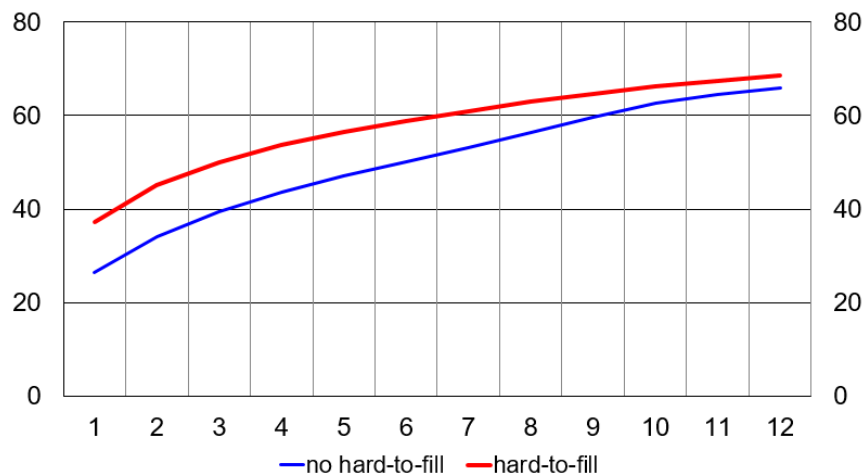


Figure 16: Share of people who found a job after a termination. Source: our calculations based on Excelsior and CICO data. Individuals whose employment contract ended on average in the period 2017-2020 are included; retirements and terminations due to death of the employee are excluded.

$$y_{i,t+k} = \alpha + \beta_1 dHF_{ros,t} + \gamma_1 X_{i,t+k} + \gamma_2 Z_i + \phi_{t+k} + \epsilon_{i,t+k} \quad (1)$$

where workers are indexed by  $i$ , regions by  $r$ , occupations by  $o$  and sectors by  $s$ ,  $k = 3, 6, 12$  months and  $y_{i,t+k}$  is either:

1. a dummy equal to 1 if worker  $i$  is employed in month  $t + k$  (Table 6);
2. a dummy equal to 1 if a person, who is employed as a temporary worker at time  $t$ , holds a permanent contract at  $t + k$  (Table 7, column 1);
3. a dummy equal to 1 if a person, who is employed at time  $t$ , holds a contract in a different region or occupation at  $t + k$  (Table 7, columns 2–3).

The coefficients of interest is  $\beta_1$  that captures the effect of being employed in hard-to-fill jobs ( $dHF_{ros,t}$ ). We control for individual time variant characteristics ( $X_{i,t+k}$ , age and age squared, education, sector, occupation, type of contract) and time invariant characteristics ( $Z_i$ , gender, citizenship). We estimate equation (1) including time fixed-effects ( $\phi_{t+k}$ , year-month). Standard errors are clustered at the individual level.

We start by investigating whether workers with hard-to-fill jobs are more likely to remain employed with respect to the others. To this end, we follow these workers to observe their employment status 3, 6 and 12 months ahead. Results reported in Table 6 show that over this 12-month period the employment probability is higher for these workers: they are between 0.7 and 1.18 percentage points more likely to be employed in the term, semester and year ahead, from an average employment probability of, respectively, 95%, 92%, and 90%. The coefficient estimates are all highly statistically significant. These results are in line with expectations and suggest that workers in occupations with higher labour shortages may have an employment advantage.

We then look at employment transitions. We take into account outcomes with a 12-month lag, but our findings remain robust when considering 3- or 6-month lags as well. In each specification, we control for individual time-varying and invariant characteristics, including time-fixed effects with clustering at the individual level. Firstly, we are interested in understanding the effects of labour shortage on workers' stabilization (Table 7, column 1); we consider all flows, within the

same firm (i.e. conversion) and between firms. Results indicate that the probability of being employed with an open-ended contract is 1.35 percentage points higher for workers in hard-to-fill jobs, compared to an average probability of 40%. This observation suggests that firms facing recruitment difficulties may opt for more stable contracts to retain employees.

Second, we look at employees' regional mobility (Table 7, column 2). Results show that working in hard-to-fill jobs increases the likelihood of moving to another region by 0.26 percentage points (from an average probability of 1.5%). Finally, we consider employees changing occupation (Table 7, column 3). We find evidence that being employed in a hard-to-fill job reduces the probability of changing occupation by 0.48 percentage points (from an average of 3.7%). The analysis suggests that positions characterized by a scarcity of labour provide an employment advantage concerning employee retention or contract stability, which employees unwilling to forgo.

