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**Industrial relations and firm-level innovation. A
comparative analysis of establishment data in
Germany and Italy**

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Industrial relations and firm-level innovation. A comparative analysis of establishment data in Germany and Italy

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Abstract

A large body of research has investigated the impact of industrial relations on workplace innovation. Econometric research based on U.S. data suggests that unions are detrimental to innovation, while evidence from Europe is more mixed. This points to the importance of ‘contextualized’ theorizing about the effects of industrial relations on firm-level innovation. Such an approach is common in qualitative research but is infrequently seen in quantitative studies. To address this gap, our article investigates the link between industrial relations and innovation at the firm level using establishment-level surveys from Germany (IAB establishment data) and Italy (INAPP-RIL establishment data). Our findings point to significant cross-country differences in how industrial relations institutions, including workplace representation and firm/sectoral agreements, can influence firm-level innovation. This cross-country variation underscores that similar institutions may serve different functions depending on the specificities of the national context.

JEL classification: J51, J54, J24 .

Keywords: Germany, Italy, collective bargaining, unions, innovation.

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1 Introduction

Are industrial relations good or bad for firm-level innovation? On the one hand, unions have been argued to undermine firms' innovation capacity because they disincentivize workers' individual efforts in the workplace, and they appropriate rents, reducing firms' incentives and resources to invest in innovation (Grout, 1984; Connolly et al., 1986; Bradley et al., 2017). On the other hand, industrial relations institutions can positively influence firms' absorptive capacity, that is, the ability of firms to assimilate and use knowledge (Cohen and Levinthal, 1990), because they affect how work is organized, and how skills are developed and utilized within the firm (Lam and Marsden, 2017; Cetrulo et al., 2022). Through collective bargaining, unions can help managers adopt high-involvement human resource practices such as teamwork, training and quality circles (Ulph and Ulph, 1994; Appelbaum et al., 2000; Wang et al., 2023) and serve as a bottom-up feedback channel that can lead to process improvements (Freeman and Medoff, 1984). Furthermore, by preventing employers from competing over labour costs, sectoral collective agreements have been argued to promote specialization in less price-sensitive market segment, which requires investments in technological and work organization innovations (Sorge and Streeck, 1987; Streeck, 1991).

The industrial relations context is likely to be at least partly responsible for the contradictory nature of the research findings (Addison et al., 2017a, p.73). Indeed, the presence of unions and collective agreements in the workplace cannot be assumed to have the same impact on firm-level innovation across countries because the mechanisms underlying industrial relations, the logics of action of collective actors and workplace politics differ even when national institutional arrangements might look similar (Locke and Thelen, 1995; Almond and Connolly, 2020). Qualitative studies have explored the role of these differences, comparing the influence of national, or even sectoral, institutional settings on workers' skills and (tacit) competences, and on firms' ability or mode to innovate (Maurice et al., 1986; Menezes-Filho et al., 1998; Lam, 2000; Casper and Matraves, 2003). In contrast, econometric studies focusing on industrial relations and innovation are usually limited to one country, predominantly Anglo-Saxon countries, and their theorization of unions' role for innovation is mostly decontextualized from the specific industrial relations system in which unions are embedded (Connolly et al., 1986; Menezes-Filho et al., 1998; Bradley et al., 2017).

Thus, there is a need for more systematic exploration of the role of institutional differences for firm-level innovation through econometric analysis. To our knowledge, there are

only few econometric studies that explore cross-country differences (Cardullo et al., 2015; Bryson and Dale-Olsen, 2023), or that explicitly highlight the role of contextual specificities in their results (Addison et al., 2017a). This article contributes to this budding literature and represents an attempt to deliver contextualized econometric research on the relationship between industrial relations and firm-level innovation.

We focus on Italy and Germany and use the German Institute for Employment Research (IAB) Establishment Panel and the Italian Rilevazione Imprese e Lavoro (RIL) establishment dataset, managed by INAPP, for the analysis of the impact of industrial relations in the workplace on firm-level innovation. To the best of our knowledge, this is the first time that the two datasets have been used together. We carefully built the two national datasets so that the variables mirror each other as closely as possible. Yet, our analysis highlights how national differences in the scope and strength of industrial relations institutions affect firm-level innovation. Given the nature of our data, we do not draw inferences between countries but use within-country correlations between industrial relations institutions and innovation to show the value of different industrial relations variables within each national context and compare these effects – see for a similar approach was the study on unions and innovation in Norway and UK by Bryson and Dale-Olsen (2023) or the study on incentive pay in France and UK by Marsden and Belfield (2010).

The next section will illustrate the academic debate while the third section will describe the main differences and similarities in the industrial relations context respectively in Italy and in Germany and develop the hypotheses. The methodology section illustrates the German IAB establishment-level dataset and the Italian INAPP-RIL establishment dataset and justifies our variable choice and econometric strategy. The fifth section presents our results, and the sixth section discusses them and draws theoretical implications.

2 Theoretical considerations on industrial relations and innovation

In the academic literature, the verdict is still out on the question of whether unions are good or bad for innovation. On the one hand, scholars have argued that the presence of unions is detrimental to innovation. The main argument is that unions affect the level of investments in R&D or new technologies because they raise labour costs and decrease profitability, reducing the firms' resources that could be invested in innovation (Connolly et al., 1986). An ancillary argument is that unions disincentivize investments because they

can increase wage demands after investments are made, leading to ex-ante under investment by employers, who fear post-investment hold-up problems (Groux, 1984). Furthermore, unions can negatively impact employees' contribution to innovation, in terms of skills, competences, and commitment. For instance, Bradley et al. (2017) found that the presence of unions reduces the consequences of withdrawing effort and, therefore, negatively impacts the productivity of inventors; they also suggest that the presence of unions incentivizes the departure of the firms' talents who most contribute to innovation because it reduces wage premiums by compressing the wage distribution. Even qualitative studies e.g. in the UK and North America during the Eighties and Nineties found that unions resisted the introduction of workplace innovations such as new technologies, new training systems or human resource practices for fear of losing control over working conditions, occupational boundaries or, more generally, of losing traditional union jobs (Lane, 1994; Bratton, 2001).

On the other hand, unions have been argued to positively influence firm-level innovation. The main mechanism is that unions represent an important voice channel for workers: they provide bottom-up feedback for improving processes and can assist in the implementation of new technologies or training measures (Freeman and Medoff, 1984). Furthermore, through their representative functions, they increase workers' long-term commitment and reduce turnover, which has been shown to negatively impact innovation due to the 'exit' of employees' firm-specific knowledge (Wang et al., 2015). Evidence of these mechanisms was found in qualitative studies e.g. in the German and Swedish manufacturing industry in the Eighties (Sorge and Streeck, 1987; Berggren, 1994), but also in more recent econometric studies on the impact of workers' voice on technology adoption in Europe (Belloc et al., 2023) or on investments in intangible assets in Italy (Cetrulo et al., 2022). Claims that unions are detrimental to innovation are mainly supported by research findings from the US or other Anglo-Saxon countries, while research suggesting that there might be a positive (or nihil) effect of unions on firm-level innovation is mainly based on European evidence (see Doucouliagos and Laroche (2013); Bryson and Dale-Olsen (2023); Addison et al. (2017a) for a similar observation).

These differences are lively due to the institutional context in which unions act. For instance, in Europe, sectoral agreements usually set basic salary bands and cover also companies that do not have workplace representation. Company-level agreements, bargained by workplace representatives, focus on variable pay elements, working time, benefits and other working conditions (Doellgast and Benassi, 2020). This suggests that workplace

unions in many European countries might not have the same rent-extracting effect found in the US (see also [Menezes-Filho and Van Reenen \(2003\)](#) for a similar point) and that, depending on the industrial relations system, the effects of workplace representation and collective agreements need to be considered separately ([Benassi and Vlandas, 2022](#)). Furthermore, encompassing sectoral agreements should prevent employers from competing over labour costs and therefore push them to invest in new technologies, training and/or other workplace innovations to increase workers' productivity and to specialise in less price sensitive high value-added market niches ([Sorge and Streeck, 1987](#); [Streeck, 1991](#)). These mechanisms of 'paving the high road' were observed, for instance, in qualitative studies in the German manufacturing industry ([Sorge and Streeck, 2016](#)) and in the Danish telecom industry ([Doellgast and Marsden, 2019](#)). Secondly, encompassing sectoral agreements have been argued to reduce workers' incentives to change their employer, thus promoting employment stability and investment in firm-specific skills ([Hall and Soskice, 2001](#)). These mechanisms do not necessarily apply to company-level agreements, especially in countries where these represent an addition to sectoral collective agreements. Company-level agreements are argued to better align the incentives of managers and employees/unions than sectoral bargaining or competitive wage-settings, favouring the resolution of conflicts ([Grimshaw et al., 2017](#)). Unions also influence directly firms' strategies via the company-level agreements, orienting them towards value-creation and innovation ([Belloc et al., 2022](#); [Cetrulo et al., 2022](#)), given their expectation of rising wages and employment in the medium and long-term ([Ulph and Ulph, 1994](#); [Cardullo et al., 2020](#)).

