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Organized Labour and R&D: Evidence from Italy

Armanda Cetrulo^{*} Valeria Cirillo[†] Fabio Landini[‡]

Abstract

This paper investigates the impact of firm-level collective bargaining on firms' investment in intangible assets and, specifically R&D. While standard hold-up theories predict a negative effect of organized labour on intangible investments, the inclusion of pay-for-performance schemes in complementary negotiation can actually invert the prediction. Moreover, the industrial relation literature suggests that, in presence of asymmetric power relations, firm-level collective bargaining can allow workers to make their voice heard and induce management to invest in assets that drive competition away from wages, including R&D. We exploit a rich and representative survey on Italian non-agricultural companies conducted by the National Institute for the Analysis of Public Policies (INAPP) to test these predictions. Baseline estimates suggest that the presence of second-level collective bargaining is associated with higher investments in R&D and that power relation is the main mechanism driving this result. These findings are confirmed also in a robustness check where we exploit size contingent legislation governing the creation of employee representative bodies involved in firm-level bargaining in a regression discontinuity design (RDD) framework. The implications for the design of innovation policy are discussed.

JEL Classification: J50, O32, O33

Keywords: R&D, Intangibles, Unions, Collective Bargaining, Complementary Negotiation

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1 Introduction

Innovation is the key determinant of long-term economic growth, and R&D and intangible investments represent crucial inputs for technological change. Indeed, the evolutionary approach has always emphasized the complex nature of the innovative activity, and the increasing importance of scientific inputs in the innovative process, requiring to adopt a long-run perspective in the planning of R&D within firms. Similarly, it has been stressed the importance of innovation generated by learning-by-doing embodied into people and organisations since technology primarily concerns problem-solving activities involving, to varying degrees, also tacit forms of knowledge embodied in individuals and organisational procedures (Dosi, 1984; Cimoli and Dosi, 1995). According to this view, R&D nourishes firms' absorptive capacity (Cohen and Levinthal, 1989) and represents the typical learning mechanism for firms to exploit the knowledge base through formalised search efforts.

Different streams of literature have also analysed the relation between innovation and economic growth. At the macro level, endogenous growth models have stressed the importance of human capital and knowledge accumulation through R&D as major sources of long-term growth (Mankiw et al., 1992; Romer, 1994). Similarly, at the micro level, a variety of studies have documented the relevance of R&D and intangibles for firm's productivity and growth (Kancs and Siliverstovs, 2016; Marrocu et al., 2012; Coad et al., 2016; Bontempi and Mairesse, 2015; García-Manjón and Romero-Merino, 2012; Bianchini et al., 2018) highlighting that innovation can have beneficial effects on firms' performance and competitiveness (Addison et al., 2017; Doucouliagos and Laroche, 2013; Jiménez-Jiménez and Sanz-Valle, 2011). These results have led both scholars and policy makers to devote growing attention to the factors that effectively stimulate private investments in these types of assets (Barge-Gil and López, 2014; Martin, 2016).

This paper contributes to this line of research by studying if and how labour market institutions affect firm's decisions to invest in R&D and other intangible assets. As said, firms' ability to innovate is subject to a variety of internal practices and external influences (financial support, demand, structure of markets, etc.). Internal factors such those related to labour organization are of crucial importance to enable, support and sustain innovative activities (Wang et al., 2022). In particular, our focus is on the role played by firm-level collective bargaining as it exists in many European countries. While integrating national- and/or industry-level contracts on many dimensions, including wages, this type of bargaining allows workers to make their "voice" heard at the firm level (Hirschman, 1970) and this may affect investment decisions. To understand whether such effect extends also to R&D and intangibles is of crucial importance, since it can provide insights on potential virtuous circles between labor market institutions and the modern economy.

Theoretically, the impact of trade unions and firm-level collective bargaining on private R&D and intangible investments is ambiguous (Menezes-Filho and Van Reenen, 2003). On the one hand, trade union's demand for higher wages can have a negative impact on firms' profitability, consequently affecting the level of investment. Moreover, once investments are done, organized labour can "hold-up", trying to appropriate the benefits of the investment through pay rise or sub-optimal asset operation, neglecting the sunk costs incurred by the company. This may ultimately discourage the firms to make investments in the first place (Grout, 1984). On the other hand, however, the possibility to engage unionized workers in firm-level collective bargaining may compensate and potentially reverse such relationship. Oftentimes, in fact, these agreements are used to introduce contractual practices that help to align wages with firm performance (including employment growth), thus resolving potential incentive problems (Cardullo et al., 2020). Also, when collective bargaining is extended to address not only pay scales, but also technology, work organization and working time, it can activate a virtuous "power relation channel" where conflicting interests tend (and sometimes risk) to align (Russo et al., 2019; Cirillo et al., 2021). This can in turn give to workers the power to influence strategic decisions, driving them towards activities that reduce the competitive pressure on wages, such as R&D and innovation. Therefore, trade unions may deter employers from pursuing 'low road' strategies to competitiveness, encouraging them to innovate (Michie and Sheehan, 2003; Zhou et al., 2011; Osterman, 2018)