## 7. Conclusion

Many countries have faced labour shortages since the early stages of the post-pandemic recovery, in a context of broader supply bottlenecks that have been challenging the capacity of firms to meet demand needs on a global scale (Causa et al., 2022). In recent years Italy has experienced a sharp rise in unfilled job vacancies and hiring difficulties, documented by several indicators. According to Istat, in the third quarter of 2023 the vacancy rate was 2.2% (1.4% in 2019); according to Excelsior, in 2022 about 40% of firms seeking to hire workers said that hiring was very difficult (25.6% in 2019); this reached as high as 53% for firms within the construction sector.

This paper provides an overview of the causes and, more importantly, of the implications of labour shortages for firms and employees. The analysis extends to the strategies adopted by employers to deal with these shortages, as well as the perspective of the workers affected by these dynamics. Labour shortages can arise from a number of sources on both the demand and the supply side. With regard to the former, an expansionary phase of the business cycle, and thus an increase in labour demand, can lead to temporary recruitment difficulties. With regard to the latter, labour shortages can be attributed to a lack of potential workers, mainly due to a shrinking and ageing population. Finally, recruitment difficulties may be due to a change in the preferences of workers, who are less willing to perform certain jobs. The importance of different structural drivers varies significantly by occupation and sector. On one side, in fields such as STEM or healthcare, a limited supply of skilled workers may pose a challenge; on the other side, in occupations characterised by more manual skills and lower educational requirements, poor working conditions and difficulties in attracting and retaining workers play a significant role. There is also variability in recruitment challenges based on the characteristics of firms. In our survey data indicates that labour shortages are higher among firms that do not export (or do so to a limited extent) and do not belong to a group, those with higher labour intensity, as well as companies operating in growing sectors. Remote work seems to reduce the incidence of this issue among firms. Looking at the negative effects on business activity, our analysis shows that recruitment difficulties have reduced firms' ability to deliver goods and services on time and affected the turnover rates of their labour force.

Firms that face higher hiring difficulties are likely to take several actions to deal with labour imbalances. According to Italian census data, these strategies include mainly economic incentives, but also non-wage forms of compensation, such as increasing the degree of autonomy of workers, providing company benefits and offering on-the-job training opportunities. Moreover, firms might increase recruiting efforts to fill vacancies. The strategies that companies are using to deal with labour scarcity can also have an impact on workers: labour hoarding actually leads to the worker being offered a job on better terms and conditions, in particular in terms of the stability and

duration of the employment relationship. This paper further contributes to the literature by examining the extent to which labour shortages influence employment prospects of workers employed in an hard-to-fill job, following the entire working history of these employees. We use detailed administrative data on job contracts combined with data on labour shortages at the regional, sector, occupation and year level to compare the outcomes of workers with different degree of labour shortages. Our results indicate that there is a statistically significant positive relationship between being employed in an hard-to-fill job and the worker's employment perspectives, in terms of contract stabilization and regional mobility. The empirical analysis confirms that working in an occupation characterised by higher labour shortage can translate into an employment advantage for the employees to the extent that firms experiencing recruitment difficulties are more likely to retain workers by offering more stable contracts. It is worth noting that our data are subject to some limitations. In particular, we do not have reliable information on wages (Basso et al., 2023b), which is a possible key action that firms may use to deal with hiring difficulties. Further research on this important aspects is warranted.

Yet, the evidence we provide is of crucial relevance for policymakers, providing a quantitative and qualitative characterization of labour shortages and an assessment of potential challenges to address it. Analysing the heterogeneity in labour scarcity can be useful to develop the appropriate policy responses and to identify the proper management of the missing human resources, in order to facilitate an efficient matching with the labour supply that is already available and with the one that could be created in the following years.

In a context where the green, digital and demographic transitions are placing growing pressure on the labour market to reallocate labour between different tasks, jobs and economic activities (Kiss et al., 2022), targeted policies are essential to address emerging challenges. This may involve protecting workers most affected by labour market disruptions and facilitating their reallocation toward other jobs (Bank of Italy, 2024).

The evolving job requirements and increasing demand for higher-skilled occupations necessitate a greater emphasis on retraining and upskilling workers, as well as improved alignment between labor market, training programs, and schools. More generally, education systems should integrate general and vocational education in a more efficient and balanced way (Signorini, L. F., 2018): the former may improve the adaptable, problem-solving abilities required in the labor market to operate with new technologies, the latter has the advantage of focusing on specific skills and raising employability in established technologies (Krueger and Kumar, 2004).

Furthermore, efforts to increase labor force participation of underrepresented groups and older workers could partly offset the effects of population decline. Support for employment may also come from migration flows (European Commission, 2023; Eurofound, 2023); managing this flow will require balancing the needs of the production system with social equilibria, and enhancing integration measures for foreign citizens (Bank of Italy, 2024).