This discussion points to the importance of taking into account differences across industrial relations systems in studies on innovation, as unions might follow different logics of action or pursue different interests depending on the political, institutional and socio-economic context they are embedded in ([Locke and Thelen, 1995](#)). While the econometric literature has taken into consideration an increasing variety of industrial relations systems including the US ([Bradley et al., 2017](#)), UK ([Wang et al., 2023](#)), Germany ([Addison et al., 2017a](#)), and Italy ([Cetrulo et al., 2022](#)), there is still scant literature that attempts to contextualize the theorization of the relationship between industrial relations and innovation, especially at the organizational level. Notable exceptions in the econometric literature are the analysis of the effect of unions on innovation in the UK and Norway by [Bryson and Dale-Olsen \(2023\)](#) and the implicit comparison between their findings on German industrial relations and innovation and existing findings from the US context by [Addison et al. \(2017a\)](#).

We want to contribute to develop this literature through our analysis of unions, collective agreements and innovation respectively in Italy and Germany. By so doing, we answer the call for more research aimed at rebalancing the current Anglo-Saxon bias in the literature on unions and innovation (Menezes-Filho and Van Reenen, 2003). Furthermore, given the similarities between the industrial relations systems in the two countries (see section below), uncovering differences in their effect on firm-level innovation allows us to make an even stronger case for a contextualised economic approach. The next section illustrates the institutional context and develops hypotheses based on institutional differences and similarities.

3 Industrial relations institutions and innovation in Italy and Germany

The institutions of industrial relations respectively in Italy and Germany present both similarities and differences. First, in both countries, unions and employer organisations represent workers and employers within a specific industry; thus, collective bargaining takes place primarily at sectoral level. However, sectoral collective agreements have higher coverage in Italy than in Germany. In Italy the coverage of over 90% (Biagiotti et al., 2020) is achieved thanks to the right to fair remuneration set in the Italian Constitution, which labour courts interpret as the collectively negotiated salary. Therefore, companies are, albeit indirectly, legally required to apply collective agreements, or they risk legal liability. In Germany, extension to the whole sector occurs only under specific circumstances, and the application of the collective agreement depends on companies' membership in the employer organisation (with some exceptions), which is not mandatory. Thus, the collective bargaining coverage in Germany is around 50-60% (OECD, 2024).

Second, workplace representative bodies benefit of stronger bargaining rights in Germany than in Italy. German works councils have codetermination rights on issues such as working time, variable pay, and aspects of work organization. Furthermore, German works councils often use their codetermination rights to bargain over strategically important issues such as investments in dual vocational training and training more generally, thereby expanding their influence (Benassi, 2024). In Italy workplace union representatives have only the right to information and consultation, so they rely more on employers' cooperative attitudes and their mobilization power in the workplace to successfully negotiate over those issues. Beyond the strength of institutionalized rights, the logic of

action of workers' representation bodies in Italy and in Germany also differs. The German industrial relations system is characterized by the 'dual-channel' representation, mandating works councils to represent both workforce and company interests, while the Italian model is single-channel, with stronger formal connections between unions and employee representatives. Typically, German works councils are considered more attuned to competitiveness issues than their Italian counterparts (Benassi et al., 2019).

Third, in both Germany and Italy, company-level agreements may deviate from sectoral standards if such deviations preserve or create jobs, improve company's competitiveness, and are approved by sectoral unions and employers' associations (Jäger et al., 2022, p.61). Additionally, companies can implement company-level agreements in place of the sectoral collective agreement in Germany and in Italy. Yet, both 'in peius' deviations and the exclusive application of firm-level agreements are more common in Germany. Specifically, 10% of the companies are covered only by company agreements (Jäger et al., 2022), while Italian companies rarely deviate from sectoral agreements due to legal uncertainties in labor court rulings (Giardino, 2022). Thus, firm-level agreements are almost always negotiated in addition to the sectoral agreements.

This discussion has highlighted that, while the institutional settings - including 'sectoral agreements', 'union presence in the workplace' and 'firm-level agreements' - might appear similar between Italy and Germany, these institutions are used differently or serve distinct purposes. The following hypotheses reflect the potential implications of such cross-country diversity.

Sectoral collective agreements are applied differently across the two countries. In Germany, sectoral coverage is voluntary for firms, so they signal cooperative social partnership that is typically positive for firm-level innovation. Furthermore, a compressed distribution of relatively high wages has been argued to have a positive effect on investments in innovation (Sorge and Streeck, 1987). In contrast, in Italy, practically most companies apply sectoral agreements - despite the rise of "pirate" agreements (Lucifora and Garnero, 2020) - so they are not likely to provide a competitive advantage to companies in terms of innovation. Thus, we could derive the following expectations:

- HP_{1a} : In Germany, sectoral collective agreements are likely to have a positive impact on firm-level innovation.
- HP_{1b} : In Italy, sectoral collective agreements are likely to have no significant impact on innovation.

In both countries, unlike the US experience, we would not expect union presence to negatively affect innovation through their rent-extracting activities, as wage negotiations occur mainly at the sectoral level, while workplace negotiations cover a broad range of issues, including future employment (Ulph and Ulph, 1994). German works councils have stronger bargaining rights than workers' representative bodies in Italian companies, and the former also have a clear mandate to contribute to companies' competitiveness in the medium/long-term, with the purpose of securing employment for the future. Thus, German firms should benefit of strong social partnership in the workplace with a limited risk of 'hold-up' problems. Indeed, while the impact of works councils on product innovation and R&D investments has been found to be non-significant (Addison et al., 2007, 2017a), their impact on process innovation has been confirmed as positive (Addison et al., 2017a). On the other hand, union representation in Italian workplaces is weaker, and unions might be under pressure to obtain short-term gains, preventing them from committing to medium/long-term innovation goals, because their bargaining power primarily relies on the mobilisation of their members through elections and industrial action. Thus, we expect the following:

- HP_{2a} : Works councils in Germany are likely to have a large positive impact on firm-level innovation.
- HP_{2b} : Workers' representatives in Italy are likely to have a weak or non-significant positive impact on firm-level innovation.

Finally, firm-level agreements likely exert varying influences on firm-level innovation. Due to the specific variable construction in the IAB establishment survey (see following section), our analysis is confined to those firm-level agreements in Germany that are used as an alternative to sectoral agreements. These agreements signal cooperative relationships in the workplace and provide wage premia similar to those found in sectoral agreements, but exclusively for the company's workers (Addison et al., 2014, 2017b). Indeed, they are associated with lower turnover (Pfeifer, 2011). Firm-level agreements in Italy mostly integrate and expand upon sectoral agreements, signalling the presence of 'active' voice channels within the company and of cooperative workplace relations (Cetrulo et al., 2022; Russo et al., 2019). Thus, even though firm-level agreements serve different purposes in each national context, we can formulate the following hypotheses:

- HP_{3a} : Firm-level agreements are likely to be positively correlated with firm-level innovation in Germany.

- HP_{3b} : Firm-level agreements are likely to be positively correlated with firm-level innovation in Italy.

4 Data and methods

The empirical analysis leverages a unique combination of independent data sources, access to which was secured through a detailed application process. This study utilizes a German IAB dataset and the Italian INAPP-RIL dataset. To our knowledge, this is the first time that the two datasets are used together for comparing Germany and Italy industrial relations structures and their respective impact on firms' innovation output.

Data on Italy

The Italian dataset RIL (Rilevazione Imprese e Lavoro), managed by INAPP, collects a broad array of information on the main characteristics of Italian firms. The survey targets non-agricultural firms active in the private sector excluding cooperatives and other specific legal forms of enterprises, such as individual companies, consortia, and associations. Its sampling strategy is derived from a stratification process based on size, regional location, and sector of the economic activity. With six waves available from 2011 to 2018, each wave represents a sample of around 30,000 Italian firms. Moreover, a subset of companies participating in previous waves is observed across different editions of the survey, facilitating longitudinal analysis for about 34% of the final sample. The survey employs Computer-Assisted Telephone Interview (CATI), preceded by the distribution of questionnaire to the respondents.

Data on Germany

The German dataset is extracted from the most comprehensive establishment level survey conducted in the country, the Institute for Employment Research (IAB) Establishment Panel. This annual survey of establishments encompasses a wide array of industries and establishment sizes nationally. It is based on a disproportionately stratified sample according to establishment size, industry and federal state. It provides data on a wide range of employment topics including labour force composition and turnover, wages, working hours, training, investment, innovation and covers around 16,000 establishments in all sectors of the economy. Most establishments are surveyed face-to-face (over 70% on average). The survey comprises a longitudinal component allowing us to analyze companies

tracked over time using the IAB-provided “merging option do file” (for more details see [Ellguth and Kohaut \(2021\)](#); [Fischer et al. \(2009\)](#)).