Given these opposing theoretical predictions, assessing the relation between the variables under study becomes essentially an empirical issue. We thus perform an analysis aimed at investigating the empirical relevance of such contrasting arguments. We exploit the last two waves of the 'Rilevazione Imprese e Lavoro' (RIL) survey conducted by the National Institute for the Analysis of Public Policies (INAPP) in 2015 and 2018. Such survey covers a representative sample of non-agricultural firms and provides detailed information about different forms of employee representation and collective bargaining, including the domains covered by the collective agreement (if present). Moreover, the survey reports whether the firms conduct innovationrelated activities, such as investment in R&D and intangibles. The availability of such wealth of information allows us to investigate not only the relationship between these variables, but also to disentangle among the different mechanisms behind it.

Our econometric analysis reveals a positive and statistically significant association between firm-level collective bargaining and R&D investments. This result is robust in a battery of linear probability, probit and logit models where we control for an extended set of covariates, including the presence of employee representative bodies and other collective contracts at the national, territorial and/or sectoral level. None of these alternative industrial relation variables seem to play an important role as driver of R&D and intangible investments. When we dig into the mechanisms we find that the positive association between our variables of interest holds even after controlling for the presence of performance-related pay arrangements in the firm-level collective contract. This casts doubt on "incentive alignment" as the main mechanism driving the baseline relationship. Moreover, the direct effect of firm-level collective bargaining is picked up when we control for firm's unionization rate, which is a proxy of the negotiating power of employees. This result provides support for the "power relation" channel as an important driver of R&D investments. All these results resist also in a robustness check where we deal with endogeneity by exploiting size contingent legislation governing the creation of employee representative bodies involved in firm-level bargaining in a regression discontinuity design framework.

Our paper relates to two main streams of research. First, it extends the mounting evidence about the importance of institutional drivers of R&D. While earlier innovation studies focused primarily on structural factors behind R&D such as firm size (Klepper and M Cohen, 1996), market power (Aghion et al., 2005), demand pull (Piva and Vivarelli, 2007) and inter-industry differentials associated with technological opportunity (Klevorick et al., 1995) and appropriability (Lerner, 2009), recent research has emphasized the importance of institutions. The latter can indeed affect firms' orientation toward innovation-related activities through several channels such as improving access to external finance (La Porta et al., 1997), mitigating opaque information (Hillier et al., 2011), facilitating interactions with innovation intermediaries (Wu et al., 2016) and providing incentives to carry out private R&D (Alfranca and Huffman, 2003). Along these lines, several authors have investigated the contribution that different institutional components offer to innovation, such as government effectiveness, rule of law, regulation as well as corruption and political instability (Alam et al., 2019). Less attention, however, has been paid on the role played by labour market institutions. Only recently, a new wave of studies has started to deepen the analysis of their effect on innovation, focusing primarily on the impact of employment flexibility (Kleinknecht et al., 2014; Hoxha and Kleinknecht, 2020; Reljic et al., 2021; Dughera et al., 2022), work organization (Franco and Landini, 2022) and partly trade unions (Berton et al., 2021). A very recent attempt has been realized by Wang et al. (2022), that inspect the pathways through which trade unions may influence innovation at the firm level, indicating that unions can have a positive impact on innovations, particularly those that relate to changes to processes of production or service delivery. None of these studies, however, considers the influence of firm-level collective bargaining on R&D investments. Moreover, no previous

studies (to the best of our knowledge) goes as far as to disentangle the distinct mechanisms behind such relationship.

