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Abstract

In the last decades, socio-economic literature has paid considerable attention to the distribution of costs and benefits of technological introduction and ICT diffusion for different segments of the workforce, mainly across distinct occupational or educational groups. This study explores how wage returns to ICT use differ between temporary and permanent workers focusing on the role of trade unions in mitigating this contractual divide. Using recent European microdata from the ESJ2 survey (CEDEFOP 2022), we examine whether union membership enhances wage outcomes for temporary workers using digital skills, and how this effect varies depending on national patterns of union representation. By combining individual-level information with country-level indicators of trade union density across contractual types, we assess how micro and macro level dynamics shape wage parity in ICT returns. Overall, our findings reveal a clear penalty for non-unionised temporary workers. The protective role of trade union membership is nonetheless significant only in national contexts characterized by similar level of trade union density across contractual groups. These results underscore both the conditionalities and potentials of industrial relations in fostering inclusive labour markets amid technological change.

JEL Classification: J2, E24, O30, J50

Keywords: ICT skills, wage premiums, European labour markets, temporary contracts, trade unions

* This article and accompanying paper elements are fictional and do not represent an actual published research study. They have been created solely to demonstrate a sample template format.

Introduction

Over the past two decades, extensive socio-economic research has demonstrated how the diffusion of information and communication technologies (ICT) has fundamentally changed the way labour markets operate. As digital skills have become increasingly important in organisational and production processes, this shift has significantly reshaped wage distribution and income inequality patterns across different contexts and workforce groups (Kristal, 2020). It is now apparent that—although to varying degrees—digital technologies have spread across occupations, requiring digital skills that are often complementary to other competencies needed for revised job roles (Pedersen and Wilkinson, 2018). Therefore, the possession of digital skills has become highly influential in determining individual as well as group-specific labour market outcomes and prospects (De Vries et al., 2020; Gil-Hernandez et al. 2023; Hershbein and Kahn, 2018). In this respect, the academic debate on robotization, digitalization and, more broadly, technological innovation, has mainly pointed in the direction of changing returns to education and skills for distinct segments of the workforce, either defined in terms of different occupations or job task content (Autor et al., 2003; Goos et al., 2014; Haslberger, 2021; Oesch and Rodríguez Menés, 2011). Relatedly, it has been now extensively documented how employment opportunities, wages levels, and income stability trends can diverge both within and between sectors and occupations over time, depending on the level of skills and tasks complementary of specific jobs in presence of relevant technological innovations in the production process (Acemoglu, 2002; Bisello et al., 2019; De Vries et al., 2020; Goldin and Katz, 2007; Hershbein and Kahn, 2018). That being said, several contributions have shown how such inequalities are far from being strictly determined by technological change in itself, while they rather tend to be context-specific, depending upon labour market regulations intervening in the employment relations field (Barbieri et al., 2022; Fernandez Macias and Hurley, 2016; Klenert et al., 2020; Kristal and Edler, 2021; Minardi et al., 2023; Oesch and Piccitto, 2019). More specifically, adopting an industrial

perspective, it is apparent that technological change (either in terms of robotization or digitalization) is not neutral hence its costs and benefits for workers also depend on power relations between labour and capital (Spencer, 2017), leaving room for relevant heterogeneity in the effects across distinct workforce segments, largely according to groups-specific exposure and vulnerability to employer's strategies to lower labour costs Especially in response to the dynamics of technical change, trade unions have indeed been proven to shape the distribution of employment opportunities and wage premia across different educational, occupational, and cohort-based groups (Haapanala et al., 2023; Minardi, 2024; Parolin, 2021). Therefore, even if generally speaking unions still play an important role in buffering labour market inequalities (Martinez Lucio et al., 2021) in contemporary societies, it is more debated the extent to which they address and shape these inequalities between non-standard and permanent workers (Doellgast, et al. , 2018; Pulignano and Signoretti, 2016, Benassi and Dorigatti, 2015), and in particular how the consequences of digitalization can diverge between contractual groups (Cutuli and Tomelleri, 2023). Several studies have indeed argued that even if labour organizations yield overall positive results for the covered segments of the workforce, the bargaining outputs tend to work systematically better for permanent workers (Gumbrell-McCormick 2011, Adolfsson et al. 2023, Canzio, 2024), even to the detriment of temporary workers (Palier and Thelen, 2012, Bentolila et al., 2012). Other studies have found more balanced outcomes between permanent and contingent workers, highlighting the pressures exerted by unions to transform non-standard contracts into permanent positions (Carver and Doellgast, 2021, Pulignano and Signoretti, 2016) or their encompassing collective bargaining actions in several national contexts (Heery, 2009, Doerflinger and Pulignano, 2015, Carver and Doellgast, 2021). Unions would address these labour market inequalities by supporting temporary workers' membership both in individual, i.e. providing knowledge over employment rights and assistance in grievances (Heery, 2009, Keune, 2013), and collective terms (Carver and Doellgast, 2021). Among the various potential elements of inequalities, wages constitute a crucial element of job quality and workers' concerns, and it is now importantly related to returns for digital skills usage (Benassi and Vlandas, 2015, Canzio, 2024).

However, largely due to the bottleneck of data availability, the literature is still far from allowing clear interpretations about the micro and macro conditionalities and implications of alternative insider-outsider, competition or inclusive dynamics. Previous research did not rely on microdata on non-standard workers' individual membership or on reliable firm level data (see as examples of valuable exceptions McGrath-Champ et al. 2022, Aldolfssson et al. 2023, Canzio, 2024). Therefore, most empirical studies fall somewhere short in considering if and how the magnitude of the defensive effect of trade unions in favour of non-standard in terms of wage parity for digital skills usage workers can be jointly affected by individual and collective factors. Moreover, the union's role in addressing labour market inequalities across contractual cleavages has been rarely inquired about the usage of digital skills despite their pervasiveness in current workplaces.

The present study aims to provide a contribution to this field connecting technological change, union role and inequalities in labour markets focusing on wage parity. We first assess wage outcomes of temporary and permanent workers using the same number of digital skills. Then, we test if temporary workers' union membership can effectively enhance capacity to pursue fair wage treatments and dynamics of wage parity between contractual groups. Then, by leveraging power resource theory to study intra-union relationships (Arnholtz and Resflund, 2024), we propose considering aggregate trade union density at the national level as a potential moderator of the role of individual membership. This is central to shed light on the macro conditionality of the effects of micro-level negotiations according to different macro-level factors, such as constraints and opportunities associated with different levels of trade union densities for temporary and permanent workers. We pursue these goals by investigating a recent European dataset on skills and job survey (ESJ2, Cedefop 2022), which, even if available in a cross-sectional form, crucially contains information on contractual status, digital skill usage and trade union membership. This allows us to focus specifically on the role played by trade unions in shaping income inequality stemming from different wage effects of ICT use at the workplace, in this specific case allowing for different returns between temporary and permanent workers, leveraging individual trade union membership and aggregate trade union composition in

contractual terms. Therefore, we pose a threefold research question: Q1) if temporary workers are penalized in terms of wage returns for ICT use compared to permanent workers; Q2) if contingent workers' union membership addresses this penalization and Q3) if this union membership has different relevance on the grounds of different aggregate union composition. We carry out these analyses by allowing for different levels of usage of digital skills, too. The overall pattern of the findings not only indicates that the wage returns of digital skill use are, caeteris paribus, sensitive to structural/institutional cleavages, such as the one between contingent and standard workers, but it also confirms how the ICT wage premia are moderated by individual and aggregate factors in the industrial relations domain and related social processes.

LITERATURE REVIEW

Temporary workers in contemporary labour markets

Following neo-liberal policies of labour market deregulation over the last three decades (Barbieri and Cutuli, 2016; Stecy-Hildebrandt et al., 2019, McGrath-Champ et al., 2022, Tomelleri, 2021), despite of a partial retrenchment in concomitance with the COVID 19 crisis and local regulations (Martinenz Lucio and MacKenzie, 2024), there is a persistent relevant percentage of people employed through temporary contracts in European labour market: around 12 per cent in the overall active population, with different degrees of overexposure for specific groups, being the share 14 per cent among females, and with stronger overexposures for non-EU-members and young workers, 23 per cent and 30 per cent, respectively (Eurostat, 2023). This renders pivotal the analysis of temporary workers' potential penalization compared to permanent workers in the contemporary labour market, especially in response to new sources of technological-related changes. Alongside work organization and human resource management systems (Signoretti et al., 2021), and unemployment risks (Latner and Saks, 2019), wages can arguably be considered a relevant element of job quality and an important driver of inequality between contingent and regular workers (Benassi and Vlandas, 2015, Canzio, 2024).