Comparative analysis

As reported in Tables 1 and 2, the selection of variables for the econometric models was carefully designed to ensure comparability across the two national datasets. The innovation variable, our main dependent variable, is coded as a dummy variable 1/0 that indicates the presence (or absence) of innovation in product (new or improved) and/or process (i.e., ICT, real estate, transport, and other facilities). The descriptive statistics in the Tables 6 and 7 in the Appendix reveal that 60% of German firms and 45% of Italian firms in our two panels engage in innovation. These statistics align with the European Innovation Scoreboard data that indicate a higher propensity to abstain from innovation among Italian companies (38.4%) compared to the EU average (30.7%) and to 12.9% of German companies. At the same time, Italy also boasts an important share of in-house product innovators introducing market novelties (16.6% vs 8.5% in Germany and 12.2% EU average), and both exceed the EU average in terms of in-house business process innovation (23.8% for Germany and 17.6% for Italy vs. 16.5% EU average) ([European Commission, 2023](#)). These higher-than-average rates can be attributed to the pivotal role of the manufacturing sector in both economies, where employment shares surpass the EU average (19.7% for Germany and 18.6% for Italy vs. 16.4% EU average), even though Germany leans more towards high-tech manufacturing compared to Italy ([Celi et al., 2018](#); [Cresti et al., 2023](#)).

Industrial relations variables are represented by three dummy variables indicating the presence of a workers’ representative body (works council in the case of Germany and unitary worker representations called RSU/RSA in Italy), the application of sectoral level agreements, and the application of firm-level agreements. As previously mentioned, in Germany, the variable refers to those firm-level agreements that are applied in alternative to sectoral agreements, whereas in Italy the firm-level agreements supplement sectoral agreements. Control variables are constructed to ensure comparability across the two countries, while acknowledging other confounding factors identified in the literature as influential on firms’ innovative capabilities. These include workforce composition by job titles (share of white-collar workers) as a proxy for human capital ([Aghion et al., 1998](#)), a variable for firms offering training courses ([Cirillo et al., 2023](#); [Addison et al., 2017a](#)), and non-standard job contracts, distinguishing between part-time and temporary workers ([Cetrulo et al., 2019](#); [Reljic et al., 2023](#)).

Italian Dataset	Type of variable	Question/Questions in the survey
Dependent variable		
<i>Innovation</i>	Dummy equal to 1 if the firm has carried out product or process innovation (or both) in the last three years, 0 if otherwise	Has the firm carried out innovations in the range of products and services or in the production process in the past 3 years?
Explanatory and control variables		
<i>Trade union in workplace</i>	Dummy equal to 1 if the RSU/RSA is present in the firm, 0 if otherwise	Are forms of trade unions representation present in the firm?
<i>Firm level agreement</i>	Dummy equal to 1 if the firm has activated second-level bargaining, 0 if otherwise	Has the firm activated second-level bargaining?
<i>Sectoral Collective Agreement</i>	Dummy variable equal to 1 if the firm is covered by a sectoral collective agreement, 0 if otherwise	Does the company apply one or more national sectoral collective agreements?
<i>Part time workers</i>	Share of part-time workers over total workers	What is currently the total number of part-time employees?
<i>Temporary workers</i>	Share of temporary workers over total workers	What is currently the number of employees of the enterprise (workers on the payroll, excluding contractors of all forms and types) employed on a fixed-term basis [excluding on-call contract]?
<i>Training for workers of the firm</i>	Dummy equal to 1 if training initiatives were organized during the previous year, 0 if otherwise	Were training initiatives organized for firm's employees during last year?
<i>Sector</i>	Dummy equal to 1 if the sector of the firm belongs to manufacturing, 0 if otherwise	Main economic activity sector of the enterprise
<i>White Collars Workers</i>	Share of white-collars workers over total workers	What is currently the total number of workers employed by the enterprise (workers on the payroll, excluding consultants and collaborators of all forms and types) qualified as white-collars?
<i>Size of the firm</i>	Number of employees	What is currently the total number of workers employed by the enterprise (workers on the payroll, excluding consultants and collaborators of all forms and types)?
<i>Geographical Area</i>	Categorical variable equal to 1 for Northern Italy, 2 for Central Italy, 3 for Southern Italy and Islands	Registered office location of the enterprise (City/Province)
<i>Age of the firm</i>	Year of establishment	Year of establishment of the enterprise
<i>Revenues per employees</i>	Total revenues divided by the total number of employees	Referring to the company's 2014 financial statements, what is the amount of the company's revenues?
<i>Employment Loss</i>	Dummy equal to 1 if number of total employees in 2018 is lower than the number of total employees in 2015	

Table 1: Variables from the RIL dataset

German Dataset	Type of variable	Question/Questions in the survey
Dependent variable		
<i>Innovation</i>	Dummy equal to 1 if the firm has carried out product or process innovation (or both) in the last three years, 0 if otherwise	In the last business year, did your establishment start to offer a product/service that had been available on the market before, improve or further develop a product or service which had previously been part of your portfolio, invest in ICT or production facilities, plant and equipment, furniture and fixture?
Explanatory and control variables		
<i>Trade union in workplace</i>	Dummy equal to 1 if the work council is present in the firm, 0 if otherwise	Does your establishment have a works or staff council elected in accordance with the Works Constitution Act or the Staff Representation Act?
<i>Firm level agreement</i>	Dummy equal to 1 if the firm and the trade union have concluded a firm agreement, 0 if otherwise	Is this establishment bound by: a) an industry-wide wage agreement; b) a company agreement concluded by the establishment and the trade unions; c) not bound by a collective agreement (dummy=1 if b)
<i>Sectoral Collective Agreement</i>	Dummy equal to 1 if the firm is bounded by an industry-wide agreement, 0 if otherwise	Is the establishment bound by: a) and industry-wide agreement; b) a company agreement concluded by the establishment and trade unions; c) not bound by a collective agreement (dummy=1 if a)
<i>Part time workers</i>	Share of part time workers over total workers	Are there part-time workers among the employees? (Indicate the number)
<i>Temporary workers</i>	Share of fixed term workers over total workers	Did the total number of employees include employees with fixed-term contracts? (Indicate the number)
<i>Training for workers of the firm</i>	Dummy equal to 1 if internal training was organised, 0 if otherwise	For which of the following internal or external training courses did your establishment release staff and cover the expenses in full or in part? (internal training courses, seminars, workshops)
<i>Sector</i>	Dummy equal to 1 if the sector of the firm belongs to manufacturing, 0 if otherwise	Please indicate which industry branch your establishment is now active in using the industry classification table on the next page.
<i>White Collars Workers</i>	No. empl., white-coll./clerks, university degree, total	Indicate total number of employees requiring a university degree.
<i>Size of the firm</i>	Number of employees	Please indicate the total number of employees.
<i>Geographical Area</i>	Dummy variable equal to 1 if West Germany, 0 if East Germany	
<i>Age of the firm</i>	Year of establishment	Year of establishment of the enterprise
<i>Profits</i>	Dummy variable equal to 1 if i), ii), iii), 0 if otherwise	Please give your assessment of the profit situation of your business in the last business year. Profitability was i) very good; ii) good; iii) satisfactory; iv) sufficient; v) unsatisfactory.
<i>Employment Loss</i>	Dummy variable equal to 1 if number of total employees in 2018 is lower than the number of total employees in 2015	

Table 2: Variables from the IAB dataset

The distinction between manufacturing and service sectors captures the broader notion of technological paradigms and sectoral systems of innovation (Malerba, 2002), while accounting for firms' specific characteristics such as the size, age and profitability (Coad et al., 2016; Petruzzelli et al., 2018). Given the significant regional disparities in both countries (Iuzzolino et al., 2011; Kluge and Weber, 2018), the analysis differentiates firms' geographical locations by macro-regional areas. Lastly, to account for potential motivations linking innovation decisions to labour-saving objectives, we include a variable for company-level employment loss during the period under study. For both countries, the sample is restricted to companies with more than two employees.

We now present descriptive evidence of the relationship between innovation and our main industrial relations variables: the presence of trade unions at the establishment level, sectoral agreement coverage and the presence of firm-level agreements. The bar graphs in Figures 1-3 illustrate the interaction between innovation and these variables. Figure 1A reveals that in Italy companies covered by sectoral agreements are more likely to innovate, although the majority of firms, regardless of agreement status, do not innovate. Conversely, Figure 1B shows that in Germany, a significant portion of companies innovate, particularly those without sectoral agreements. In Germany, the presence of a works council at the establishment level correlates with a higher share of innovating firms compared to non-innovating ones, as depicted in Figure 2B. In Italy, although firms not innovating remain the majority whether trade unions are present or not, the gap between the number of innovating and non-innovating firms narrows when a trade union is present, as shown in Figure 2A. Figure 3A highlights a distinctive scenario for Italy, where firms with firm-level agreements are more likely to innovate than those without such agreements. In Germany, despite the relatively low share of firms covered by firm-level agreements, a slightly higher proportion of these firms innovate, as indicated in Figure 3B. To better explore the relationship between firms' innovative capabilities and industrial relations, we proceed with a formal econometric analysis.