Secondly, our work integrates the voluminous literature on the effect of organized labour on different types of firm outcomes. Since the seminal contribution by Freeman and Medoff (1984) the economic literature has seen a proliferation of studies on the relation between trade unions and firm performance, both with respect to productivity growth, profitability and innovation. Based on quite different theoretical assumptions about the nature of the production process and the role of workers, empirical results have been however inconclusive, leaving the debate still open (Doucouliagos et al., 2017). More in detail, while scientific articles focusing on United States converge on the presence of a negative impact of trade unions on firms' R&D investment, studies on European countries suggest the absence of any significant relationship between the two variables. Where negative, the impact seems to decrease in intensity if observed over time and if the depicted unit of analysis is the company rather than the sector. More recent research on European data has documented that in some cases the effect of unions on innovation turns out to be weak but positive (Holman and Rafferty, 2018; Berton et al., 2021; Belloc et al., 2022b). According to Schnabel and Wagner (1994), these heterogeneous results confirm the necessity of looking at the role of institutional models of industrial relations, workers' involvement, and effective scope of trade union intervention in company decisions. In this paper we follow such direction and focus our analysis on the contribution of institutional forms associated with decentralized collective bargaining. Although specific to some industrial relation regimes, such forms have been increasingly adopted by many countries (including Italy) over the last decades. Even more importantly, the focus on a specific type of institutions allow us to go much more into the details of the channels through which organized labour can affect innovation.

The paper proceeds as follows: Section 2 offers a critical review of the theoretical and empirical literature on the topic; Section 3 provides details, on the one hand, on the Italian institutional context in terms of interactions and coverage of firm-level collective bargaining with respect to sectoral agreements and, on the other hand, on the diffusion of investments in intangible and R&D across Italian companies. Section 4 describes the database and presents some descriptive evidence. The empirical strategy is illustrated in Section 5 as well as econometric results. Section 6 brings the contribution to conclusion.

2 Background literature

2.1 A contested view on unions and innovation

As early as the 1940s, economists pointed out the difficulty in criticising unions from an economic point of view. According to Henry C. Simon: "One simply cannot argue that organization is injurious to labour; one is either for labor or against it, and the test is one's attitude towards unionism" (Simons, 1944, p.I). Nevertheless, especially since the 80s, an increasing number of scholars have started to focus on the relation between firm performance and unions, often underlining the emergence of a negative link. One of the most investigated topics has been assessing the relation between a unionized workforce and investment.

In his seminal contribution, Grout (1984) mainly describes the problem applying the prisoner dilemma scheme. According to his perspective, employers and unions initially agree through a non-binding agreement on investment and wages, but once the investment is undertaken, rentseeking unions will start claiming for higher wages. Thereby, employers will be "held up" by unionized workers and be pushed to modify their investment decisions. This "opportunistic" behavior will be particularly effective in expropriating quasi-rents from intangible assets such as R&D that, by nature, only leads to profits in the medium to long term (Connolly et al., 1986). In other words, in this framework, unions are conceived as a sort of "tax" on capital (since they increase its real cost), which ultimately discourage investment.¹ Moreover, their detrimental impact extends also to profitability (Menezes-Filho, 1997) and, more generally, to the distribution of revenues across different stakeholders, increasing the wealth of the workers at the expense of shareholders (Hirsch, 1991; Becker and Olson, 1992).

An opposite prediction, however, can be derived by taking a closer look at the strategic nature of the interaction between firms and unions. According to Baldwin (1983), in fact, the main problem lies in the different time horizons that guide the strategic choices of the actors involved. While investment in physical and intangible capital takes years to display its effect, unions focus on shorter time horizons to satisfy the claims of their members. Workers will prefer to increase wages today, rather than wait for a future (but uncertain) redistribution of productivity gains due to investment in new assets. On this ground, one solution could be to modify the conditions of the contractual agreement between the two parties, through the introduction of a "self-enforcing wage agreement". By providing adequate incentives to extend the time horizon of unions, the latter can indeed be successful in protecting the firm from the "predatory behavior" of the counterpart.

¹The net effect on firm investment plans will obviously depend on several factors, such as the change in the relative price of capital and labor and the prevalence of a scale or substitution effect (Van der Ploeg, 1985).