Contradictory theories and underlying forces are at play when looking at the direction and intensity of inequality between non-standard and permanent workers (Håkansson and Isidorsson, 2012, Jahn and Pozzoli, 2013, Laß and Wooden, 2019). According to the theory of compensating wage differentials (Smith, 1979), workers employed in jobs with disadvantageous conditions, other things equal, should in principle be paid more than their counterparts. Moreover, contrary to the flexible firm theory (Atkinson, 1984; Atkinson & Meager, 1986; Doeringer & Piore, 1971), according to which contingent workers would be mainly hired to perform secondary tasks under a numerical flexibility rationale, there is evidence that permanent and contingent workers in contemporary labour market can work in the same occupations and carry out the same job tasks within organizations (Håkansson and Isidorsson, 2012, Benassi and Dorigatti 2014, Signoretti et al, 2021). Therefore, non-standard workers performing the same job and using the same skills as their colleagues hired through an open-ended contract should be characterized by the same level of compensation or even receive comparatively higher wages given their lower job security and higher risk of unemployment. This principle of equality is strengthened by legal provisions at the European level, which prescribe that workers performing the same job should receive the same pay although hired through different contractual arrangements (Nienhüser and Matiaske, 2006, European Commission, 2008). Indeed, empirical evidence generally contradicts the expectation of equal or even advantageous treatment, and it rather identifies net wage penalties for temporary workers, particularly for those at the lower end of the wage distribution (Mertens et al. 2007; Barbieri and Cutuli, 2018; Westoff, 2022).

That is because several social mechanisms run in the opposite direction to social, organizational and legal principles of equality. First, despite being employed to perform the same job, contingent workers can be more easily fired to cope with market downturns or to meet company's competitive strategies (Booth et al., 2002, Kalleberg, 2003, Mitlacher, 2007). The different degrees of job security experienced by non-standard and permanent workers entail different bargaining power (Laß and Wooden, 2019). Regular workers can bargain for higher wages given their position of relative strength towards employers, while contingent workers can be prone to accept lower wages to avoid

unemployment (Eurofound, 2006; Barbieri and Cutuli, 2018), leaving higher leeway for firms to erode employment conditions and to achieve higher profits (Andrijasevic and Sacchetto, 2016). Further to different power asymmetries between labour and capital, contingent workers can also result disproportionally excluded from training. This occurs either because employers are less incentivized in sponsoring programs devoted to people that are bound or are more likely to leave their company, or because workers are not prone to invest in firm-specific skills for the same reason (Houseman, 2001; Cutuli & Guetto, 2013, Adolfsson et al. 2023). Also, if temporary positions are conceived as entry port and function as an extended probationary period (Gebel, 2010; Barbieri and Cutuli, 2016; Signoretti et al., 2021; Fauser, 2024), people can accept a period of lower pay to get a promotion into a permanent position.

On the grounds of what is highlighted by the literature as the general average wage effect of temporary status, we would thus expect a penalization of contingent employment also in the specific domain of wage returns associated with the use of digital competences. Building on these streams of the literature, we also test for variability of ICT returns for workers displaying different levels of digital skills use (Q1), operationalized by the number of digital skills commonly utilized at the workplace.

Unions' role and contractual cleavages

The sociological and industrial relations literature have consistently shown that adverse market conditions suffered by temporary workers can be significantly mitigated by unions' action (Pulignano and Signoretti, 2016, Keune, 2013; Grimshaw, Johnson and Rubery, 2016). However, it is debated if the union's 'sword of justice' (Flanders, 1970), i.e. collective labour actors' capacity to rebalance the structural power asymmetry between labour and capital (Resflund and Arnholtz, 2022), holds evenly across contractual cleavages. We contribute to the mixed (if not puzzling) empirical evidence of trade unions' role in reducing contractual inequalities by considering wage returns for temporary and permanent workers deploying the same level of digital skills at work. We start analyzing the effect of

temporary workers' union membership in terms of micro social processes possibly activated at the individual level by such membership. As a matter of fact, the collective organization of temporary workers is widely acknowledged as a major challenge for contemporary trade unions (Visser, 2024). Traditional mobilization and bargaining strategies, typically designed for permanent workers, often prove less effective in the context of temporary employment contracts. For instance, firms can instrumentally divide workers (Benassi, Dorigatti and Pannini, 2020, Larsen et al., 2022) and heterogeneity in claims and bargaining priorities (if not conflictive interests) can characterize workers hired with different employment contracts (Lindbeck and Snower, 1988, Bellani and Bosio, 2021). Given such organizing difficulties, social processes activated by individual union membership can be relevant to achieving wage parity over the usage of the same digital skills. Some scholars have highlighted how it can be expected that temporary workers will stand to gain from individual union membership through an "awareness effect" (Meager et al., 2002; Heery, 2009, Keune, 2013). Contingent workers' rights in terms of wage parity in relation to permanent workers performing the same job are established at the European level, and so they can be claimed individually about the recognition of the same ICT wage premium. Research has shown that unionized workers are more likely to be aware of their employment rights (Budd and McCall 2004, Gustman and Steinmeier 2005) and to receive due wages (Hirsch et al. 1997) thus addressing the missing application of labour regulations by employers (Brown et al., 2002; Fullin, 2019). This process can be expected to be particularly relevant, caeteris paribus, for temporary workers, since the lack of knowledge over employment rights is particularly acute among them (Meager et al., 2002). Moreover, whether previously informed or not, under the circumstances of employers' willingness to not abide by wage parity regulations, unions can also threaten and pursue grievances inducing employers to change their actions and strategies (Heery, 2009; MacKenzie, 2010).

However, there are forces that run in the opposite direction. The union 'awareness effect' can be counteracted by temporary workers' fear of being dismissed if they raise issues (Holdcroft, 2013). Moreover, given their turnover across employers, contingent workers might not look primarily for

wage parity support (Barbieri and Cutuli, 2018) prioritizing other aspects such as information on job opportunities, contractual conversion, and mutual insurance to be protected in unemployment periods (Heery, 2009, Keune, 2013). We thus aim to verify if temporary workers' union membership at the individual level favours wage parity in relation to permanent workers considering the utilization of the same levels of digital skills. Previous research on micro social processes of union membership was based on qualitative data, and it did not concern temporary workers and digital skills utilization. Therefore, we pursue this goal by relying on a vast data set including temporary workers' union membership (or not) across a wide spectrum of digital skills utilization.

We also speculate that unions' effect might impinge upon differently across the span of digital skills levels. On the one hand, unions tend to represent low-skilled workers (Scheuer, 2011) and reduce their low-pay risk (Schmitt, 2008, Svarstad, 2023). This direction of union action would suggest a stronger positive union effect at the lower parts of wage distribution. On the other hand, temporary workers using higher levels of digital skills have higher labour market opportunities and employers would be more available to accommodate their requests given their better working performance, and the costs implied by their job turnover (Laß and Wooden, 2019). On the grounds of these contradictory mechanisms, we test if unions are in a stronger position to ensure wage parity for workers using lower or higher levels of digital skills, Q2)

It is nonetheless debatable to the extent to which this potential micro-union effect holds considering temporary workers' weight within union organizations. Market dualization theorists highlight that unions would promote/defend permanent workers' employment conditions by using their bargaining strength to the detriment of the peripheral workforce (Palier and Thelen, 2012, Bentolila et al., 2012). That is because regular workers still represent the main constituency of union organizations. Unions are both ideological and interest-representation organizations, but even a fully solidaristic union orientation would pay attention to internal decisional outcomes (Malo, 2006, Keune, 2013). The different attention paid by unions to workers hired with a standard or contingent employment contract can thus be importantly linked to different internal power among different groups of workers in their

capacity to affect union claims and strategies. We rely on power resource theory to study intra-union relationships between permanent and non-standard workers. Power resource theory has been directed to explain the relationship between labour and capital and particularly the different power resources labour organizations can leverage. It has also been usefully adopted to conceptualize and study inter-union relationships (Signoretti et al., 2025). We use it to inquire if potential differences in union action can be traced back to different power resources of permanent and temporary workers in relation to one another. We refer to the associational power resource, i.e. workforce union density and its capacity to exert voice (Resflund and Arnholtz, 2022, Arnholts and Resflund, 2024). If unions recruit a higher number of temporary workers compared to regular employees because of ideological (e.g. social justice) and/or rational (e.g. deterioration of working conditions for the whole workforce, their increasing presence in the labour market) reasons (Benassi and Vlandas, 2015, Stecy-Hildebrandt et al., 2019, Bonet et al., 2022), union density among non-standard workers would be comparatively high. Therefore, this category of the workforce would be fully part of union constituency being able to influence union action and strategies (Lindvall and Rueda, 2014).