Figure 1: Innovation and Sectoral Collective Agreements

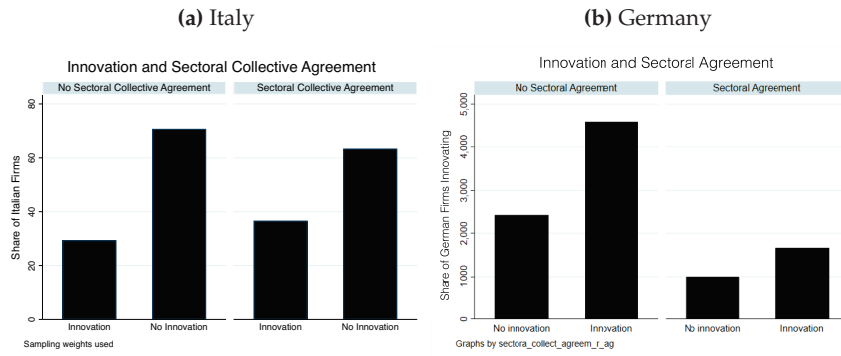


Figure 2: Innovation and Trade Unions

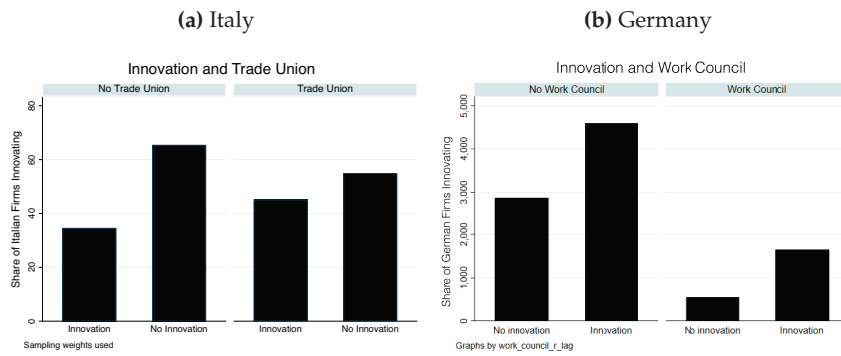
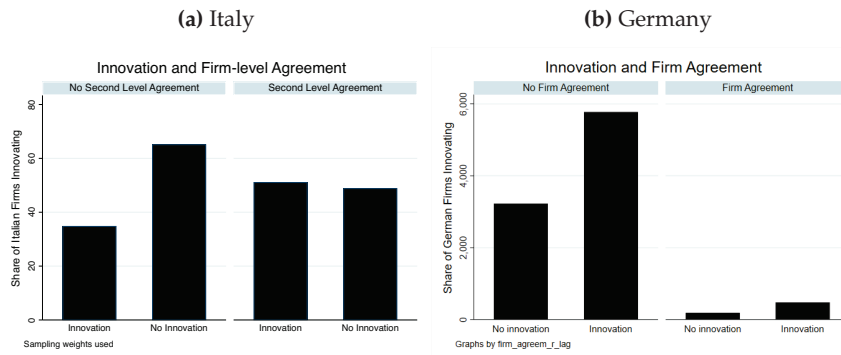


Figure 3: Innovation and Firm-level Agreements



5 Econometric strategy and results

5.1 Econometric model

The goal of the empirical analysis is investigating which factors affect the probability that German and Italian companies introduce any product or/and process innovation, identifying in particular the role played by industrial relations institutions. Therefore, the baseline model can be written as follows:

$$P(y = 1|\mathbf{x}) = G(\beta_0 + \beta_1x_1 + \dots + \beta_kx_k) = G(\beta_0 + \mathbf{x}\boldsymbol{\beta}) \quad (1)$$

Where $P(y = 1|\mathbf{x})$ indicates the probability of success (the firm innovates), given a set of explanatory variables \mathbf{x} . To ensure that the probabilities computed in [1] lie between zero and one, we assume that the function $G(\beta_0 + \mathbf{x}\boldsymbol{\beta})$ is non-linear and that it corresponds to the cumulative distribution function of a standard logistic random variable for real numbers z , as illustrated below (Wooldridge, 2012, pp.585-586).

$$G(z) = \exp(z)/[1 + \exp(z)] = \Lambda(z) \quad (2)$$

The key explanatory variables relate to the main characteristics of social actors within the firm, namely the presence of a trade union/work council, the presence of sectoral agreements, and the presence of firm-level agreement. As explained above, several control variables are included in the model to account for other crucial factors that can largely affect innovative capabilities. First, company-level controls include: i) workforce composition in terms of job contract and occupation (% of part-time workers, % of temporary workers, % of white-collars workers); ii) employment growth/loss; iii) profits of the establishment; iv) the presence of training courses delivered to employees. Moreover, we control for the type of sector distinguishing between manufacturing and service sectors and for the geographical location of the firm. All the explanatory variables are lagged and refer to the previous wave/year available to reduce the risk of endogeneity and reverse causality. Therefore, the period covered is respectively 2015-2017 for Germany and 2015-2018 for Italy.

5.2 Results

The German analysis shows that sectoral collective agreements have a negative significant effect on firm-level innovation while the presence of works councils has a positive significant impact on innovation. Firm-level agreements turn out to be negative but non-significant in the final model. The Italian analysis, on the other hand, shows that all our main explanatory variables - trade unions, firm-level agreements, and sectoral agreement coverage - have a positive and statistically significant effect on innovation. Among the controls, training, belonging to the manufacturing sector, and size show the strongest positive and significant effects on firm-level innovation in both countries.

We further explore the differentiated impact that our main explanatory variables have on the probability of innovation through the computation of their average marginal effects (AME). Given that all three independent variables are dummies, the AME needs to be interpreted as the estimated average impact on the firm's probability of innovating once we move from a status of, for instance, no trade unions in the workplace to the presence of unions. As shown in Table 3, in Italy the three variables have a similar effect in terms of magnitude, as their impact is within the range from 3% to 4.5%. Still, the positive effect of the presence of trade unions in the workplace results higher than the effect of, respectively, the sectoral coverage and company-level agreement coverage. In the case of Germany, we consider only the variables that resulted statistically significant, namely the presence of a works council and of a sectoral agreement. As in the Italian case, the presence of work council has a significantly positive, albeit smaller, effect, while the presence of sectoral collective agreements has a negative impact on our explanatory variable. It is also worth noting that, as suggested by the width of the confidence intervals, the effect of works councils on innovation seems to be more consistent across German companies, while the variation observed for the corresponding variable 'union presence' is greater across Italian companies.

Several robustness analyses have been performed to better assess the validity of our results. First, the adopted stepwise procedure was validated through the computation of the likelihood ratio tests for each pair of models per country, rejecting in all cases the restricted model (as shown in Table 9 in the Appendix) and confirming the validity of a full model specification. Moreover, for both models, we estimated the ROC curve that graphically shows their performance, looking at both the sensitivity (the fraction of observed positive events classified as positive) and specificity (the fraction of observed negative events classified as negative), along the variation of the classification threshold. The bigger the area

	<i>Model 0</i>	<i>Model 1</i>	<i>Model 2</i>
Trade Union	0.3667*** (0.0540)	0.1498** (0.0587)	0.2027*** (0.0597)
Second Level Agreement	0.3664*** (0.0689)	0.1797** (0.0730)	0.1560** (0.0737)
Sectoral Level Agreement	0.2179*** (0.0802)	0.1895** (0.0848)	0.1809** (0.0865)
Training	0.5057*** (0.0455)	0.5416*** (0.0479)	0.5080*** (0.0486)
Age		-0.0036** (0.0016)	-0.0040** (0.0016)
Size		0.0004** (0.0002)	0.0004** (0.0002)
Manufacturing		1.0534*** (0.0477)	1.1472*** (0.0509)
Central Italy		-0.2243*** (0.0584)	-0.1955*** (0.0591)
Southern Italy and Islands		-0.3517*** (0.0582)	-0.2809*** (0.0591)
Revenues per employee		-5.91e-10 (1.52e-09)	-2.59e-10 (1.43e-09)
White Collars Workers (%)			0.6197*** (0.0779)
Part-time Workers (%)			-0.4276*** (0.1159)
Temporary Workers (%)			-0.0343 (0.1720)
Employment Loss			-0.4992*** (0.0478)
Constant	-0.8348*** (0.0801)	6.2304** (-3.0900)	6.8044** (-3.1456)
R-squared	0.0283	0.0771	0.0926
Number of observations	9,013	9,013	9,013

Table 3: Logistic regression analysis for Italy

	<i>Model 0</i>	<i>Model 1</i>	<i>Model 2</i>
Work Council	0.5825*** (0.0617)	0.2479*** (0.0669)	0.1722** (.0688)
Firm level agreement	-0.1216 (0.0969)	-0.1794* (0.0992)	-0.1647 (0.1002)
Sectoral level agreement	-0.3096*** (0.05118)	-0.3312*** (0.0528)	-0.2684*** (0.0539)
Training	0.5333*** (0.0454)	0.4514*** (0.0464)	0.429076*** (0.0469)
Age		-0.0032 (0.0028)	-0.0022 (0.0029)
Size		0.0041*** (0.0004)	0.0039*** (0.0004)
Manufacturing		0.4852*** (0.0584)	0.4929*** (0.0599)
West Germany		0.3260*** (0.0477)	0.3489 *** (0.0485)
Profit		0.2339*** (0.0628)	0.22524*** (0.0636)
% White Collars Workers			0.01479*** (0.0014)
% Part-time Workers			-0.0011 (0.0008)
% Temporary Workers			0.0020 (0.0017)
Employment Loss			-0.1577** (0.0479)
Constant	0.2528*** (0.0359)	6.1148 (5.7115)	4.0994 (5.8145)
Pseudo R-squared	0.0253	0.0532	0.0646
Number of observations	9,668	9,668	9,668

Table 4: Logistic regression analysis for Germany

Italian data	dy/dx	Std. Err.	z	P>z	[95% Conf.	Interval]
Trade Union	.0446	.0132	3.37	0.001	.0186	.0706
Second Level Agreement	.0343	.0163	2.10	0.035	.0023	.0662
Sectoral Level Agreement	.0392	.0186	2.11	0.035	.0027	.0757
German Data	dy/dx	Std. Err.	z	P>z	[95% Conf.	Interval]
Work Council	.0363	.0145	2.50	0.012	.0078	.0648
Sectoral Level Agreement	-.0566	.0113	-5.00	0.000	.0027	-0.0344

Table 5: Average Marginal Effects of IR variables (Italian and German data)

behind the curve, the higher will be the predictive power of the model. In our case, the two ROC curves record a value equal to 0.69 in the case of Italy and 0.66 for Germany, thereby attesting a sufficient predictive power (Figure 4a and 4b in the Appendix).