The idea of making use of decentralized agreements as a tool to align firms and unions incentives has been exploited in many contexts to argue in favour of a potentially positive link between organized labour and investment. In this view, the adoption of efficient contracts should rule out "right to manage" models where firms set the employment level (Nickell and Andrews, 1983), allowing instead bargaining over both wages and employment(McDonald and Solow, 1992; Oswald, 1986). This could reduce rent seeking behavior on the side of unions, given the necessity to account for the trade-off between higher wage demands and risk of employment reduction, ultimately leading to potentially higher investments. Ulph and Ulph (1994, 1998) present a specific application of this argument to the case of R&D investment. By developing a model of patent race in R&D and ex-post bargaining, they show that when collective bargaining extends beyond wages alone, R&D spending can actually increase. The reason is that unions support the most strategic choice, since they are aware that stimulating R&D investments can rise the firm's profitability and market share, with a positive impact in terms of new hires and rising wages. By using a related argument, but focusing on two-tier bargaining in a search and matching model, Cardullo et al. (2020) achieve a similar conclusion with respect to capital investments.

Obviously, several obstacles to the adoption of an "incentive-compatible contract" can arise, depending both on unions that do not recognize the interest of the firm as their own interest, and by the opportunistic behaviour of capitalists. Indeed, the literature has shown that managers can reduce corporate cash holdings to dampen wage demands (Klasa et al., 2009), decide to lower investments or alter their financial structure to increase their debt-equity ratios (Bronars and Deere, 1991) instead of running the risks to share part of the revenues with workers. Furthermore, the viability of such agreements depends on whether collective bargaining is repeated over time. This can influence the outcome through different mechanisms such as: i) reputation building; ii) risk of punishment; and iii) ongoing learning process due to previous interactions. All these factors can lead to more cooperative relations (Espinosa and Rhee, 1989) and favour the emergence of self-enforcing agreements (Addison and Chilton, 1998). When these features are absent, on the contrary, the development of a shared long-term perspective is more difficult to accomplish, making the agreement at risk of unilateral defection.

Although informative about the strategic nature of bargaining relations, these theoretical contributions present two important limitations. The first one is that the presence of strongly unbalanced distribution of bargaining powers and asymmetric information between the two parties is usually neglected or not questioned in depth, while the consequences of different "power resources" endowment (Lévesque and Murray, 2010) are not fully integrated into theoretical

models.² Moreover, most of the papers focus on measures such as the presence of unionized workforce, or the share of union members whereas little attention is devoted to capture the "enacted power", namely the "potential available power that parties actually use" (Leap and Grigsby, 1986, p.205), for instance through collective bargaining.

Secondly, the above mentioned approaches rely on a monopolistic view of unions as labor providers, according to which their main (detrimental) goal will be to increase the wage over the equilibrium level and protect workers, thus reducing economic efficiency and increasing inequality (Oswald, 1986). Nevertheless, as explained by Freeman and Medoff (1979), embracing such a view implies neglecting a fundamental role of unions, that is providing "voice" to workers. According to the collective voice approach, rooted on the concepts introduced by Hirschman (1970), the presence of employee representative bodies within organizations is fundamental to enhance a real participatory mechanism. In fact, the involvement of the workforce through the agency of unions allows to collect the ideas of workers on how to improve working conditions, solve problems and inefficiencies (Freeman, 1976). On this basis, industrial relations become an instrument through which the innovative performance of the firms can be fostered: the presence of an active union becomes an element of positive pressure over management, as it pushes towards the improvement of production standards (e.g. through R&D) to preserve profits despite higher wages (Freeman and Medoff, 1984). In addition, the recognition of this space for action, although contested, can mitigate the risk of shirking by the workers, or decision to exit the firm in presence of viable alternatives, fostering trust and cooperation.³

Once the presence of imperfect information and arising conflicting interests within the workplace are accounted for, firm-level collective bargaining can thus represent an organized response to common problems that would have been otherwise confined to the individual sphere (Freeman and Medoff, 1984). In this sense, "voice" can be interpreted "as political action par excellence" (Hirschman, 1970, p.16) and "collective bargaining can be viewed as the most developed form of representative or collective voice, as it is typically carried out within a framework of rules, procedures, and rights set out in national and international law" (Doellgast and Benassi, 2020, p.3). Such forms of collective organizing can thus be interpreted as "beneficial constraints" (Streeck et al., 1997) that induce firms to increase their spending on performance-enhancing activities, including intangible assets and R&D. Clearly, the effective activation of such beneficial constraints will also depend on the distribution of power resources between so-

²There are, however, some exceptions. For instance, Manning (1987) considers a "sequential bargaining model" where unions and management bargain on wages and employment (and even capital) at different stages and with different bargaining powers. He shows that, according to his theoretical perspective, it is not the presence of unions itself the potential cause of under-investment, but the departure from an efficient bargaining model where unions' bargaining powers are equal over the different subjects.