## References

- ACCETTURO, A., G. ALBANESE, R. TORRINI, D. DEPALO, S. GIACOMELLI, G. MESSINA, F. SCOCCIANI, AND V. P. VACCA (2022): “Il divario Nord Sud: sviluppo economico e intervento pubblico,” Workshops and Conferences 25, Bank of Italy, Economic Research and International Relations Area.
- ACEMOGLU, D. (2010): “When Does Labor Scarcity Encourage Innovation?” *Journal of Political Economy*, 118, 1037–1078.
- ACEMOGLU, D. AND S. JOHNSON (2023): *Power and Progress: Our Thousand-Year Struggle Over Technology and Prosperity*, Hachette UK.
- ARROW, K. J. AND W. M. CAPRON (1959): “Dynamic Shortages and Price Rises: The Engineer-Scientist Case,” *The Quarterly Journal of Economics*, 73, 292–308.
- BANK OF ITALY (2023a): “Annual Report for 2022,” Annual report, Bank of Italy.
- (2023b): “The Governor’s Concluding Remarks,” Annual report, Bank of Italy.
- (2024): “The Governor’s Concluding Remarks,” Annual report, Bank of Italy.
- BARNOW, B. S. (2013): *Occupational labor shortages: Concepts, causes, consequences, and cures*, WE Upjohn Institute.
- BARRON, J. M., M. C. BERGER, AND D. A. BLACK (1997): *On-the-Job Training*, no. ojt in Books from Upjohn Press, W.E. Upjohn Institute for Employment Research.
- BASSO, G., F. COLONNA, D. DEPALO, AND G. MENDICINO (2023a): “The Green Transition and the Italian labour market,” *Questioni di Economia e Finanza (Economic working papers)* 881, Bank of Italy, Economic Research and International Relations Area.
- BASSO, G., D. DEPALO, AND S. LATTANZIO (2023b): “Worker flows and reallocation during the recovery,” *Labour Economics*, 83.
- BASSO, G., A. GROMPONE, AND F. MODENA (2021): “The (little) reallocation potential of workers most hit by the COVID-19 crisis,” *Politica economica*, 151–186.
- BERNARD, A. B., J. B. JENSEN, S. J. REDDING, AND P. K. SCHOTT (2007): “Firms in International Trade,” *Journal of Economic Perspectives*, 21, 105–130.
- BLANCHARD, O., A. DOMASH, AND L. H. SUMMERS (2022): “Bad news for the fed from the Beveridge space,” *Peterson Institute for International Economics Policy Brief*, 22–7.
- CARIOLI, P. AND D. CZARNITZKI (2023): “Skills shortage and innovation openness,” ZEW Discussion Papers 23-031, ZEW - Leibniz Centre for European Economic Research.
- CAUSA, O., M. ABENDSCHEIN, N. LUU, E. SOLDANI, AND C. SORIOLO (2022): “The post-COVID-19 rise in labour shortages,” OECD Economics Department Working Papers 1721, OECD Publishing.

- CIANI, E., F. DAVID, AND G. DE BLASIO (2017): “Local labour market heterogeneity in Italy: estimates and simulations using responses to labour demand shocks,” *Tem di discussione (Economic working papers)* 1112, Bank of Italy, Economic Research and International Relations Area.
- COAD, A., G. PELLEGRINO, AND M. SAVONA (2016): “Barriers to innovation and firm productivity,” *Economics of Innovation and New Technology*, 25, 321–334.
- CONNELL, J. (1993): *Kitanai, kitsui and kiken: The rise of labour migration to Japan*, Economic & Regional Restructuring Research Unit, University of Sydney.
- DE ZEEUW, M. AND E. TERRY (2018): “How Do Firms Respond to Hiring Difficulties? Evidence from the Federal Reserve Banks’ Small Business Credit Survey,” FRB Atlanta Community and Economic Development Discussion Paper 2018-1, Federal Reserve Bank of Atlanta.
- DUVAL, R., Y. JI, L. LI, M. OIKONOMOU, C. PIZZINELLI, I. SHIBATA, A. SOZZI, AND M. M. TAVARES (2022): *Labor market tightness in advanced economies*, International Monetary Fund.
- EUROFOUND (2023): “Measures to tackle labour shortages: Lessons for future policy,” *Publications Office of the European Union*.
- EUROPEAN CENTRAL BANK (2019): “Economic bulletin issue 4-2019,” Periodical report 4, European Central Bank.
- EUROPEAN COMMISSION (2023): “Employment and Social Developments in Europe. Addressing labour shortages and skills gaps in the EU,” *European economy - discussion papers*, Directorate-General for Employment, Social Affairs and Inclusion, European Commission.
- FANG, T. (2009): “Workplace responses to vacancies and skill shortages in Canada,” *International Journal of Manpower*, 30, 326–348.
- FROHM, E. (2021): “Labour shortages and wage growth,” Working Paper Series 2576, European Central Bank.
- GROSS, M. AND D. SONDERMANN (2023): “Help wanted: the drivers and implications of labour shortages,” Working Paper Series 2863, European Central Bank.
- HEALY, J., K. MAVROMARAS, AND P. J. SLOANE (2015): “Adjusting to skill shortages in Australian SMEs,” *Applied Economics*, 47, 2470–2487.
- HORBACH, J. AND C. RAMMER (2022): “Skills shortage and innovation,” *Industry and Innovation*, 29, 734–759.
- KISS, A., M. C. MORANDINI, A. TURRINI, AND A. VANDEPLAS (2022): “Slack and Tightness: Making Sense of Post COVID-19 Labour Market Developments in the EU,” *European Economy - Discussion Papers* 178, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.
- KRUEGER, D. AND K. B. KUMAR (2004): “Skill-Specific rather than General Education: A Reason for US–Europe Growth Differences?” *Journal of Economic Growth*, 9, 167–207.