Given the specific assumptions behind the logistic regression model, the same empirical analysis has been tested against a probit econometric specification providing similar results (Table 10 and 11 in the Appendix). In the probit analysis, firm-level agreements in Germany are also negatively correlated but weakly significant. Given the high degree of complementarity between product and process innovation, our dependent variable includes any product and/or process innovation in the period under analysis. As a further robustness check, we run a multinomial logistic regression, where we test the correlation between our key explanatory variables and three distinct events corresponding to firms introducing: i) only product innovation, ii) only process innovation; iii) both product and process innovation. Industrial relations institutions, and in particular the presence of workers representative bodies, seem to play a more significant role on the probability that firms will introduce process innovation both in the case of Italy and Germany (Table 12 and 13 in the Appendix).

This finding is consistent with the evidence that process innovation is associated with organizational changes aimed at increasing labor productivity such as new production techniques or technologies (Pianta, 2001; Reljic et al., 2023), which workers' representatives can and want to influence to a greater extent than product innovation. We also run a further robustness check to account for another potential channel of firms' variation and heterogeneity, that is, the firm-specific 'innovation path'. We focus on those firms that were innovating in time $(t - j)$ - with j equal to 2 years in the case of Germany and 3 years in the case of Italy - but then stopped innovating at time t , 'losing' the status of innovator. Once we have identified these companies, we test for correlation between our industrial relations variables and changing status. In both countries, industrial relations variables seem to play no role on the probability that innovating firms stop introducing innova-

Hypotheses	Italy	Germany
<i>Sectoral Collective agreements</i>		
HP _{1a} : +*	Non confirmed (+*)	
HP _{1b} : NS		Non confirmed
<i>Union/works councils' presence</i>		
HP _{2a} : +*	Confirmed	
HP _{2b} : +(*)		Confirmed
<i>Firm-level agreements</i>		
HP _{3a} : +*	Confirmed	
HP _{3b} : +*		Non confirmed (-)

Table 6: Summary table of the research hypotheses

tion at time, with the exception of sectoral collective agreements in Italy, that negatively correlate to the probability of this worsening scenario (Table 14).

6 Discussion and conclusion

Table 5 below summarizes our results given our initial hypotheses. As for Italy, our hypothesis that sectoral agreements would have a non-significant impact on firm-level innovation given their almost complete coverage was not confirmed; even though 90% of the companies in the dataset apply the sectoral agreement (see Table 7 in the Appendix), it is still possible to identify a positive significant effect, that should nevertheless be interpreted cautiously. In Germany, instead, sectoral collective agreements have a significant negative effect on firm-level innovation. This finding is compatible with the results of [Addison et al. \(2017a\)](#), who found that the impact of sectoral collective agreements on innovation is predominantly negative and only positive and significant on process innovation if combined with the works council presence. An explanation for the negative effect of sectoral agreements could be that compressed wage premia are responsible for the loss of talents in those companies that are covered by collective agreements ([Bradley et al., 2017](#)) when the collective bargaining coverage in the sector is not encompassing.

Results confirm our second set of hypotheses as the presence of works councils is positive for innovation in German workplaces and in Italian workplaces (see [Addison et al. \(2017a\)](#); [Berton et al. \(2021\)](#) for similar results). The greater variation in the effect of trade union presence on innovation across Italian companies might indicate that company-specific unobserved characteristics (e.g. the quality of social partnership, the orientation or strategy of the employer or of the union) matter more in Italy than in Germany be-

cause unions have weaker statutory rights to influence employers' strategic investments in innovation.

Our third set of hypotheses on the positive effect of firm-level agreements on innovation is not confirmed in the case of Germany, where firm-level agreements seem to have a negative and non-significant (or weakly significant in the probit analysis) impact; unfortunately, the limited number of companies applying such agreements prevents a confident estimate (Addison et al., 2017a). However, firm-level agreements in Italy are positively associated with firm-level innovation. This result is compatible with another study on their effect on the firm-level investment in R&D, which was found to be positive and significant (Cetrulo et al., 2022). This suggests that Italian unions can force employers to make long-term investments through collective bargaining, exerting a positive pressure on firms' competitive strategies and innovative capabilities.

The results of the German analysis seem to reflect the profound transformation undergone by the German industrial relations system in the last thirty years (Keller and Kirsch, 2020). In particular, the argument on sectoral collective agreements serving as 'beneficial constraints' for firms (Streeck, 1991) does not seem to hold anymore. This might be due to the decline in collective bargaining coverage such that sectoral agreements do not prevent labour cost-based competition anymore; in contrast, they compress wage distribution within companies (Hirsch and Mueller, 2020), possibly preventing them from using wages and benefits to attract and retain high-skilled employees, as argued by (Diessner et al., 2022). Firm-level agreements seem to have a similar effect. Thus, firms without any agreements might be more successful innovators also thanks to their freedom to attract and retain human capital. At the same time, however, the positive effect of works councils suggests that the importance of workers' voice in the workplace for process improvement, commitment and trust remains important (Schnabel and Wagner, 1994; Addison et al., 2017a).

In contrast, in Italy industrial relations seem to have a positive significant effect on firm-level innovation. Firm-level agreements that integrate rather than replace sectoral standards and sectoral collective agreements exhibit a positive relation with firms' decisions to innovate and the presence of unions in the workplace, as well, turns to be relevant for innovation. The positive effect of sectoral agreements is an unexpected finding, which differs from the German analysis. A possible explanation is that the Italian system of industrial relations has remained more encompassing than the German system and, therefore, collective agreements are better able to serve as 'beneficial constraints' (Streeck,

1991). Indeed, while the cross-country comparison requires caution, the interpretation of findings from both countries seems to suggest that collective agreements undermine innovation when their coverage is patchy, possibly because they disadvantage covered firms *vis a vis* their uncovered competitors, that can implement effective strategies of talent attraction and retention. Thus, from our joint interpretation of the findings we can derive that encompassing collective agreements actually have a positive effect on innovation.

Yet, this argument cannot fully explain why the presence of unions in the workplace seems to be more supportive of innovation in the Italian case despite weaker bargaining rights. A further line of argumentation could be that industrial relations in Italy act in an “innovation context” that is weaker than in Germany and therefore they are more likely to make a greater difference in pushing firms to invest in innovation and in supporting workplace-based innovation processes. Indeed, the two countries present important differences in terms of innovative capabilities. According to the reports of the World Intellectual Property Organisation (WIPO), Germany is at the top of the ranking for global innovation both for innovation inputs (infrastructures, human capital and research, business sophistication, institutions, market sophistication) and outputs (creative outputs, knowledge and technology outputs). In contrast, Italy underperforms along most input dimensions, which points at the ‘weakness’ of the Italian context (WIPO, 2024). In particular, the German innovation system distinguishes itself for the much higher private and public investment in innovation-related activities and the better quality of human capital (European Commission, 2023). These structural heterogeneities are also reflected in the current uneven diffusion of Industry 4.0 technologies. While Italian companies show a certain delay in the adoption of I4.0 artifacts, such as internet of things and advanced robotics (Cirillo et al., 2021), German firms are at the European forefront of this new technological wave especially thanks to the huge public investment devoted to firms’ technological upgrading (Schuh et al., 2017).

Overall, our contextualized analysis and joint interpretation of the findings suggest that apparently similar industrial relations institutions can have a different impact on firm-level innovation depending on the broader context they are embedded in and the specific purpose they serve within that context. By so doing, this article contributes to demonstrate the value of ‘contextualized’ theorization also in the literature on industrial relations and innovation that predominantly relies on econometric analyses and enriches the emerging literature pointing in this direction (Addison et al., 2017a; Bryson and Dale-Olsen, 2023).

Furthermore, our findings from the cross-country comparison suggest the policy impli-

cation that encompassing collective bargaining and social partnership at work can make a positive difference, especially in countries where firm-level innovation is limited such as Southern Europe. This claim contradicts recent calls for decentralizing collective bargaining in order to increase company's competitiveness, which are mostly based on the German case itself (Dustmann et al., 2014; Terzi, 2016).