³For a review on the concept of "union voice", see Addison and Belfield (2004).

cial actors (Lévesque and Murray, 2010), namely those "characteristics which provide actors – individuals or collectivities – with the ability to punish or reward other actors" (Korpi, 2018, p.15). In this sense, it is not simply the presence of employee representation, but also the degree of its involvement in firm-level collective bargaining and its negotiation power that can act as tools to foster labour-friendly production endeavours based on innovation and R&D.

2.2 Empirical evidence

Given the political relevance of these topics, several empirical analyses have been performed to ascertain the "economic impact" of a unionized workforce at the workplace. Initially, most studies focused on the US, always finding a negative effect of unionization, not only on R&D (Hirsch and Link, 1987; Hirsch, 1991) but also on other types of investment related more generally to plants and equipment (Bronars and Deere, 1993). Connolly et al. (1986), for instance, focus on the impact of trade unions on R&D market values and firm investment decisions on a sample of 367 Fortune 500 firms. The results show that unionized firms invest less in intangible assets and R&D compared to non-unionized ones and that, consistently with the rationale proposed by Baldwin (1983), the age composition of union members seems to play a role in explaining their shortsighted choices. Similar results have been obtained by Betts et al. (2001) using industry-level Canadian data, which still confirm the existence of a negative linkage between unionization and R&D investment. Moreover, Bradley et al. (2017) suggest that the detrimental impact of unions on innovation extends beyond the investment stage. By using data on patent applications of US firms they find that their innovative output is lower in presence of unions. Their interpretation is that this effect is due partly to the fact that unionized firms face a reduction in R&D investment, and partly to a higher external mobility of innovative investors in unionized firms compared to non-unionized ones.⁴

This seemingly consistent evidence on the negative impact of unions on innovation-related activities has lately been disputed by a series of studies using European data Menezes-Filho and Van Reenen (2003). Ulph and Ulph (2018) and Addison and Wagner (1994), for instance, showed that in UK the effect of unionization on innovative performance can be positive or negative depending on the specific industry under study, and that in aggregate it tends to be null. Similar evidence is reported by Menezes-Filho et al. (1998) which use British firm and establishment-level data to show that the relation between unionization and R&D expenditures tends to become statistically insignificant once specific factors are accounted for, such as firm

⁴While the fall of R&D expenditure is essentially due - according to the authors - to the "hold-up" problem, the loss of talented innovators should derive from the increasing wage equality across the workforce pursued by unions, that result into small wage gaps between the most and least skilled workers.

age and technological opportunities. With reference to Germany, Schnabel and Wagner (1992) also find no statistically significant association between R&D and union density at the industry level. Moreover, Schnabel and Wagner (1994) suggest that in Germany the effect of organized labour on R&D expenditure differ depending on the institutional channel that one considers; in particular, it is positive for work councils and negative for union density. Finally, recent works by Berton et al. (2021) and Wang et al. (2022) document a positive and statistically significant association between unions and innovation in Italian and British firms, respectively.

This empirical ambiguity and in particular the heterogeneity of the evidence across different national-institutional contexts calls for studies that place greater attention to specific institutions of employee representation. Rather than focusing only on the presence or absence of union bodies at the workplace, it is important to consider the actual channels through which unions can affect investment decisions within the more general system of industrial relations. On this ground, for instance, Cardullo et al. (2020) compare investment decision under different wage setting scenarios and document that in Italian firms capital investment per worker are positively correlated with the presence of firm-level collective agreements. Their interpretation is that such agreements improve the alignment between wages and productivity, thus resolving potential incentive issues. Similarly, Bryson and Dale-Olsen (2020) show that local union bargaining is positively associated with product innovations in both UK and Norway, and they rationalize such result through a voice mechanisms: by fostering worker participation, unions reduce the costs of facilitating and implementing innovation (Bryson et al., 2013).

2.3 Summary

Overall, the theoretical and empirical literature discussed above remains quite controversial. If on the one hand the available evidence is not conclusive, on the other the mechanisms through which organized labour affects innovation remain open to debate. While in theory different arguments have been proposed, so far the empirical analysis have failed to directly test them. In this paper we will fill such gap by focusing on the Italian context. Our goal is to investigate the relationship between firm-level collective bargaining and investment in R&D and intangible assets, dissecting the relevance of the alternative theoretical mechanisms that explain it. Namely, we will test whether i) trade unions adopt a rent seeking behaviour, leading firms into the "holdup" trap that negatively affects investment; ii) the problem lies in contract inefficiency and can be solved through ad-hoc incentives and interests alignment (e.g. pay-for-performance schemes); iii) unions and firm-level collective bargaining are expression of "collective voice" in presence of unbalanced power relations and can positively impact investment.