Temporary workers' associational power resource within the union would strengthen the efficacy of individual union membership through various mechanisms. First, unions would promote legislative measures and collective agreements that would reinforce the application of equal treatment, e.g. higher sanctions for employers not respecting them (Malo, 2006). Second, dedicated structures would be shaped within the union for this specific group, improving the quality of union services, e.g., in terms of training or assistance in grievances (Keune, 2013; Burroni and Pedaci, 2014; Pavolini and Perdersini, 2022). Third, unions would encourage local representatives to pay specific attention to the needs of this category of the workforce (Sanchez, 2007, Marino, 2015). Furthermore, voice channels for special groups are crucial to build class-based solidarities that can reinforce collective action (Martinez-Lucio, 2017). In this vein, temporary workers can promote their concerns by leveraging the bargain strength of permanent workers (Pulignano and Signoretti, 2016). As highlighted, mobilizing and organizing the contingent workforce is complicated, but research has shown that it is

possible to develop a sense of collective identity along with permanent workers to counter employers' injustices (MacKenzie, 2010, Simms and Dean, 2015, Benassi et al., 2019).

That being said, this body of research falls somewhat short in putting under scrutiny the consequences of representation for temporary and regular workers on the grounds of changes in associational power resources of contingent and permanent workers. We thus test the effect of contingent workers' weight with union organizations over wage parity returns of digital skills as moderator for possible micro level effect of individual membership. Empirically, this is done by computing the country-specific ratio of temporary-permanent union density rates. This ratio provides a composite measure of the structural underrepresentation of temporary contracts among trade union members in distinct national labour markets (Cutuli and Tomelleri, 2023; OECD, 2019).As far as temporary positions are concerned, we argue that for individual membership to produce positive externalities, the effectiveness of awareness (and unions' investments and capacities in bargaining processes) will be magnified solely in contexts in which non-standard workers display, collectively, high trade union densities. We refer to a relative comparison given that permanent workers always represent most union members in absolute terms (Visser, 2019). As regards collective union membership effects, in order to assess if unions have higher bargaining power when firms' requests of skills are higher (Payne et al., 2023, Lloyd and Payne, 2023), we test if the unionization role is stronger the higher the level of individual skill endowments, measured through individual ICT implementation at the workplace (Q3).

Trade unions, temporary employment and digitalization

As regards digitalization and dynamics of deployment of non-standard contracts, scholars have mainly concentrated on the analysis of bogus self-employment and precarious positions in the platform economy (Cini and Goldmann, 2020, Lopez et al., 2023). For what concerns interplay between unions and digitalization, research has shown both that the presence of employee

organizations favors the adoption of advanced digital technologies at the workplace level (Berton et al., 2023), and the development of digital skills (Haipeter, 2024, Marcolin and Gasparri, 2024). Unions themselves can gain organizing advantages by using such technologies (Frangi et al., 2020, Hansen and Hau, 2024). In any case, as anticipated in the introduction, scholars have highlighted that technology (either in terms of robotization or digitalization) is not neutral hence costs and benefits for workers depend on power relations (Spencer, 2017). More specifically, the equalizing effect between contingent and permanent workers potentially exerted by unions in the reward for digital skills usage has not been tested yet.

As above mentioned, in this study we theoretically expect, and we empirically test if and to what extent contingent workers' union membership leads to wage parity returns in the digital skills used by temporary and permanent workers. On the top of this, we also speculate that unions' effect might impinge upon differently across the span of digital skills levels. On the one hand, unions tend to represent low-skilled workers (Scheuer, 2011) and reduce their low-pay risk (Schmitt, 2008, Svarstad, 2023). Additionally, the awareness effect can be higher for low-skilled workers. This direction of union action would suggest a stronger positive union effect on the lower parts of wage distribution. On the other hand, temporary workers using higher levels of digital skills have higher labour market opportunities and employers would be more available to accommodate their requests given their better working performance, and the costs implied by their job turnover (Laß and Wooden, 2019). From the collective viewpoint, unions have higher bargaining power when firms' requests of skills are higher, as happens in the banking sector (Payne et al., 2023, Lloyd and Payne, 2023). On the grounds of these contradictory mechanisms, we test if unions are in a stronger position to ensure wage parity for workers using lower or higher levels of digital skills.

Analytically, this last aspect of our research questions will boil down to testing for the existence and the magnitude of the effect of individual membership on the wage returns of digital skills utilisation of temporary workers, and for the variability of this effect between low- and high-skilled workers.

Data and methods

Data

The European Skills and Jobs Survey (ESJS) is a large-scale survey conducted by the European Centre for the Development of Vocational Training (CEDEFOP). Its primary objective is to gather information about various aspects of work, including the types of tasks people perform, the digital technologies they use, and the skills they need. Most importantly for the purpose of this paper, it also collects data on contract types and union membership. It also aims to identify the demand for specific skills, the incidence of skill gaps, and the impact of technological changes on job tasks and skill requirements. All this information enables us to focus on the effective usage of ICT skills in the workplace, which we conceive of as largely demand-driven, the related (if any) contractual wage gap, and the moderating role of trade unions through individual and collective channels of representation. To date, the ESJS is one of the most extensive and complete sources of information on the evolving nature of skills and jobs in Europe. In this paper, we draw on data from the second wave of the survey, carried out in 2021, which places a greater emphasis on the impact of digital technologies.

The data consists of nationally representative samples of employees aged 25-64, encompassing 46,213 observations across all European Union Member States as well as Norway and Iceland. The survey uses random sampling techniques to select participants, ensuring that the sample reflects the broader population of adult workers in terms of age, gender, education level, and occupation, as well as an additional sample drawn from the CEDEFOP in-house non-probabilistic online Profiles panel[1]. To investigate the role of contract and union membership in shaping the returns to digital skill use, we considered only observations with non-missing earnings, trade union status and type of contract. Our final sample consists of 20,205 observations.

[1] More information on https://www.cedefop.europa.eu/en/projects/european-skills-and-jobs-survey-esjs and on the related sample strategy report.

Our dependent variable is the logarithm of hourly net income, obtained by dividing the weekly net income[2] by the number of hours worked per week and by taking its logarithm. *Ictskills* represents a counter of digital skills declared by the respondent that ranges from 0 to 10: for each item of the *Digital Technologies at Work* section of the questionnaire, we count how many digital activities the computer users' respondents declared to use. The items present in the questionnaire are 10 and ranges from internet browsing and text editing to coding, programming using artificial intelligence methods, and developing or maintaining IT systems[3]. In this way, the more digital skills someone employs, the more likely they are to be advanced. The final index ranges from 0 to 10, with an average of 4.16, a standard deviation of 2.69 and shows a very high correlation with the level of digital skills (0.86, see the Appendix). This operationalisation gives us a general (simple but clean) index of ICT skill use to be interacted with trade unions and the type of contract. Employing more complex indices that account for heterogeneity in digital skills requires assigning weights to individual items, which can be subjective and potentially controversial, as they may be not equal across sectors and occupations. Furthermore, an analysis of the heterogeneity of returns is beyond the scope of this paper, but we discuss this aspect in a general manner in the conclusion.