While covering two countries in our study led to rich and nuanced findings, the choice also came with trade-offs. Firm-level innovation is a complex phenomenon characterized by strong path dependent dynamics and affected by multiple factors, including organizational capabilities, which are difficult to capture in a comprehensive manner (Dosi et al., 2000). Yet, our empirical strategy had to focus on preserving the highest degree of comparability across the two countries while including the most relevant factors and correctly identifying industrial relations variables. Single-country studies can clearly adopt more sophisticated identification strategies, and we referred to the most relevant studies in this article to corroborate our findings for respectively Italy and Germany. While single country case studies remain therefore very important for the advancement of the debate, we believe that further cross-country research could help to uncover the interaction between industrial relations systems and other contextual factors that might support (or not) firm-level innovation.

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References

- Addison, J., P. Teixeira, K. Evers, and L. Bellmann (2014). Indicative and Updated Estimates of the Collective Bargaining Premium in Germany. *Industrial Relations: A Journal of Economy and Society* 53(1), 125–156.
- Addison, J. T., T. Schank, C. Schnabel, and J. Wagner (2007). Do Works Councils Inhibit Investment? *ILR Review* 60(2), 187–203.
- Addison, J. T., P. Teixeira, K. Evers, and L. Bellmann (2017a). Collective Bargaining and In-

- novation in Germany: A Case of Cooperative Industrial Relations? *Industrial Relations: A Journal of Economy and Society* 56(1), 73–121.
- Addison, J. T., P. Teixeira, K. Evers, and L. Bellmann (2017b). Contract Innovation in Germany: An Economic Evaluation of Pacts for Employment and Competitiveness. *British Journal of Industrial Relations* 55(3), 500–526.
- Aghion, P., P. Howitt, M. Brant-Collett, and C. García-Peñalosa (1998). *Endogenous Growth Theory*. MIT Press, Cambridge.
- Almond, P. and H. Connolly (2020). A manifesto for ‘slow’ comparative research on work and employment. *European Journal of Industrial Relations* 26(1), 59–74.
- Appelbaum, E., T. Bailey, P. Berg, and A. Kalleberg (2000). *Manufacturing advantage: Why high-performance work systems pay off*. Cornell University Press.
- Belloc, F., G. Burdin, L. Cattani, W. Ellis, and F. Landini (2022). Coevolution of Job Automation Risk and Workplace Governance. *Research Policy* 51(3), 1:18.
- Belloc, F., G. Burdin, and F. Landini (2023). Advanced Technologies and Worker Voice. *Economica* 90(357), 1–38.
- Benassi, C. (2024). Societal Institutions and Contradictions in the Workplace: A comparative analysis of lean management systems in Germany, Italy, and the United Kingdom. *Organization Studies* 45(3), 385–407.
- Benassi, C., L. Dorigatti, and E. Pannini (2019). Explaining divergent bargaining outcomes for agency workers: The role of labour divides and labour market reforms. *European Journal of Industrial Relations* 25(2), 163–179.
- Benassi, C. and T. Vlandas (2022). Trade unions, Bargaining Coverage and Low Pay: A Multilevel Test of Institutional Effects on Low-Pay Risk in Germany. *Work, Employment and Society* 36(6), 1018–1037.
- Berggren, C. (1994). NUMMI vs. Uddevalla. *Sloan Management Review* 35(2), 37–45.
- Berton, F., A. Ricci, and S. Dughera (2021). Are Unions Detrimental to Innovation? Theory and Evidence. *IZA Discussion Paper* (No. 14102).
- Biagiotti, M., S. Tomaro, and L. Venturi (2020). Un progetto per il nuovo archivio della contrattazione collettiva. In *XXII Rapporto. Mercato del lavoro e contrattazione collettiva*, pp. 227–242.

- Bradley, D., I. Kim, and X. Tian (2017). Do Unions Affect Innovation? *Management Science* 63(7), 2251–2271.
- Bratton, J. A. (2001). Why workers are reluctant learners: the case of the Canadian pulp and paper industry. *Journal of Workplace Learning* 13(7/8), 333–344.
- Bryson, A. and H. Dale-Olsen (2023). Unions, tripartite competition and innovation. *IZA Discussion Paper No. 13015*.
- Cardullo, G., M. Conti, and G. Sulis (2015). Sunk capital, unions and the hold-up problem: Theory and evidence from cross-country sectoral data. *European Economic Review* 76, 253–274.
- Cardullo, G., M. Conti, and G. Sulis (2020). A model of unions, two-tier bargaining and capital investment. *Labour Economics* 67, 101936.
- Casper, S. and C. Matraves (2003). Institutional frameworks and innovation in the German and UK pharmaceutical industry. *Research Policy* 32(10), 1865–1879.
- Celi, G., A. Ginzburg, D. Guarascio, and A. Simonazzi (2018). *Crisis in the European Monetary Union. A Core-Periphery Perspective*. Routledge, London.
- Cetrulo, A., V. Cirillo, and D. Guarascio (2019). Weaker jobs, weaker innovation. Exploring the effects of temporary employment on new products. *Applied Economics* 51(59), 6350–6375.
- Cetrulo, A., V. Cirillo, and F. Landini (2022). Organized Labour and R&D: Evidence from Italy. *GLO Discussion Paper*, No. 1195.
- Cirillo, V., L. Fanti, A. Mina, and A. Ricci (2021). Upgrading Italy's Industrial Capacity: Industry 4.0 across Regions and Sectors. *Sinapsi XI n.2*, pp.14–35.
- Cirillo, V., L. Fanti, A. Mina, and A. Ricci (2023). The Adoption of Digital Technologies: Investment, Skills, Work Organisation. *Structural Change and Economic Dynamics* 66, 89–105.
- Coad, A., A. Segarra, and M. Teruel (2016). Innovation and firm growth: Does firm age play a role? *Research Policy* 45(2), 387–400.
- Cohen, W. M. and D. A. Levinthal (1990). Absorptive Capacity: A new Perspective on Learning and Innovation. *Administrative Science Quarterly* 35(1), 128–152.

- Connolly, R. A., B. T. Hirsch, and M. Hirschey (1986). Union Rent Seeking, Intangible Capital, and Market Value of the Firm. *The Review of Economics and Statistics*, 567–577.
- Cresti, L., G. Dosi, F. Riccio, and M. E. Virgillito (2023). Italy and the Trap of GVC Downgrading: Labour Dependence in the European Geography of Production. *Italian Economic Journal* 9(3), 869–906.
- Diessner, S., N. Durazzi, and D. Hope (2022). Skill-Biased Liberalization: Germany’s Transition to the Knowledge Economy. *Politics & Society* 50(1), 117–155.
- Doellgast, V. and C. Benassi (2020). Collective bargaining. In *Handbook of research on employee voice*, pp. 239–258. Edward Elgar Publishing.
- Doellgast, V. and D. Marsden (2019). Institutions as constraints and resources: Explaining cross-national divergence in performance management. *Human Resource Management Journal* 29(2), 199–216.
- Dosi, G., R. R. Nelson, and S. G. Winter (2000). *The Nature and Dynamics of Organizational Capabilities*. Oxford University Press.
- Doucouliafos, H. and P. Laroche (2013). Unions and Innovation: New Insights from the Cross-Country Evidence. *Industrial Relations: A Journal of Economy and Society* 52(2), 467–491.
- Dustmann, C., B. Fitzenberger, U. Schönberg, and A. Spitz-Oener (2014). From Sick Man of Europe to Economic Superstar: Germany’s Resurgent Economy. *Journal of Economic Perspectives* 28(1), 167–188.
- Ellguth, P. and S. Kohaut (2021). Tarifbindung und betriebliche Interessenvertretung: Ergebnisse aus dem IAB-Betriebspanel 2020. *WSI-Mitteilungen* 74(4), 306–314.
- European Commission (2023). *European Innovation Scoreboard*. Directorate-General for Research and Innovation. Publications Office of the European Union.
- Fischer, G., F. Janik, D. Müller, and A. Schmucker (2009). The IAB Establishment Panel—Things Users Should Know. *Journal of Contextual Economics—Schmollers Jahrbuch* (1), 133–148.
- Freeman, R. B. and J. L. Medoff (1984). What Do Unions Do. *ILR Review* 38, 244–263.
- Giardino, D. (2022). Il contratto collettivo aziendale può derogare, anche in pejus, al contratto collettivo nazionale? *Giuricivile.it*, 5(online).