- LE BARBANCHON, T., M. RONCHI, AND J. SAUVAGNAT (2023): “Hiring Difficulties and Firm Growth,” CEPR Discussion Papers 17891, C.E.P.R. Discussion Papers.
- LEDUC, S. AND L. E. OLIVEIRA (2023): “From Hiring Difficulties to Labor Hoarding?” *FRBSF Economic Letter*, 2023, 1–6.
- MCGUINNESS, S., K. POULIAKAS, AND P. REDMOND (2017): “How Useful Is the Concept of Skills Mismatch?” IZA Discussion Papers 10786, Institute of Labor Economics (IZA).
- MELITZ, M. J. (2003): “The impact of trade on intra-industry reallocations and aggregate industry productivity,” *econometrica*, 71, 1695–1725.
- MICHAILLAT, P. AND E. SAEZ (2022): “ $u^* = \sqrt{uv}$ ,” Tech. rep., National Bureau of Economic Research.
- REYEMEN, D., M. GERARD, P. DE BEER, A. MEIERKORD, M. PASKOV, V. DI STASIO, V. DONLEVY, I. ATKINSON, A. MAKULEC, U. FAMIRA-MÜHLBERGER, ET AL. (2015): “Labour market shortages in the European Union,” *WIFO Studies*.
- SESTITO, P. AND E. VIVIANO (2018): “Firing costs and firm hiring: evidence from an Italian reform,” *Economic Policy*, 33, 101–130.
- SIGNORINI, L. F. (2018): “Labour market participation: Forces at work and policy challenges,” Cepr conference: Labour market participation: Forces at work and policy challenges, Bank of Italy.
- STEVENS, P. A. (2007): “Skill shortages and firms’ employment behaviour,” *Labour Economics*, 14, 231–249.
- TOIVANEN, O. AND L. VÄÄNÄNEN (2016): “Education and Invention,” *The Review of Economics and Statistics*, 98, 382–396.
- ZWEIMÜLLER, J. AND R. WINTER-EBMER (2003): “On-the-job-training, job search and job mobility,” *Swiss Journal of Economics and Statistics (SJES)*, 139, 563–576.

## Tables

Table 1: Strategies to attract and retain qualified personnel by sector and firm-size

	<b>Strategies</b>								
	Career paths	Salary inc.	Training	Benefits	Formal recognition	Autonomy	Company shares	Other	No practice
<b>Sector</b>									
Total	5.8	34.1	12.2	14.8	5.2	20.1	0.6	7.7	32.7
Industry	4.9	40.0	10.3	15.5	4.6	21.1	0.4	6.8	32.4
Utilities	5.4	29.7	11.2	18.5	5.1	17.4	0.2	9.1	39.4
Construction	5.9	36.6	12.7	15.2	5.0	21.5	0.6	7.6	29.9
Trade	5.5	28.1	12.4	15.1	4.8	19.6	0.4	7.4	34.2
Transports	4.3	31.7	9.3	13.1	5.3	14.1	0.3	8.0	38.7
Tourism	5.8	28.7	10.5	5.4	5.4	16.0	0.4	7.9	37.5
Information	15.5	48.5	25.6	30.5	7.3	28.1	3.4	9.3	15.8
Finance	12.9	30.9	18.2	29.9	11.5	25.0	1.0	13.5	18.2
Real estate	5.1	22.5	8.8	17.0	4.6	18.7	1.1	6.2	40.1
Professions	9.0	37.2	18.0	23.8	7.0	27.8	2.4	7.7	23.9
Administrative	4.4	27.3	11.5	13.5	4.9	18.9	0.6	8.2	36.7
Recreation	4.5	22.0	10.1	9.4	4.8	16.2	0.5	8.0	39.7
Other services	5.3	22.2	15.3	8.9	4.5	16.2	0.6	10.0	35.2
<b>Firm size</b>									
10-19	4.4	30.2	10.7	11.0	4.5	18.6	0.6	6.9	35.0
20-49	6.3	38.5	13.0	17.8	5.6	21.5	0.6	8.0	31.4
50-99	9.3	44.2	15.4	24.0	6.7	23.1	0.7	9.6	26.4
100-249	12.6	45.5	19.3	30.7	8.2	25.8	0.8	11.2	22.2
250-499	17.9	49.2	21.5	37.8	8.7	28.3	1.0	12.9	17.7
Over 500	26.9	48.6	26.8	43.8	13.1	32.2	1.9	16.1	14.7

Source: Source: our calculations based on Companies Census data, Istat. Year: 2022.