Variable *age* reports the age of the responders, while *tenure* represents the number of years with the same (current) employer. The *contract* represents the share of temporary workers, *gender* represents the share of female workers, *public* represents the share of workers employed in the public sector, and *weekly hours* represent the number of hours worked in a week by the respondents.

Table 1: Descriptive Statistics

[2] Weekly net income is derived by dividing the monthly net income by the average number of weeks in a month, i.e. 4.3452.

[3] More information on https://www.cedefop.europa.eu/en/projects/european-skills-and-jobs-survey-esjs and on the related sample strategy report.

Union member	No		Yes		Total	
	mean	sd	mean	sd	mean	sd
ln(hourly wages)	2.01	0.75	2.34	0.79	2.09	0.77
hourly wages	9.71	9.81	13.33	11.42	10.55	10.32
weekly hours	37.94	7.86	37.57	7.47	37.85	7.77
ictskills	4.15	2.70	4.20	2.67	4.16	2.70
temporary (share)	0.14	0.35	0.09	0.29	0.13	0.34
tenure	9.40	8.81	13.01	10.35	10.23	9.31
public	0.29	0.45	0.47	0.50	0.33	0.47
training	0.60	0.49	0.69	0.46	0.62	0.49
gender	0.76	0.43	0.84	0.37	0.78	0.41
age	42.84	10.23	45.04	10.25	43.35	10.28
total	15,530		4,675		20,205	

As shown in Table 1, across EU member states[4], workers who are members of trade unions tend to earn, on average, higher wages even if their levels of ICT skills use (*ictskills)* are similar to those of non-unionised workers. Union members are generally slightly older, have longer job tenures, are less likely to be on fixed-term contracts, and tend to participate more in training. Furthermore, a higher proportion of unionised workers are employed in the public sector. There are no relevant differences in gender distribution or the number of hours worked per week between unionised and non-unionised workers. Statistical tests of differences in means are provided in the appendix.

Another important factor we consider is the ratio of permanent to temporary union density rates at the country level. This ratio was calculated based on individual union memberships and serves as a composite measure of the structural underrepresentation of temporary contracts among trade union members in different national labour markets (OECD, 2019). Essentially, this variable highlights the relative advantage in terms of membership and representation that permanent contracts have within each national labour market. Table 2 reports descriptive statistics for trade union density among permanent and temporary workers, as well as the constructed trade union density ratio at the country

[4] Including Norway and Iceland.

level. Trade union density for permanent workers has a mean of 0.24 with a standard deviation of 0.17, based on 17,590 observations. For temporary workers, the mean density is lower at 0.17, also with a standard deviation of 0.17, calculated from 2,615 observations. These figures are derived from individual-level data and reflect the proportion of unionised workers within each contract type and are aggregated at the country level, so that the mean represents the average of each country-specific trade union density for the two contractual groups. By construction, this logic also applies to the trade union density ratio: the mean represents the average of all country-specific trade union densities.

Table 2: Descriptive Statistics, union density ratio

	mean	sd	n
trade union density (perm)	0.24	0.17	17590
trade union density (temp)	0.17	0.17	2615
trade union density ratio	0.70	0.36	20205
Observations	20205		

Identification strategy

To analyse the returns related to the use of ICT skills at work, we employ a Mincer earnings equation. This equation relates a workers' wages to their level of education, age, tenure and gender, as well as to structural variables such as occupation and industry. Mincer's earning function is a common standard in the literature, but here, we estimated it also in a nested model specification including interactions among ICT skills, *contract* and *trade union membership* to check whether the returns to digital skills change in significance and magnitude. This can be more formally represented as

$$Y_{i,c,s} = X_{ki}\beta_k + \delta_c + \gamma_s + \varepsilon_i \quad (1)$$

where y_i is an i-dimensional vector referring to the logarithm of the hourly wage of individual i in country c working in sector s. X = (x1, …, x13) is the i-by-k matrix of independent variables, whose

components, respectively, correspond to age and to the individual level of the reported tenure with the current employer and its square (x1 to x4 = age, age2, tenure and tenure2), to the individual's gender (x5 = gender), to the highest level of formal education obtained (x6 = educ – ISCED in three categories) and to the type of occupation (x7 = ISCO – 1 digit). We also included a dummy indicating those working in the public sector (x8 = public) and firm size (x9 = firm_size – four categories). δc and γ_s capture country and sector fixed effects, respectively, while ε_i represents an i-dimensional vector of i.i.d. normal error terms with finite unitary variances. Our three main variables of interest are permanent versus temporary contract (x10 = contract), the individual trade union membership (x11 = tradun), and the number of digital skills used at work (x12 = ictskills). We estimated the nested model specifications of the Mincer function and interacted ictskills with the contract type as well as the trade union membership.

Unionised workers may differ from non-unionised workers for various reasons, and this is the case in our sample, as shown in subsection Data and reported in a specific section of additional descriptive statistics in the appendix. For this reason, we employ a *propensity score matching* (PSM) and use the resulting weights in the Mincerian equation to make the two groups of workers comparable with respect to their observable characteristics. Balance tests for the different matching algorithms are included in the Appendix.

Another issue is to determine the causal direction between individual ICT usage and wage levels to avoid reverse causality issues that could affect the analysis. The relationship between ICT use and wages might be subject to endogeneity problems at least for two reasons: individuals self-selecting into ICT-intensive firms, and the spread of ICT in specific companies at the meso-level. These factors could influence potential income at the individual level. To overcome issues stemming from unobserved context-specific/between-firm heterogeneity, we adopt a two-stage least squares (2SLS) regression estimate using a leave-one-out mean instrumental variable on the use of ICT skills at work. More specifically, following Cette et al. (2022) and Cutuli and Tomelleri (2023), we instrument the

leave-one-out mean of *ictskills* within a sector, firm size and ISCO code, leaving out the values of the variable for all workers employed in the same country as individual i:

$$\widetilde{\text{ictskills}}_i = \frac{1}{N_{s,f,I}^{-c_i}} \sum_{j \in (s,f,I) c_j \neq c_i} \text{ictskills}_j$$

where $\widetilde{\text{ictskills}}_i$ represents the instrumented value for individual i, (s, f, I) indicates the sector-firm size-ISCO cell to which individual i belongs, $\sum_{j \in (s,f,I)} ictskills_j$ is the summation that excludes individuals from the same country as i $(c_j \neq c_i)$, $(\mathrm{N}_{\mathrm{s,f,I}}^{-\mathrm{c_i}})$ is number of individuals in cell (s, f, I) excluding those from country c_i.

Results

Table 3 shows the different specifications for the model illustrated in the Identification strategy subsection, investigating the relationship between temporary employment, ICT skills, union membership, and their interactions on earnings. The models differ in specification, including baseline OLS (column 1), interaction terms (column 2), matching trade union membership via Propensity Score Matching (PSM) and interaction terms (PSM, column 3), Instrumental Variables (IV, column 4), and a combined IV-PSM approach (column 5). All model specifications take into account country, sector (NACE Rev. 1, 1 digit), and ISCO (1 digit) fixed effects as well as individual and structural variables described in the section **Data and methods**. Robust standard errors are reported in parentheses for models 1, 2 and 3, and instrument clustered standard error for the two IV models.

Across all specifications, being employed under a temporary contract is consistently associated with significantly lower hourly income. In the baseline model, temporary workers earn approximately 9 per cent less than permanent workers, everything else equal (–0.090, $p < 0.001$). This negative effect persists and even intensifies when we control for selection into trade union membership (PSM model,

column 3[5]) or when we exogeny the effect of digital skills (IV and IV-PSM model column 4 and 5), leading to an 11-12 per cent wage penalty.

ICT skills (*ictskills)* show a robust and positive correlation with hourly income. In the baseline specification, for each additional ICT skill used at work, there is a 2.6 per cent increase in the hourly wage, everything else equal (0.026, $p < 0.001$). The magnitude does not change much across all the model specifications. In general, in European labour markets, as the digital skills used at work increase, hourly wages increase by a range from 2.2 to 3.5 per cent, depending on the model specification. Interaction terms introduced in models (2) and (3) provide additional insights. The interaction between temporary contract and ICT skills is negative and statistically significant in model (2) (–0.017, $p < 0.01$) and significant at the 10% in model 3, suggesting that the returns to ICT skills are lower for temporary workers, everything else equal. Union membership does not show a consistent or significant effect across specifications. Interaction terms involving union membership, either with temporary status or ICT skills, are uniformly statistically insignificant. From the empirical evidence provided so far, only the contract plays a role in our story, while the moderating role of the trade union does not seem to have any effect. But is this really the case? To better understand the dynamics resulting from the interplay between trade unions and the contract on ICT skills returns, we must compute marginal effects.