- Grimshaw, D., A. Koukiadaki, and I. Tavora (2017). Social Dialogue and Economic Performance. *Conditions of Work and Employment Series 89*.
- Grout, P. A. (1984). Investment and Wages in the Absence of Binding Contracts: A Nash Bargaining Approach. *Econometrica: Journal of the Econometric Society*, 449–460.
- Hall, P. A. and D. Soskice (2001). An Introduction to Varieties of Capitalism. In *Varieties of capitalism: The institutional foundations of comparative advantage*, pp. 1–68. Oxford University Press Oxford.
- Hirsch, B. and S. Mueller (2020). Firm Wage Premia, Industrial Relations, and Rent Sharing in Germany. *ILR Review* 73(5), 1119–1146.
- Iuzzolino, G., G. Pellegrini, and G. Viesti (2011). Convergence among Italian regions, 1861–2011. *Bank of Italy Economic History Working Paper* (22).
- Jäger, S., S. Noy, and B. Schoefer (2022). The German model of industrial relations: Balancing flexibility and collective action. *Journal of Economic Perspectives* 36(4), 53–80.
- Keller, B. K. and A. Kirsch (2020). Employment Relations in Germany. In F. C. V. D. Bamber, G.J. and C. Wright (Eds.), *International and Comparative Employment Relations*, pp. 179–207. SAGE: Thousand Oaks.
- Kluge, J. and M. Weber (2018). Decomposing the German East–West wage gap. *Economics of Transition* 26(1), 91–125.
- Lam, A. (2000). Tacit Knowledge, Organizational Learning and Societal Institutions: An Integrated Framework. *Organization Studies* 21(3), 487–513.
- Lam, A. and D. Marsden (2017). Employment Systems, Skills and Knowledge. In M. K. F. D. Warhust, C. and J. Buchanan (Eds.), *The Oxford Handbook of Skills and Training*, pp. 466–490. Oxford University Press Oxford.
- Lane, C. (1994). Industrial Order and the Transformation of Industrial Relations: Britain, Germany and France compared. In R. Hyman and A. Ferner (Eds.), *New Frontiers in European Industrial Relations*, pp. pp. 167–192. Cambridge (USA): Blackwell Publishers.
- Locke, R. M. and K. Thelen (1995). Apples and Oranges Revisited: Contextualized Comparisons and the Study of Comparative Labor Politics. *Politics & Society* 23(3), 337–367.

- Lucifora, C. and A. Garnero (2020). L'erosione della contrattazione collettiva in Italia e il dibattito sul salario minimo legale. *Giornale di diritto del lavoro e di relazioni industriali*: 166, 295–315.
- Malerba, F. (2002). Sectoral systems of innovation and production. *Research Policy* 31(2), 247–264.
- Marsden, D. and R. Belfield (2010). Institutions and the Management of Human Resources: Incentive Pay Systems in France and Great Britain. *British Journal of Industrial Relations* 48(2), 235–283.
- Maurice, M., F. Sellier, and J.-J. Silvestre (1986). *The Social Foundations of Industrial Power: A Comparison of France and Germany*. MIT Press, Cambridge.
- Menezes-Filho, N., D. Ulph, and J. Van Reenen (1998). R&D and Unionism: Comparative Evidence from British Companies and Establishments. *ILR Review* 52(1), 45–63.
- Menezes-Filho, N. and J. Van Reenen (2003). Unions and Innovation: A Survey of the Theory and Empirical Evidence. In A. J.T. and C. Schnabel (Eds.), *International Handbook of Trade Unions*. Edward Elgar: Cheltenham.
- OECD (2024). Collective bargaining. <https://www.oecd.org/employment/collective-bargaining.htm>. Accessed: 02/04/24.
- Petruzzelli, A. M., L. Ardito, and T. Savino (2018). Maturity of knowledge inputs and innovation value: The moderating effect of firm age and size. *Journal of Business Research* 86, 190–201.
- Pfeifer, C. (2011). Works councils, union bargaining and quits in German firms. *Economic and Industrial Democracy* 32(2), 243–260.
- Pianta, M. (2001). Innovation, Demand and Employment. In P. Petit and L. Soete (Eds.), *Technology and the Future of European Employment*, pp. 142–165. Cheltenham: Elgar.
- Reljic, J., A. Cetrulo, V. Cirillo, and A. Coveri (2023). Non-standard work and innovation: Evidence from European industries. *Economics of Innovation and New Technology* 32(1), 136–164.
- Russo, M., P. Pavone, and A. Cetrulo (2019). Conflict and Participation in Bargaining at Company Level: The Lamborghini Case. *Economia & Lavoro* 53(1), 53–74.

- Schnabel, C. and J. Wagner (1994). Industrial Relations and Trade Union Effects on Innovation in Germany. *Labour* 8(3), 489–504.
- Schuh, G., R. Anderl, J. Gausemeier, M. ten Hompel, and W. Wahlster (2017). *Industrie 4.0 maturity index. Managing the Digital Transformation of Companies*. Munich: Herbert Utz Verlag.
- Sorge, A. and W. Streeck (1987). *Industrial Relations and Technical Change: The Case for an Extended Perspective*. Wissenschaftszentrum Berlin.
- Sorge, A. and W. Streeck (2016). Diversified Quality Production Revisited: the Transformation of Production Systems and Regulatory Regimes in Germany. *MPIfG Discussion Paper* (No. 16/13).
- Streeck, W. (1991). On institutional conditions of diversified quality production. In E. Matzner and W. Streeck (Eds.), *Beyond Keynesianism: The Socio-Economic of Production and Full Employment*. Edward Elgar.
- Terzi, A. (2016). An Italian job: The need for collective wage bargaining reform. *Bruegel Policy Contribution* (2016/11).
- Ulph, A. M. and D. T. Ulph (1994). Labour markets and innovation: Ex-post bargaining. *European Economic Review* 38(1), 195–210.
- Wang, T., B. Zhao, and S. Thornhill (2015). Pay dispersion and organizational innovation: The mediation effects of employee participation and voluntary turnover. *Human Relations* 68(7), 1155–1181.
- Wang, W., J. Heyes, and R. Seifert (2023). Trade union influence on innovation in the British private sector: Direct and indirect paths. *Economic and Industrial Democracy* 44(2), 604–627.
- WIPO (2024). Global innovation index 2022. https://www.wipo.int/global_innovation_index/en/2022/. Accessed: 02/04/24.
- Wooldridge, J. M. (2012). *Introduction Econometrics: a Modern Approach. 5th Edition*. South-Western, Cengage Learning.

Technical Appendix

Variable	Obs	Mean	Std. Dev.	Min	Max
Innovation	9,013	.4591146	.4983532	0	1
Product Innovation	9,013	.3804505	.4855245	0	1
Process Innovation	9,013	.3604793	.4801662	0	1
Trade Union	9,013	.2841451	.4510313	0	1
Second Level Agreement	9,013	.149007	.3561151	0	1
Sectoral Level Agreement	9,013	.9153445	.2783838	0	1
Training	9,013	.6091202	.4879746	0	1
Age (year of birth)	9,013	1986.644	15.10267	1901	2015
Size (number of employees)	9,013	77.11572	276.2527	3	9775
Manufacturing	9,013	.3504937	.4771511	0	1
Geographical Macro Areas	9,013	.6525019	.822295	0	2
Revenues per employee	9,013	731705.7	1.49e+07	0	1.00e+09
White Collar Workers (%)	9,013	.3781793	.3104951	0	1
Part-time Workers (%)	9,013	.1458281	.218863	0	1
Temporary Workers (%)	9,013	.0655118	.1415445	0	1
Employment Loss	9,013	.3552646	.47862	0	1

Table 7: Descriptive Statistics for Italy

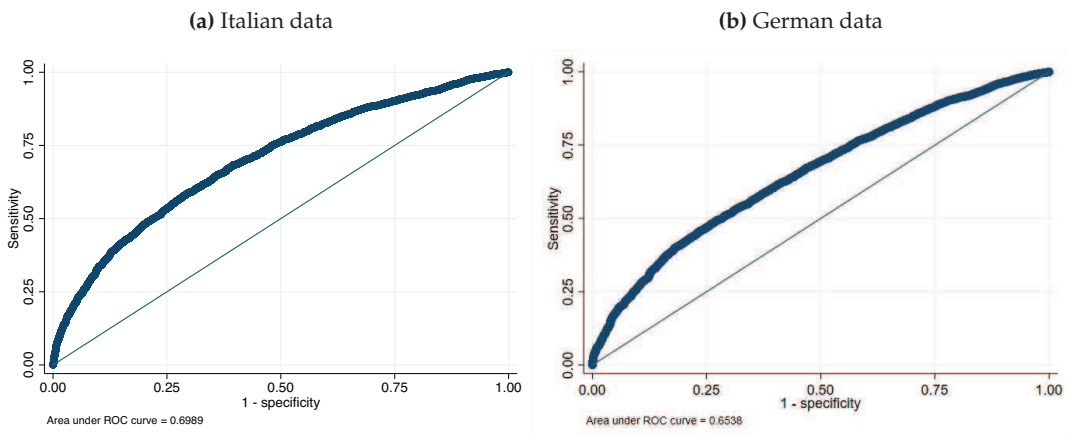
Variable	Obs	Mean	Std. Dev.	Min	Max
Innovation	9,668	.6467729	.4779972	0	1
Product Innovation	9,668	.2384106	.4261335	0	1
Process Innovation	9,645	.4369103	.4960294	0	1
Trade Union	9,668	.2267273	.4187364	0	1
Second Level Agreement	9,668	.0690939	.2536269	0	1
Sectoral Level Agreement	9,668	.2752379	.4466572	0	1
Training	9,668	.6292925	.4830192	0	1
Age (year of birth)	9,668	2001.341	8.209235	1990	2017
Size (number of employees)	9,668	70.7139	260.1456	3	10744
Manufacturing	9,668	.2332437	.4229179	0	1
East/West Germany	9,668	.4928631	.4999749	0	1
Profit	9,668	.8601572	.3468418	0	1
White Collar Workers (%)	9,668	9.132166	18.40253	0	100
Part-time Workers (%)	9,668	25.96439	26.64604	0	100
Temporary Workers (%)	9,668	6.046747	13.5954	0	100
Employment Loss	9,668	.3435043	.4749026	0	1