Table 2: Heterogeneity in firm hiring difficulties.

	(1)	(2)	(3)	(4)	(5)
Export share: 1st fourth	0.047** (0.02)	0.012 (0.02)	0.001 (0.02)	0.003 (0.02)	-0.004 (0.02)
Export share: 2nd fourth	-0.018 (0.02)	-0.050** (0.03)	-0.049** (0.03)	-0.047* (0.03)	-0.036 (0.03)
Export share: 3rd fourth	-0.047* (0.03)	-0.078*** (0.03)	-0.075*** (0.03)	-0.078*** (0.03)	-0.094*** (0.03)
Export share: 4th fourth	-0.086*** (0.03)	-0.126*** (0.03)	-0.124*** (0.03)	-0.131*** (0.03)	-0.148*** (0.03)
Firm belongs to a group	-0.027 (0.02)	-0.042** (0.02)	-0.038** (0.02)	-0.037** (0.02)	0.006 (0.02)
Firm size: 50-99	0.027 (0.02)	0.024 (0.02)	0.019 (0.02)	0.012 (0.02)	0.036* (0.02)
Firm size: 100-199	-0.002 (0.03)	-0.000 (0.03)	-0.003 (0.03)	-0.008 (0.03)	-0.003 (0.03)
Firm size: 200+	0.022 (0.03)	0.009 (0.03)	0.009 (0.03)	0.001 (0.03)	0.003 (0.03)
NUTS1: North East		-0.006 (0.02)	-0.003 (0.02)	-0.003 (0.02)	0.021 (0.02)
NUTS1: Centre		-0.064*** (0.02)	-0.060*** (0.02)	-0.061*** (0.02)	-0.039* (0.02)
NUTS1: Mezzogiorno		-0.132*** (0.02)	-0.130*** (0.02)	-0.134*** (0.02)	-0.107*** (0.02)
Revenue growth: -25% to -3%		-0.023 (0.02)	-0.023 (0.02)	-0.024 (0.02)	-0.032 (0.02)
Revenue growth: -3% to +3%		-0.035 (0.03)	-0.025 (0.03)	-0.026 (0.03)	-0.064** (0.03)
Revenue growth: 3% to 25%		-0.002 (0.03)	0.005 (0.03)	0.004 (0.03)	-0.015 (0.03)
Revenue growth: 25%+		0.043 (0.03)	0.047* (0.03)	0.043 (0.03)	-0.008 (0.03)
Labour intensity: 2nd fourth			0.047** (0.02)	0.052** (0.02)	0.084*** (0.02)
Labour intensity: 3rd fourth			0.097*** (0.02)	0.100*** (0.02)	0.146*** (0.02)
Labour intensity: 4th fourth			-0.008 (0.03)	-0.002 (0.03)	0.010 (0.03)
Expanding sectors				0.058*** (0.02)	0.059*** (0.02)
Use smart-working					-0.051** (0.02)
Observations	1,956	1,956	1,956	1,956	1,646
Adjusted R2	0.018	0.038	0.047	0.051	0.058

Source: Bank of Italy (Invind Survey), Cerved Group and INPS.

Notes: The dependent variable is *labour shortage*, a dummy equal to 1 if a firm reports a significant labour shortage in the period between September 2022 and the survey date, and to 0 otherwise. All models include age, and sector dummies, along with a constant term. Sector dummies are defined in footnote 25. Firm-size: the omitted category refers to 20-49. Export share: the omitted category refers to non-exporting firms. Revenue growth: thresholds set to be symmetric around nil and to allow for a comparable number of firms in each group. Expanding sectors are defined in footnote 24. *Use smart-working* is a binary variable=1 if the share of workers working from home in 2022 is at least 5 per cent (median value). Sample restricted to firms with all information needed to estimate model 4. \* p<0.10 \*\* p<0.05 \*\*\* p<0.01

Table 3: Estimated effect of labour shortages on the probability to delay the provision of goods or services.