Table 3:regression result

[5] Even if the coefficient is only significant at the 10 per cent level ($p<0.10$).

	(1) baseline	(2) interaction	(3) ineract_PSM	(4) IV	(5) IV_PSM
temporary	-0.090***	-0.062**	-0.116	-0.091***	-0.113**
	(0.015)	(0.022)	(0.060)	(0.016)	(0.036)
ictskills	0.026***	0.030***	0.022***	0.024**	0.035*
	(0.002)	(0.003)	(0.004)	(0.009)	(0.014)
unionised	0.014	0.026	-0.012	0.014	0.007
	(0.012)	(0.023)	(0.027)	(0.012)	(0.013)
temporary*ictskills		-0.017**	-0.035		
		(0.006)	(0.019)		
temporary*unionised		0.062	0.094		
		(0.052)	(0.076)		
unionised*ictskills		-0.007	-0.001		
		(0.005)	(0.006)		
N	19,967	19,967	19,967	19,967	19,967
r2	.617	.618	.586	.617	.582

Standard errors in parentheses

First-stage F-statistic: model 4, F(67, 19899) = 315.82 — model 5, F(67, 19899) = 133.83

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: all the model specifications include the full set of controls described in the section Identification strategy.

While interaction terms in regression models capture heterogeneity effects, their coefficients alone do not provide an intuitive or complete understanding of how the relationship between two variables changes across subgroups. In particular, when the model includes interactions between a continuous variable (e.g., ICT skills) and a binary variable (e.g., temporary employment), the marginal effect of the continuous variable depends on the value of the binary one. This becomes even more complex if we want to assess the moderating role of the trade union in this dynamic. Therefore, computing average marginal effects allows us to quantify more distinctly the moderating role of trade unions on the returns to ICT skills for temporary and permanent workers. This approach yields more interpretable estimates, especially when interaction terms are embedded in log-linear models.

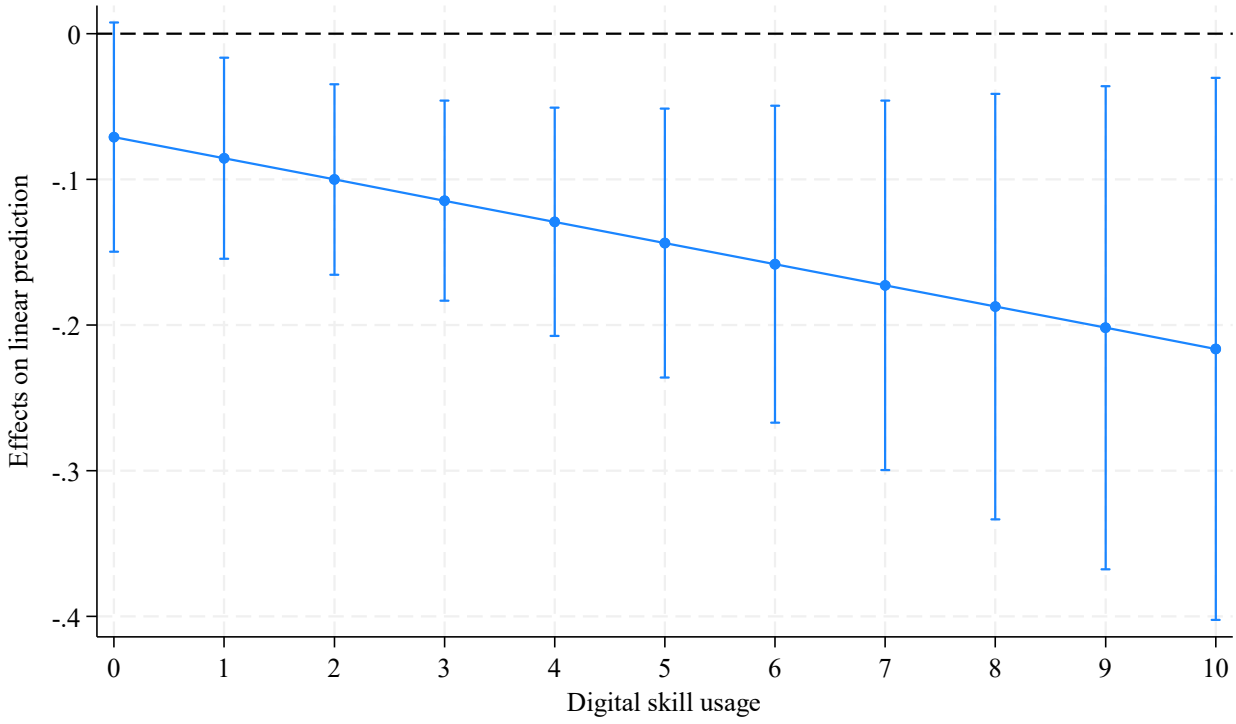
At the same time, in an instrumental variables (IV) framework, challenges arise when the model includes interaction terms involving the endogenous variable, in our case ICT skills. Because *ictskills* is endogenous, any nonlinear transformation or interaction involving *ictskills* also becomes endogenous. This means that both the main effect (*ictskills*) and each interaction terms among *ictskills*, *union*, and *contract* require valid instruments.

In our empirical strategy, we address potential endogeneity in two ways. First, we mitigate selection into union membership by using a matching approach that balances observed characteristics across union and non-union workers. Second, we address the endogeneity of ICT skills at work using an instrumental variables (IV) strategy. However, we are not able to fully account for potential endogeneity related to contract type. Specifically, there may be unobserved factors, such as worker motivation, ability, or labour market conditions, that influence both the likelihood of ending up in a temporary job and the outcome variable. Since we are unable to find a valid instrument for the type of contract, this admittedly remains a potential source of bias in our estimates. For this reason, we rely on the model specification with the interaction and the PSM on trade union membership (column 3 in Table 3). This is certainly a limitation of our estimates. Nonetheless, the instrumental variable approach helped us demonstrate to what extent the effect of *ictskill* is exogenous, in what direction it points, and the fact that our non-instrumented coefficient is, to some extent, more conservative. The fact that we cannot use this model specification may eventually lead us to underestimate the wage returns from the use of digital skills. This issue will be taken into consideration in the discussion section and deepened in the robustness checks in the appendix.

Following this strategy, our main independent variable (ICT skills) is interacted with the contract and union membership variables. For the sake of clarity, we provide and analyse the results step by step, one interaction at a time. Figure 1 shows the average marginal effects (AME) of the returns to *ictskills* for temporary workers at each skill level. Since *ictskills* is an indicator of the number of different *ictskills* used at work, as the number of skills used by the worker increases, the point estimates of wage gap for temporary workers relative to that of permanent workers increases as well: it goes from

7.1 (n.s.) to a significant 21 per cent of the hourly wage. The figure provides a clear picture: all else being equal, workers with temporary contracts who use "more" digital skills at work are penalised in terms of the remuneration of those skills compared to their colleagues holding permanent contracts. Lastly, possessing none or at least one digital skill does not make any difference in the returns in comparison to permanent workers.