3 Institutional and economic context

As stated above our analysis focuses on Italy, which is characterized by peculiar features that concern both the economic structure and the system of industrial relations. With respect to the former, it should be stressed that the Italian economy is characterized by a large share of small and micro enterprises with generally low adoption of digital technologies and low accumulation of complementary intangible assets (for recent evidence see Calvino et al., 2022). According to many, these patterns have contributed to the sluggish trend in labour productivity of the country over the last decades (Bugamelli et al. (2018); Dosi et al. (2012), etc.) as well as to the widening gap between best performing firms and the rest of the economy, also within narrowly-defined industries (Andrews et al., 2016; Berlingieri et al., 2017, 2020; Cirillo et al., 2022). Among the factors explaining the poor performance of a large fraction of Italian companies, the lack of investment in R&D, alongside other factors associated with firm characteristics (e.g. firm size and age, sector of activity) and capabilities (e.g. quality of the workforce and management), has been widely acknowledged.

To support this claim Figures 1 and 2 report the R&D expenditure by business enterprises and number of researchers involved in R&D activities for different European countries, including Italy. In both dimensions Italy faces a negative gap with respect to the other countries, which slightly increases over time. Similar evidence can be derived from the European Innovation Scoreboard 2021, which reports that in Italy the top R&D spending enterprises per 10 million population is 6.4 compared to 16.2 in Europe. Furthermore, intangible investments in Italy are not only low but also highly heterogeneous across firms and regions (Arrighetti et al., 2014). According to the last survey on intangibles realized by INAPP (Intangible Assets Survey 2012), for instance, the gap in intangible investments between small and large companies is about 33.8%. Moreover, firms investing in R&D are located mainly in Northern regions. This evidence makes the analysis of the drivers of R&D and intangible investment in Italy even more relevant from the policy point of view.

With respect to the system of industrial relations, since the mid-1990s Italy is characterized by a two-tier collective bargaining system, which implies two possible levels of negotiation: i) a first tier applicable to all firms operating within the same industry and dealing primarily with matters related to minimum wage floors for each grade of the hierarchical scale of jobs, as well as working hours and training related to health and safety issues; and ii) a second tier signed at the regional and/or firm level and covering negotiations aimed at setting changes in work organisation, working hours, work roles, workloads, vocational training, and performance-related pay.⁵ Whereas industry-level agreements are signed by major worker and employee confederations agreeing upon a common platform of demands (Fulton, 2021), firm-level agreement are negotiated by elected employee representatives, which can be either union based, in that case the representative body is called "Rappresentanza Sindacale Aziendale" (RSA), or non-union based, in that case it is named "Rappresentanza Sindacale Unitaria" (RSU)⁶. Interestingly, according to the Italian legislation, the procedures that govern the creation of these institutional bodies change depending on firm size. In particular, while for firms with more than 15 employees it is mandatory to agree with the request to form a RSA or RSU body, for firms with less than 15 employees that is not the case. This difference creates a discontinuity in the degree of employee representation and thus firm-level collective bargaining that we will exploit to address endogeneity-related issues in our empirical analysis (for more details see below).

Although there are no official statistics on the coverage of collective bargaining, according to ETUI - European Trade Unions Institute - in Italy industry-level negotiation covers about 80% of all employees in the private sector, whereas firm-level bargaining only reaches 30-40% of the workforce. Similar figures are reported by D'amuri and Nizzi (2017), which shows that between 2010 and 2016 around 20% of private companies in industry and services with more than 20 employees signed firm-level agreement. Moreover, this type of agreements tends to be much more widespread among large companies compared to small ones. According to Cardinaleschi et al. (2015), in fact, the large majority (about 69.1%) of firms with 500 or more employees are engaged with firm-level collective bargaining.