	(1)	(2)	(3)	(4)
labour shortage	0.048*** (0.02)	0.047*** (0.02)	0.042** (0.02)	0.040** (0.02)
size dummies	NO	YES	YES	YES
sector dummies	NO	NO	YES	YES
business entities dummies	NO	NO	YES	YES
age groups	NO	NO	NO	YES
group belong. dummy	NO	NO	NO	YES
constant	YES	YES	YES	YES
Observations	1,850	1,850	1,850	1,850
Adjusted R2	0.003	0.003	0.033	0.037

Source: Cerved, Inps, Invind. Labour shortage is a dummy equal to 1 if a firm reports a significant labour shortage in the period between September 2022 and the survey date (Spring 2023). Sample restricted as in Table 2. \*  $p < 0.10$  \*\*  $p < 0.05$  \*\*\*  $p < 0.01$

Table 4: Estimated effect of labour shortages on workforce turnover.

	(1) Hiring rate	(2) Separation rate
labour shortage	-0.072** (0.03)	-0.071** (0.03)
size dummies	YES	YES
sector dummies	YES	YES
business entities dummies	YES	YES
age groups	YES	YES
group belong. dummy	YES	YES
constant	YES	YES
Observations	1,956	1,956
Adjusted R2	0.222	0.166

Source: Cerved, Inps, Invind. Labour shortage is a dummy equal to 1 if a firm reports a significant labour shortage in the period between September 2022 and the survey date (Spring 2023). Sample restricted as in Table 2. \*  $p < 0.10$  \*\*  $p < 0.05$  \*\*\*  $p < 0.01$

Table 5: Most and less hard-to-fill jobs in Italy

Occupations	Share of hard-to-fill jobs	
	2019	2022
<b>Most hard-to-fill jobs</b>		
21 - STEM specialist	59	61
22 - Engineers	47	59
23 - Specialist in life science	37	66
31 - Technicians in STEM	45	55
61 - Construction and mining workers	27	53
62 - Metalworkers	46	63
63 - Other craftsmen	39	53
65 - Other workers	36	48
<b>Less hard-to-fill jobs</b>		
41 - Secretarial clerks	15	24
42 - Other clerks	22	24
44 - Clerical staff for documentation management	19	19
51 - Skilled professions in trade	16	28
81 - Unskilled professions in trade	11	25
84 - Unskilled professions in manufacturing and construction	12	27

Source: our calculations based on Excelsior data. The occupations reported, according to the two-digit CP 2011 classification, correspond to those in the last (most difficult) and first (least difficult) quartile of our aggregate national indicator distribution for 2022. For comparison, the share of hard-to-fill jobs in 2019 is also reported.

Table 6: Employment transitions

	Dep. var: employed at t+k months ahead		
	3	6	12
	(1)	(2)	(3)
$dHF_{ros,t}$	0.0068*** (0.0001)	0.0096*** (0.0002)	0.0118*** (0.0003)
$N$	77,866,203	73,445,241	64,797,612
adj. $R^2$	0.027	0.032	0.022
Worker ctrl	Yes	Yes	Yes
Firm ctrl	Yes	Yes	Yes
Worker-firm ctrl	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Sample Cluster	Employed at $t$ Individual level		
Dep.var.mean	0.9472	0.9198	0.8968

Note: estimates of model (1). Table reports individual-month-level regressions for the period 2017-2021. The dependent variable is the dummy equal to one if the individual is employed, 0 if he/she is not employed. Standard errors in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table 7: Employment transitions - other outcomes

Dep. var.	employed permanent contract (1)	change region (2)	change occupation (3)
$dHF_{ros,t}$	0.0135*** (0.0015)	0.0026*** (0.0002)	-0.0048*** (0.0002)
$N$	32,456,973	58,109,890	58,109,890
adj. $R^2$	0.100	0.007	0.007
Worker ctrl	Yes	Yes	Yes
Firm ctrl	Yes	Yes	Yes
Worker-firm ctrl	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Sample	Employed at $t$ and at 12 months ahead		
Contract at $t$	with a TC	all	all
Cluster	Individual level		
Dep.var.mean	0.4331	0.0152	0.0375

Note: estimates of model (1). The table reports individual-month-level regressions for the period 2017-2021. The dependent variable is a dummy equal to one if the individual is employed with a permanent contract (column 1), changed region (column 2) or changed occupation (column 3). Standard errors in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## Appendix - Database descriptions

### *Excelsior data - The main descriptive statistics on Excelsior data*

Table A1 shows the main evidence of labour shortages based on an index of hard to fill jobs calculated from Excelsior data. In recent years, labour market challenges have intensified, rising to 40% in 2022, compared to the previous rate of nearly 26% in 2019. Labour shortage is structurally higher in Northern Italy, although the ranking between regions has changed slightly over the period considered (see Table A3). The index is also higher for the most skilled professions and in industrial sectors (manufacturing and construction). However, the most significant increases between 2019 and 2022 concern the South and the Islands, medium-skilled jobs and, in terms of sectors, mainly construction and, secondarily, tourism.