Figure 1: AME of returns to ictskills use for temporary workers at different level of ictskills

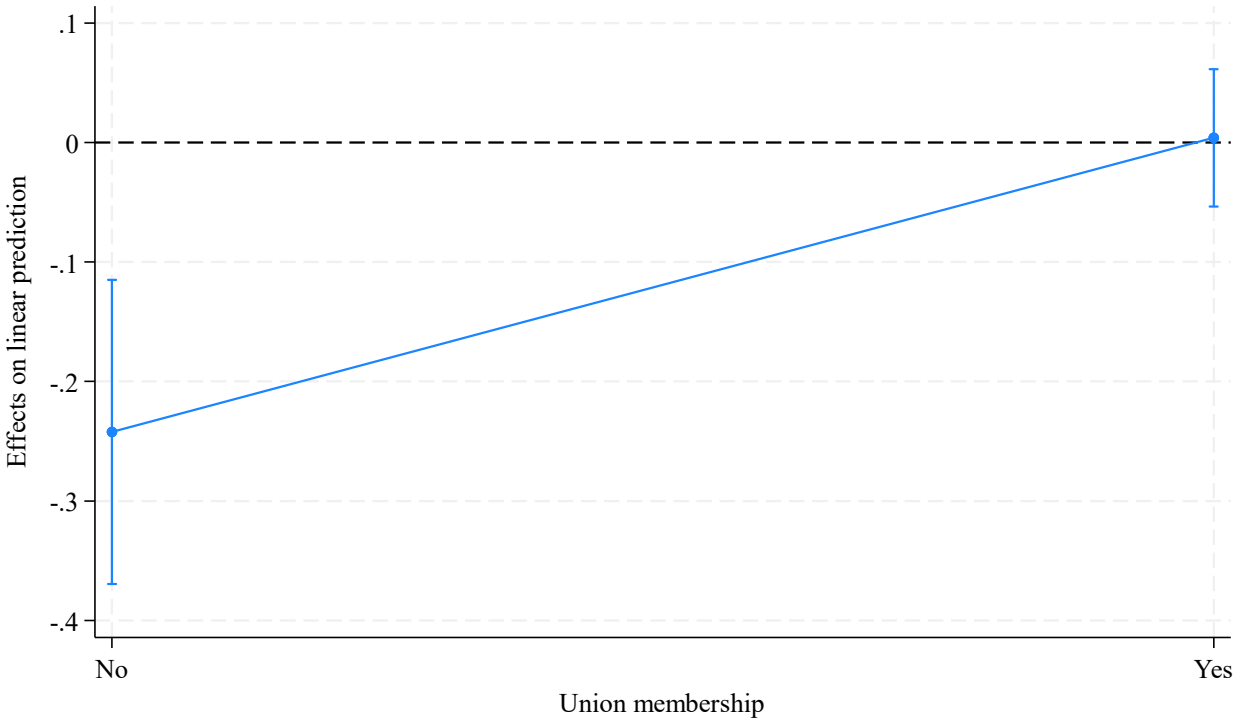


Note: confidence interval level at 95per cent.

Figure 2 illustrates the estimated effect (AME) of holding a temporary contract on log hourly wages, distinguishing between unionised and non-unionised workers. The results show a clear pattern: among non-unionised workers, having a temporary contract is associated with a statistically significant wage penalty of approximately 20.4 per cent (−0.24). In contrast, for unionised workers, the wage penalty associated with temporary employment is close to zero and not statistically significant. These findings suggest that union membership mitigates the wage penalty typically

associated with temporary contracts, helping to offset the negative wage implications typically linked to temporary contracts.

Figure 2: AME of returns to temporary contract type unionized and non-unionised workers

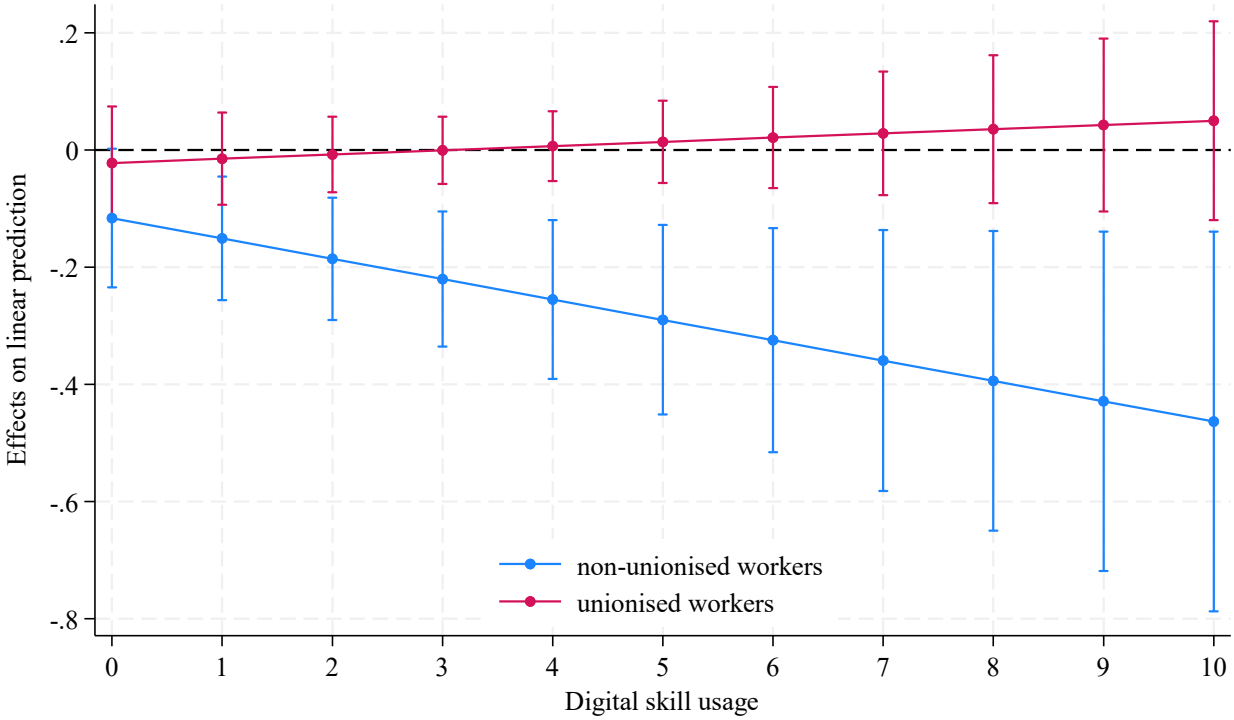


Note: the reference category are permanent workers, confidence interval level at 95per cent.

Given that temporary workers have on average lower returns to digital skills than permanent workers and that unionised workers do not show any significant wage gap attributable to their contract status, it is relevant to understand how these two factors jointly affect returns to digital skills. Figure 3 shows wage returns to digital skills for temporary workers compared to permanent workers. The logic is the same as the one adopted for Figure 1, but in this case, we distinguish between unionised and non-unionised workers. The evidence that emerges is quite clear: while unionised temporary workers do not feel any wage penalty due to the contract status in comparison to their permanent counterparts, non-unionised temporary workers do. They show an increasing wage differential in terms of digital skills returns compared to permanent workers, leading the gap to reach 50% of the hourly wage for

those who use 10 digital skills at the workplace. Furthermore, the difference between unionised temporary and non-unionised temporary workers is statistically significant, especially when more than two digital skills are used at work. The evidence shown in this figure is quite indicative: the use of additional digital skills by temporary workers is much less rewarded in terms of wages than that of workers employed on a permanent contract.

Figure 3: AME of returns to ICT use for temporary, unionised and non-unionised workers at different levels of ICT