4 Data and descriptive statistics

4.1 Data

Given the above described economic and institutional setting, we now turn to the empirical analysis of the link between firm-level collective bargaining and investment in R&D and intangibles. We exploit an original database drawn from the 'Rilevazione Imprese e Lavoro' (RIL) survey conducted by Inapp during 2015 and 2018 on a representative sample of partnerships and limited liability firms. Each wave of the survey covers over 30000 firms operating in non-agricultural

⁵More in detail, Cardinaleschi et al. (2015) highlighted that the issues most frequently covered at company level were in 2012-2013: fixed pay elements (61.1%); results-based bonuses (58.9%); hours and work organisation (50.7%); occupational training (44.6%); social benefits (welfare) 38.5%; dealing with the crisis (31.9%); types of employment contract (25.3%); relations with the unions and union rights (24.7%); grading (22.8%); and equal opportunities (15.7%)

⁶Slightly different rules apply if firm-level agreements are negotiated by RSU or RSA. If there is RSU at the plant level, a company agreement is valid if approved by a majority of RSU members. Conversely, in companies where the union body is RSA the agreement must be approved by representatives, who together or separately have the support of a majority of union members in the company and all employees can be required to vote on the agreement (Fulton, 2021)

private sectors. A sub-sample of the firms included in the survey (around 45%) are followed over time, making the RIL dataset a partial panel over the period under investigation.⁷

The RIL-INAPP survey collects a rich set of information about the composition of the workforce, including the amount of investments in training, hiring and separations, the use of flexible contractual arrangements and other workplace characteristics. Extensive information are available on management and corporate governance, productive specialization and other variables that proxy firms' strategies (such as the share of export on value added). Furthermore, the RIL-INAPP survey includes a specific set of questions designed to collect information on industrial relations. In the section "Industrial Relations", firms have been asked several questions concerning (i) affiliation to industry association; (ii) adherence to national collective agreements; (iii) decentralized bargaining (firm level agreement and territorial-level contract); (iv) topics covered by firm-level bargaining; (v) forms of employee representation in the company; (vi) unionization rate; (vii) existence of performance-related pay; (viii) forms of corporate welfare. Another relevant section of the questionnaire is "Credit and Investments" containing a set of specific questions on: (i) amount of investments; (ii) access to incentives; (iii) types of investments; (iv) access to credit; (v) amount of sales and other financial information. More in detail, firms have been asked whether in 2017 they invested in R&D and other related intangibles such as certifications, patents, licences, trademarks and software.

In this paper we focus on $R \oslash D$ and other intangible investments, that corresponds to a dichotomous variable taking value of 1 if the firm has invested in this specific category of goods and 0 otherwise. ⁸ Therefore, given the richness of the survey we can explore how and to which extent: (i) firms having decentralized collective bargaining (companies having signed a complementary collective contract at the firm level) register a higher probability to invest in R&D and other intangibles, all other things being equal; (ii) the existence of specific mechanisms mediating the decentralized bargaining-innovation nexus such as the presence of incentive practices and/or strong worker voice able to affect the outcome of the negotiation.

⁷The RIL Survey sample is stratified by size, sector, geographical area and the legal form of firms. Inclusion depends on firm size, measured by the total number of employees. This choice has required the construction of a 'direct estimator' to take into account the different probabilities of inclusion of firms belonging to specific strata. In particular, the direct estimator is defined for each sample unit (firm) as the inverse of the probability of inclusion in the sample. For more details on RIL questionnaire, sample design and methodological issues see: http://www.inapp.org/it/ril.

⁸In our setting we attribute 0 to firms that were registered as investment inactive in 2017 or invested in other forms of capital goods such as land and building, computer equipment, plant, machinery and industrial equipment.

4.2 Descriptive evidence

As first step of our empirical analysis, we consider descriptive evidence about the diffusion of firm-level collective bargaining among Italian companies and its association with investments in R&D and other intangibles. Table 1 shows that firm-level collective bargaining is by far the most common form of complementary negotiation being present in about 10% of the firms, whereas the alternative form, i.e. territorial-level bargaining, exhibits a very low incidence (around 1%). At the same time, however, complementary negotiation remains a relatively uncommon practice. On average only 1 out of 9 companies that has signed a national collective contract (and 1 out of 3 companies where an employee representative body is present) is also engaged with firm-level bargaining.⁹

With respect to the outcome variable of interest, roughly 14% of the firms report investment in R&D and other intangibles. Figure 3 shows that this value is significantly higher in firms with firm-level collective bargaining than in firms where such bargaining is absent. While such difference is significant for all firm size groups, it is particularly stark for companies with less than 20 employee. Among the latter, the fraction of firms that report investments in R&D and intangibles is nearly 8 times higher if the companies are involved with firm-level collective bargaining than if the companies are not (0.147/0.019). This difference is particularly relevant in light of the large diffusion of small firms in the Italian economy (in our sample around 60% of the firms have less than 20 employees) and the gap that they usually exhibit in innovation-related activities (in our data the incidence of R&D investment moving from firms with a number of employees between 20 and 49 to firms with less than 20 employees drops from 13% to 3%).