Table A1: Share of hard-to-fill jobs

Labour shortage		2017	2018	2019	2020	2021	2022
Total	Italy	21,6	25,3	25,6	28,9	31,8	40,3
Macroarea	North East	25,0	30,8	31,5	35,8	38,4	46,0
	North West	23,6	27,6	27,8	30,3	34,3	41,8
	Centre	20,7	23,4	23,5	26,3	29,1	37,7
	South and islands	16,8	19,0	19,3	23,3	25,8	36,1
Qualification	high	34,4	36,6	37,4	39,5	41,0	49,6
	medium	25,1	29,6	29,1	33,5	37,1	45,7
	low	15,3	18,2	18,9	21,2	24,5	33,1
Macrosector	manufacturing	30,6	35,0	35,3	37,4	40,8	46,8
	construction	21,9	26,8	27,5	32,7	39,5	52,9
	trade	17,6	21,1	20,4	23,8	25,7	33,2
	tourism	17,7	23,3	24,5	27,6	30,0	40,8
	other services	20,9	22,4	22,9	26,2	28,4	35,5

Source: our calculations based on Excelsior data. We only consider data on typical employment contracts, excluding data on atypical contracts. Low occupations include service workers, shop or market sales workers, elementary occupations; medium occupations include clerks, craft and related trades workers, plant and machine operators; high ones include managers, professionals, technicians and associate professionals (OECD Employment Outlook, 2017).

Table A2: Share of hard-to-fill jobs by occupations

<b>Occupations</b>	<b>2019</b>	<b>2022</b>
21 - Specialists in mathematical, computer, physical and natural sciences	59	61
22 - Engineers, architects and related professions	47	59
23 - Specialists in life sciences	37	66
24 - Healthcare specialists	35	67
25 - Specialists in humanities, social sciences, arts and management	29	34
26 - Education and research specialists	27	39
31 - Technical professions in science, engineering and manufacturing	45	55
32 - Technical professions in the health and life sciences	28	59
33 - Technical professions in administrative, financial and commercial activities	33	42
34 - Technical professions in public and personal services	26	30
41 - Secretarial and office machine clerks	15	24
42 - Money movement and customer service clerks	22	24
43 - Administrative, accounting and financial management clerks	21	33
44 - Clerical staff for documentation management	19	19
51 - Skilled professions in commercial activities	16	28
52 - Qualified professions in the hospitality industry	25	42
53 - Qualified professions in health and social services	28	45
54 - Qualified professions in security, cleaning and personal services	29	36
61 - Construction and mining workers	27	53
62 - Metalworkers	46	63
63 - Other craftsmen	39	53
64 - Farmers and specialised workers in agriculture	12	41
65 - Food, wood, textile, leather, entertainment craftsmen and workers	36	48
71 - Industrial plant operators	25	35
72 - Machine operators	30	46
73 - Machine operators in agriculture and the food industry	7	29
74 - Drivers of vehicles, mobile and lifting machinery	28	46
81 - Unskilled occupations in trade and services	11	25
82 - Unskilled professions in domestic, recreational and cultural activities	9	10
83 - Unskilled professions in agriculture, forestry and fishing	13	30
84 - Unskilled professions in manufacturing, mining and construction	12	27

Source: our calculations based on Excelsior data. We only consider data on typical employment contracts, excluding data on atypical contract. Occupations are classified according to the ISTAT's CP2011 coding system at 2-digit.



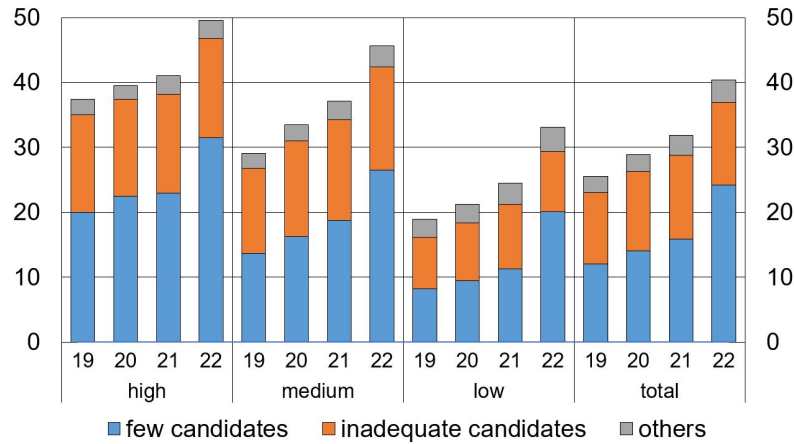
Table A3: Share of hard-to-fill jobs by region

<b>Region</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
Abruzzo	22	25	27	29	31	41
Basilicata	16	18	18	24	29	38
Bolzano	30	37	40	43	45	53
Calabria	16	18	17	22	24	38
Campania	15	18	19	24	25	35
Emilia Romagna	24	29	29	33	36	44
Friuli Venezia Giulia	26	32	35	39	42	47
Lazio	20	19	19	22	25	33
Liguria	22	24	23	27	34	42
Lombardia	24	28	28	30	34	41
Marche	21	25	27	29	32	42
Molise	16	19	20	22	26	37
Piemonte	24	29	29	32	36	44
Puglia	19	19	19	22	24	34
Sardegna	18	20	20	24	28	38
Sicilia	15	18	17	22	26	36
Toscana	22	28	28	30	33	41
Trento	24	24	25	35	37	47
Umbria	22	29	31	34	39	47
Valle d'Aosta	16	21	27	25	30	45
Veneto	25	32	32	36	39	46

Source: our calculations based on Excelsior data. We only consider data on typical employment contracts, excluding data on atypical contracts.