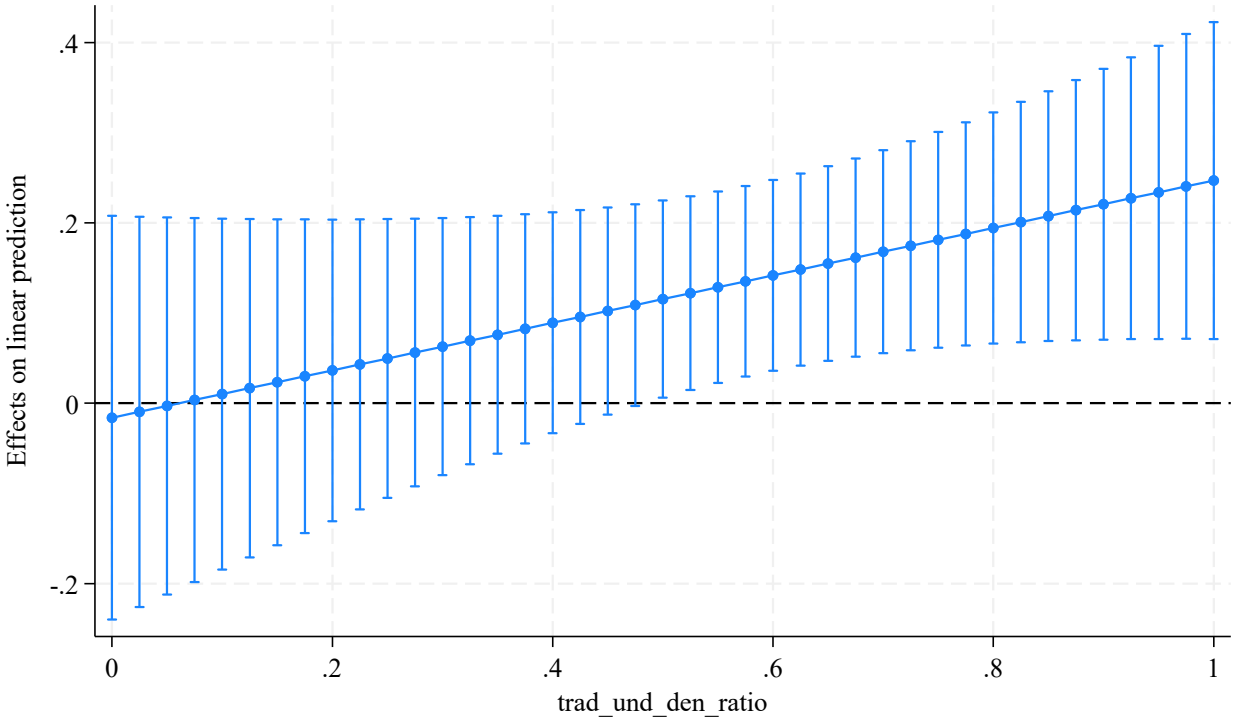


So far, our analysis has focused on the European Union as a whole, without accounting for country-specific institutional settings. However, national contexts, and particularly the structure of trade union representation, may play a key role in shaping the labour market consequences of technological change. Given our prior evidence of a wage penalty for temporary workers in the returns to ICT usage, we want to test whether temporary workers' union membership can effectively enhance the capacity to pursue fair wage treatments and dynamics of wage parity between contractual groups. To do so, we extended the model by incorporating in our three-way interaction the relative country-specific

trade union density ratio (see section Data). We propose this aggregate as a potential moderator of the role of individual membership.

Figure 4 shows how the wage return to union membership varies with the degree of union representation among temporary workers relative to permanent ones. A positive slope indicates that the wage premium associated with union membership is larger in countries where union density is more evenly balanced between temporary and permanent employees.

Figure 4: AME union membership returns at different level of trade union density ratio



Note: 95 per cent confidence intervals

Conclusions

The study provides a contribution to the socio-economic literature by investigating the wage returns of ICT skills use at work in contemporary labour markets. More specifically, it analyses how both micro and macro level factors, such as individual contractual status, trade union membership, and national trade union features, moderate, *caeteris paribus*, these wage dynamics. In these terms, it adds

to the growing body of -mainly economic- research that links differences in technology-related returns to occupational-specific changes in job demand and to the sociological research focusing on macro level institutional variation. The study's primary aim was to (i) examine how on-the-job ICT usage impacts an individual's earning potential and highlight the role of trade unions in reducing the gap in ICT-related wage premiums between different types of employment contracts (ii) through individual and (iii) collective channels of representation.

According to labour market segmentation theories, we identified a clear divide between temporary and permanent workers in terms of returns on ICT skill use, with the employment contract being the primary moderator of ICT returns among various individual and structural variables. In this setting, we examined how individual trade union membership affects wage premiums for ICT skills between contractual groups. We found that, compared to permanent workers, the temporary ones do not show any wage differential in return to digital skills once they are trade union members. More specifically, our results are consistent with a scenario where only temporary workers who are union members, especially if displaying relatively high levels of digital skills, are recognized and compensated accordingly by employers, with no penalties with respect to their permanent counterparts. Admittedly, the identification of the specific mechanisms responsible for this trade unions' protective role for the outcome at stake are beyond the analytical scope of this contribution. However, on the grounds of previous studies, these results point to the relevance of union protection at the individual level where dissemination of information over labour rights and the threat or effective use of grievances can help achieve wage parity (Heery, 2009, Keune, 2013). Still, the effect of individual union membership on the absence of a wage differential in returns to digital skills between unionised temporary and permanent workers is strengthened by temporary workers' associational power resources within the union in relation to permanent workers. This attests to the relevance of power resource theory to analyse power relations within the union organization, too. On the grounds of previous studies, we can argue that this collective effect be traced back to various intertwined factors: an increased jobs security for unionised (contingent) workers, hinging on their integration and recognition within trade

unions, thereby joining the associational strength traditionally held by permanent workers through regulatory provisions and collective bargaining (Malo, 2006, Pulignano and Signoretti, 2016, Benassi et al., 2019), and an enhanced and more widespread access to training opportunities (Adolfsson et al. 2022). Therefore, our results provide clear evidence of both (micro level) potentials and (and macro level) conditionalities of the role of industrial relations in promoting wage equality in presence of dynamics of technological change. The patterns of our results confirm the joint relevance of individual membership behaviours and equal representation across contractual groups within the trade unions constituencies as relevant factors contrasting labour market segmentation dynamics in contemporary labour markets.

More broadly, the variability in the wage differential in ICT returns between permanent, unionised and non-unionised groups of temporary workers, underscores how in contemporary and digitalized labour market is still detectable a net role of institutional factors, here in the form of collective bargaining power, in shaping wage differentials both between and within occupational and contractual groups.

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Appendix

Representativeness of the sample

Additional descriptive statistics

Table A4 shows the results of t-tests comparing the means of several variables between union members (Yes) and non-members (No).

Union members differ significantly from non-members across a range of labour market characteristics. They earn substantially higher hourly wages (both in levels and logs), have longer job tenure, and are less likely to hold temporary contracts. Union members are also more likely to be employed in the public sector and to have participated in training, and they tend to be older and slightly more likely to be women. Although union members work marginally fewer weekly hours on average, the difference is small in magnitude. By contrast, ICT skill levels do not differ significantly between the two groups. Overall, these descriptive results coming from our sample suggest that union membership is associated with more stable and better-remunerated employment profiles.

Table A4: t-test statistics

Union member	No	Yes		
	μ_{no}	μ_{yes}	t	p-value
ln(hourly wages)	2.01	2.34	-0.33	0.000
hourly wages	9.71	13.33	-3.62	0.000
weekly hours	37.94	37.57	0.37	0.004
ictskills	4.15	4.20	-0.05	0.266
temporary (share)	0.14	0.09	0.05	0.000
tenure	9.40	13.01	-3.61	0.000
public	0.29	0.47	-0.18	0.000
training	0.60	0.69	-0.09	0.000
gender	0.76	0.84	-0.08	0.000
age	42.84	45.04	-2.20	0.000

Table A5: descriptive statistics by country, sector, firm size and education

	A trade union: F_UNION: Are you a member of ...?		
	No	Yes	Total
N	15,530 (76.9%)	4,675 (23.1%)	20,205 (100.0%)
Country			
Austria	435 (2.8%)	213 (4.6%)	648 (3.2%)
Belgium	301 (1.9%)	291 (6.2%)	592 (2.9%)
Bulgaria	548 (3.5%)	120 (2.6%)	668 (3.3%)
Croatia	254 (1.6%)	82 (1.8%)	336 (1.7%)
Czech Republic	656 (4.2%)	82 (1.8%)	738 (3.7%)
Denmark	69 (0.4%)	176 (3.8%)	245 (1.2%)
Estonia	396 (2.5%)	33 (0.7%)	429 (2.1%)