Table 8: Descriptive Statistics for Germany

	Germany	Italy
Model 0 nested in Model 1	LR test 349.50 Prob >chi2 0.0000	LR test 606.41 Prob > χ^2 0.0000
Model 1 nested in Model 2	LR test 143.38 Prob >chi2 0.0000	LR test 192.05 Prob > χ^2 0.0000

Table 9: Likelihood Ratio Tests

Figure 4: LROC curves



	<i>Model 0</i>	<i>Model 1</i>	<i>Model 2</i>
Trade Union	0.2288*** (0.0336)	0.0945*** (0.0356)	0.1285*** (0.0360)
Second Level Agreement	0.2289*** (0.0428)	0.1166*** (0.0446)	0.1002** (0.0449)
Sectoral Level Agreement	0.1336*** (0.0492)	0.1131** (0.0510)	0.1038** (0.0517)
Training	0.3143*** (0.0282)	0.3325*** (0.0292)	0.3104*** (0.0295)
Age		-0.0022** (0.0010)	-0.0024** (0.0010)
Size		0.0002*** (0.0001)	0.0002*** (0.0001)
Manufacturing		0.6526*** (0.0293)	0.7075*** (0.0310)
Central Italy		-0.1373*** (0.0357)	-0.1191*** (0.0360)
Southern Italy and Islands		-0.2146*** (0.0354)	-0.1712*** (0.0359)
Revenues per employee		-4.03e-10 (9.16e-10)	-1.96e-10 (8.75e-10)
White Collars Workers (%)			0.3761*** (0.0473)
Part-time Workers (%)			-0.2481*** (0.0687)
Temporary Workers (%)			-0.0172 (0.1023)
Employment Loss			-0.3047*** (0.0291)
Constant	-0.5176*** (0.0489)	3.8203** (-1.8900)	4.2226** (-1.9154)
R-squared	0.0283	0.0771	0.0924
Number of observations	9,013	9,013	9,013

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Probit Regression Analysis for Italy

	<i>Model 0</i>	<i>Model 1</i>	<i>Model 2</i>
Work Council	0.3518*** (0.0368)	0.1594*** (0.0403)	0.1154** (0.0413)
Firm level agreement	-0.0756 (0.0581)	-0.1104* (0.0598)	-0.1026* (0.0602)
Sectoral level agreement	-0.1892*** (0.0314)	-0.1996*** (0.0323)	-0.1631*** (0.0328)
Training	0.3287*** (0.0279)	0.2839*** (0.0285)	0.2687*** (0.0288)
Age		-0.0022 (0.0017)	-0.00175 (0.0017)
Size		0.0021*** (0.0002)	0.0020*** (0.0002)
Manufacturing		0.3030*** (0.0348)	0.3083*** (0.0358)
West Germany		0.1944*** (0.0291)	0.2078*** (0.02950)
Profit situation		0.1444*** (0.0385)	0.1395*** (0.0389)
% White Collars Workers			0.0087*** (0.0008)
% Part-time Workers			-0.0007 (0.0005)
% Temporary Workers			0.00148 (0.0010)
Employment Loss			-0.1010** (0.0292)
Constant	.1578*** (.0224)	4.285 (3.493)	3.3269 (3.5396)
Pseudo R-squared	9,668	9,668	9,668
Number of observations	0.0253	0.0523	0.0639

*** p<0.01, ** p<0.05, * p<0.1

Table 11: Probit Regression Analysis for Germany

	<i>Only Product Innovation</i>	<i>Only Process Innovation</i>	<i>Product & Process Innovation</i>
Trade Union	0.0788 (0.0969)	0.3157*** (0.1027)	0.2186*** (0.0689)
Second Level Agreement	0.0870 (0.1197)	-0.0578 (0.1341)	0.2340*** (0.0822)
Sectoral Level Agreement	0.3063** (0.1459)	0.0128 (0.1469)	0.1922* (0.1039)
Training	0.2840*** (0.0791)	0.3944*** (0.0882)	0.6488*** (0.0584)
Age	-0.0039 (0.0027)	-0.0029 (0.0027)	-0.0044** (0.0018)
Size	0.0001 (0.0002)	0.0000 (0.0002)	0.0006*** (0.0002)
Manufacturing	0.5103*** (0.0898)	1.0697*** (0.0873)	1.3954*** (0.0589)
Central Italy	-0.0732 (0.0934)	-0.1434 (0.1058)	-0.2676*** (0.0695)
Southern Italy and Islands	-0.3981*** (0.1003)	-0.2455** (0.1084)	-0.2459*** (0.0707)
Revenues per employee	-4.13e-09 (4.37e-09)	1.67e-09 (1.41e-09)	-3.22e-09 (2.31e-09)
White Collars Workers (%)	0.9308*** (0.1222)	-0.4486*** (0.1588)	0.7561*** (0.0935)
Part-time Workers (%)	-0.0451 (0.1728)	-0.5020** (0.2352)	-0.6402*** (0.1448)
Temporary Workers (%)	-0.3056 (0.3029)	-0.3497 (0.3097)	0.1733 (0.2038)
Employment Loss	-0.2662*** (0.0771)	-0.4377*** (0.0883)	-0.6182*** (0.0572)
Constant	5.2911 (5.3050)	3.5990 (5.3884)	6.9246* (3.5948)
Number of Observations	9,013	9,013	9,013
Pseudo R-squared	0.0737	0.0737	0.0737

*** p<0.01, ** p<0.05, * p<0.1

Table 12: Multinomial Logistic Regression on Italy

	<i>Only Product Innovation</i>	<i>Only Process Innovation</i>	<i>Product & Process Innovation</i>
Work council	0.0087 (0.1025)	0.1339* (0.0724)	0.0680 (0.09135)
Second Level Agreement	0.1674 (0.1476)	-0.1850* (0.1088)	0.0139 (0.1303)
Sectoral Level Agreement	-0.0573 (0.084)	-0.1941** (0.0604)	-0.3217*** (0.0810)
Training	0.1963** (0.0736)	0.3222*** (0.0533)	0.6435*** (0.0758)
Age	0.0185*** (0.0045)	-0.0178*** (0.00326)	-0.0050 (0.0043)
Size	0.0009* (0.0005)	0.0034*** (0.0003)	0.0034*** (0.0003)
Manufacturing	0.2840** (0.0897)	0.0438 (0.0635)	0.2643** (0.8210)
West Germany	0.1085 (0.0742)	0.3041*** (0.0539)	0.2530*** (0.0717)
Profits	0.0039761 (0.0955)	0.3312*** (0.0737)	0.2297* (0.0976)
White Collars Workers (%)	0.0057** (0.0020)	0.0126*** (0.0014)	0.0155*** (0.0016)
Part-time Workers (%)	0.0032* (0.0013)	-0.0031** (0.0009)	-0.0019 (0.0013)
Temporary Workers (%)	0.0051* (0.0024)	-0.0003 (0.0019)	0.0046* (0.0022)
Employment Loss	-0.0499 (0.0737)	-0.2495*** (0.0536)	-0.1711* (0.0713)
Constant	-39.0488*** (9.0881)	34.570*** 6.5180	7.8425 8.7728
Number of Observations	9668	9668	9668
Pseudo R-squared	0.0379	0.0379	0.0379

*** p<0.01, ** p<0.05, * p<0.1

Table 13: Multinomial Logistic Regression on Germany

Not Innovator	Italy	Germany
Trade Union / Work Council	0.0625 (0.1203)	-0.0168 (0.1773)
Second Level Agreement	-0.2176 (0.1510)	0.2677 (0.2479)
Sectoral Level Agreement	-0.4207** (0.1875)	0.1624 (0.1491)
Training	-0.2898*** (0.1099)	-0.4033** (0.1236)
Age	0.0098*** (0.0034)	0.0004 (0.0083)
Size	-0.0001 (0.0002)	-0.0036*** (0.0009)
Manufacturing	-0.9765*** (0.1046)	-0.5502** (0.1603)
Geographical areas: West Germany /Central Italy	0.2419** (0.1233)	-0.3422* (0.1328)
Geographical areas : Southern Italy	0.4369*** (0.1272)	/
Revenues per employees/Profits	-7.19e-10 (1.96e-09)	-0.0977 (0.1816)
White Collars Workers (%)	-0.5488*** (0.1760)	-0.0110** (0.003)
Part-time Workers (%)	0.7489*** (0.2594)	-0.0037 (0.0024)
Temporary Workers (%)	0.9652** (0.3782)	-0.0035 (0.0043)
Employment Loss	0.3304*** (0.1007)	0.0157 (0.1281)
Constant	-19.4675*** -6.8071	-1.3825 (16.5888)
R-squared	0.0793	0,0523
Number of observations	2,554	1907

*** p<0.01, ** p<0.05, * p<0.1

Table 14: Logistic Regression on changing the innovation status for Italy and Germany.