As shown in Figure A1, the recent increase in hiring difficulties seems to be associated with a limited pool of candidates responding to job advertisements. Meanwhile, the share of challenges attributed to candidate unsuitability, about two-fifths of the total, appears to remain relatively constant over time.

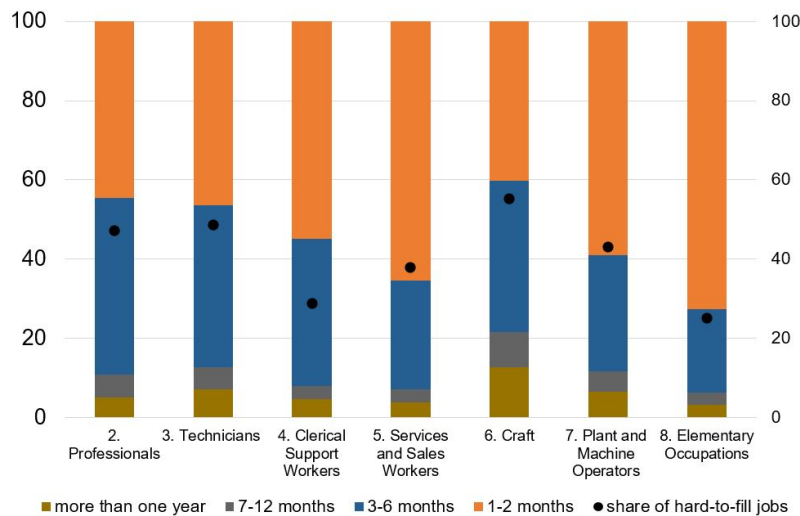
Figure A1: Labour shortage composition<sup>35</sup>



Source: our calculations based on Excelsior data. We only consider data on typical employment contracts, excluding data on atypical contracts. Low occupations include service workers, shop or market sales workers, elementary occupations; medium occupations include clerks, craft and related trades workers, plant and machine operators; high ones include managers, professionals, technicians and associate professionals (OECD Employment Outlook, 2017).

From 2022, the Excelsior survey will also include a question on the number of months it is expected to take for employers to find the workers they need. As can be seen from the figure A2, the share of hard-to-fill workers is essentially equivalent to vacancies that will take at least 3 months to fill. The share of vacancies requiring more than a year to be filled are significantly lower and is relatively larger for specialised occupations in industry and for those with higher qualifications.

Figure A2: Timeframe for finding positions in 2022



Source: our calculations based on Excelsior data. We only consider data on typical employment contracts. Occupations are classified according to the CP-2011 classification at the 1-digit level.

*Other descriptive statistics*

Table A4: The most dangerous jobs in Italy

<b>Occupations</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
53 - Qualified professions in health and social services	3.3	12.4	4.9	7.8
32 - Technical professions in the health and life sciences	2.1	8.7	3.5	7.1
84 - Unskilled professions in manufacturing, mining and construction	6.7	5.0	6.9	6.8
24 - Healthcare specialists	0.7	5.3	1.8	5.5
44 - Clerical staff for documentation management	3.5	2.6	3.1	3.9
81 - Unskilled professions in trade and services	3.6	3.3	3.3	3.6
64 - Farmers and specialised workers in agriculture	4.3	3.4	3.4	3.3
74 - Drivers of vehicles, mobile and lifting machinery	3.3	2.8	3.1	3.2
62 - Metalworkers	3.2	2.5	2.8	3.0
61 - Construction and mining workers	2.7	2.2	2.4	2.5
83 - Unskilled occupations in agriculture, forestry and fishing	2.6	2.1	2.2	2.4
72 - Machine operators	2.3	1.7	2.1	2.2
63 - Other craftsmen	2.7	2.1	2.1	2.0

Source: our calculations based on INAIL data and Istat. We consider the most dangerous professions according to our accident rate calculated by comparing the number of accidents from the INAIL source with the average number of employees per year (source Labour Force Survey, Istat). Table is sorted by 2022 data. Occupations are classified according to the ISTAT's CP2011 coding system at 2-digit. It is not possible to exclude the public sector and purge data from commuter accidents.