Finland	186 (1.2%)	359 (7.7%)	545 (2.7%)
France	1,487 (9.6%)	240 (5.1%)	1,727 (8.5%)
Germany	1,443 (9.3%)	296 (6.3%)	1,739 (8.6%)
Greece	800 (5.2%)	158 (3.4%)	958 (4.7%)
Hungary	649 (4.2%)	74 (1.6%)	723 (3.6%)
Iceland	22 (0.1%)	115 (2.5%)	137 (0.7%)
Ireland	358 (2.3%)	128 (2.7%)	486 (2.4%)
Italy	1,370 (8.8%)	330 (7.1%)	1,700 (8.4%)
Latvia	277 (1.8%)	39 (0.8%)	316 (1.6%)
Lithuania	306 (2.0%)	28 (0.6%)	334 (1.7%)
Luxembourg	182 (1.2%)	156 (3.3%)	338 (1.7%)
Netherlands	479 (3.1%)	146 (3.1%)	625 (3.1%)
Norway	122 (0.8%)	170 (3.6%)	292 (1.4%)
Poland	1,597 (10.3%)	238 (5.1%)	1,835 (9.1%)
Portugal	597 (3.8%)	107 (2.3%)	704 (3.5%)
Romania	857 (5.5%)	240 (5.1%)	1,097 (5.4%)
Slovakia	311 (2.0%)	67 (1.4%)	378 (1.9%)
Slovenia	268 (1.7%)	75 (1.6%)	343 (1.7%)
Spain	1,387 (8.9%)	280 (6.0%)	1,667 (8.3%)
Sweden	173 (1.1%)	432 (9.2%)	605 (3.0%)
sector			
Agriculture	190 (1.2%)	28 (0.6%)	218 (1.1%)
Medium-high-tech man	683 (4.4%)	189 (4.0%)	872 (4.3%)
Medium-low-tech man	539 (3.5%)	144 (3.1%)	683 (3.4%)
Low-tech man	1,152 (7.4%)	304 (6.5%)	1,456 (7.2%)
HKI serivces	1,241 (8.0%)	264 (5.7%)	1,505 (7.5%)
KI market serivces	1,473 (9.5%)	367 (7.9%)	1,840 (9.1%)
KI financial services	639 (4.1%)	203 (4.3%)	842 (4.2%)
Other KI sev	1,334 (8.6%)	491 (10.5%)	1,825 (9.0%)
Other services	2,208 (14.2%)	690 (14.8%)	2,898 (14.3%)
Construction	561 (3.6%)	127 (2.7%)	688 (3.4%)
Trade	1,903 (12.3%)	331 (7.1%)	2,234 (11.1%)
Education	1,403 (9.0%)	750 (16.1%)	2,153 (10.7%)
Tourism	709 (4.6%)	126 (2.7%)	835 (4.1%)
Healthcare	1,493 (9.6%)	658 (14.1%)	2,151 (10.6%)
Working in the public sector			
0	11,050 (71.2%)	2,466 (52.7%)	13,516 (66.9%)
1	4,480 (28.8%)	2,209 (47.3%)	6,689 (33.1%)
Firm size			
1 to 10	3,074 (19.8%)	493 (10.5%)	3,567 (17.7%)
11 to 49	4,383 (28.2%)	1,219 (26.1%)	5,602 (27.7%)
50 to 249	4,035 (26.0%)	1,335 (28.6%)	5,370 (26.6%)
250 or more	4,038 (26.0%)	1,628 (34.8%)	5,666 (28.0%)
Education			
Lower secondary education or below (ISCED 0-2)	1,319 (8.5%)	415 (8.9%)	1,734 (8.6%)
Upper secondary or post-secondary non-tertiary education (ISCED 3-4)	5,961 (38.4%)	1,714 (36.7%)	7,675 (38.0%)
Tertiary education (ISCED 5-8)	8,246 (53.1%)	2,537 (54.3%)	10,783 (53.4%)
Don't know/No Answer	4 (0.0%)	9 (0.2%)	13 (0.1%)

Matching results

The matching algorithm used was the PSM, namely psmatch2 in Stata. The selected variables were all those that may affect the propensity to become a member of a union: contract, age, country, tenure, gender, occupation, sector, firm size, average number of working hours in a week.

psmatch2 F_UNION1 i.cntrct i.A_AGE_CAT i.B_EMPDUR_CAT i.COUNTRYCODE i.A_SEX i.B_ISCOD1 i.B_NACE1 i.public i.B_SIZE i.E_HIGHED3 w_hours, outcome(ln_h_wage) common logit n(6) radius caliper(0.001)

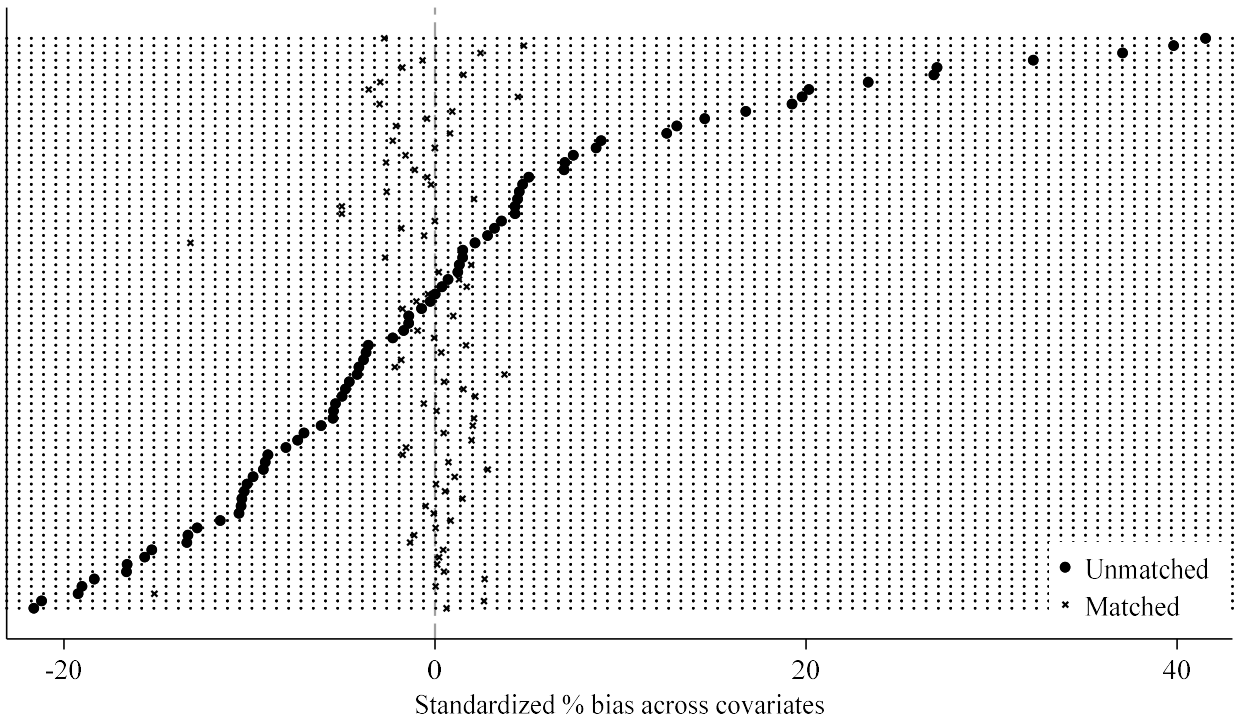
We than test for covariate imbalance with the command *pstest* and take the matching specification that was better in making the two groups more comparable. For the seake of simplicity, we report results only for the best model, other results are available upon request.

Table A6: overall imbalance test for the model

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.236	5459.70	0.000	10.4	7.5	122.8*	2.34*	100
Matched	0.009	124.61	0.001	1.8	1.5	22.8	0.85	100

* if B>25%, R outside [0.5; 2]

Figure A4: imbalance test for the model for each covariate



IV strategy

To be valid, an instrumental variable must be correlated with the dependent variable only through the endogenous variable (exogeneity condition) and, therefore, uncorrelated with the error term. As regards our instrument, it is reasonable to assume that the average *ictskills* level of workers in the same industry, size class and ISCO but employed in other countries does not affect the income of workers in the same industry, firm-size, and employment cell working in the reference country of individual *i*. More likely, within that cell, there may be firms competing in the European market (especially the large ones), which may encourage the use of ICT in firms in the country under consideration, but not an increase in the workers' wages.

In sum, also considering the matching and IV setting in column 4, it is reasonable to say that ictskills positively affect wages, whether being in a temporary contract leads to negative returns compared to permanent contracts. Regarding trade union membership, although the coefficient magnitude becomes close to zero when we employ the matching strategy, it has no significant effect on the salary. However, this setting does not provide us with further evidence of the role of trade union membership in shaping returns to *ictskills* and *contract*.