Another relevant aspect to be considered concerns the heterogeneity of the differential in innovation activities depending on firm-level bargaining across sectors. Related to this, Figure 4 dissects investments in R&D and other intangibles by bargaining type and industry of activity, distinguishing among manufacturing, services and other sectors. Among companies with less than 20 employees, the highest incidence of investments is detected in manufacturing companies that are engaged with firm-level collective bargaining. The latter are 7 times more likely to report R&D and intangible investment than firms where complementary negotiation is absent. Such difference sharply falls in companies operating in services and other sectors. In mediumsmall firms (i.e. 20-49 employees) the positive differential in favour of companies with firm-level collective bargaining remains valid for manufacturing and other sectors, but not for services, where intangible investments are actually higher in companies with no complementary negotia-

⁹The limited diffusion of complementary negotiations in Italy is confirmed also by other studies using different data sources (D'Amuri and Giorgiantonio, 2014).

tion. For firms with more than 50 employees the pattern is relatively stable and favourable to companies with firm-level collective bargaining. The only exception are medium-large manufacturing firms (i.e. 50-250 employees), where the differential is inverted, although in this case the difference is only weakly significant.

Overall, the descriptive analysis provides preliminary evidence that is fairly encouraging with respect to the role of firm-level collective bargaining in supporting innovation activities. For most groups of firms, the presence of this type of bargaining is associated with higher incidence of investment in R&D and other intangibles. This is true especially for small manufacturing firms, which represent the key backbone of the Italian economy. Obviously, this result can be driven by many factors, which are not accounted for in this analysis. Cleaner evidence requires a multivariate investigation, which is indeed the objective of the following section.

5 Results

5.1 Firm-level collective bargaining and investments in R&D

We begin by considering the following baseline specification:

$$Y_{i,t} = \alpha + \beta_1 F C_{i,t-1} + \beta_2 T C_{i,t-1} + \beta_3 N C_{i,t-1} + \beta_4 E R_{i,t-1} + \beta_5 X_{i,t-1} + \gamma_1 Z_j + \gamma_2 W_z + \epsilon_{i,t}$$
(1)

where the dependent variable represents a dichotomous variable taking value 1 if firm *i* reports investment in R&D and other intangibles, and 0 otherwise. As for explanatory variables, FC_i , our focus variable, is a dummy variable taking value 1 if the firm has signed a firm-level collective contract, and 0 otherwise, TC_i and NC_i are two dichotomous variables taking value 1 if the firm has signed, respectively, a territorial-level and/or a national level collective contract, and 0 otherwise, and ER_i is a dummy variable formalising presence of an employee representative body such as RSA or RSU at the firm level (value 1 if it is present and 0 otherwise).¹⁰ As discussed above, in the Italian institutional context companies signing firm-level collective contracts are usually classified as multi-employer bargaining since they apply agreements classified by EUROSTAT as "enterprise or single employer agreements" or "agreements applying only to workers in the local unit", in addition to – or departing from – agreements signed at more centralised levels (national or sectoral level). Therefore, the base category in equation 1 is

¹⁰RSA and RSU are two trade union representation bodies for employees, both public and private. RSUs - Rappresentanza Sindacale Unitaria - are elected by all workers present in the company, regardless of their membership of a trade union. In contrast, RSAs - Rappresentanza Sindacale Aziendale - are elected by members of a specific trade union. Thus, RSUs have the general representation of workers and participate in company bargaining, whereas RSAs protect only trade union members and until a few years ago do not participate in company bargaining.

given by firms that lack of any form of collective bargaining at all, which is the norm in most market-oriented countries, and it may apply to small firms elsewhere too.

Equation 1 includes a wide set of firm-level time-varying controls X_i referring to: (i) firm structural features such as firm size expressed as the log of the number of employees and firm age (in log too); (ii) employees' characteristics such as share of employees over 50 years, share of employees with tertiary education, share of employees having a fixed-term contract, share of directors and middle-managers, and share of clerks; (iii) firms' features concerning type of management (female management; business unit part of a business group or multinational company; multi-establishment enterprise); (iv) firm strategies concerning export and innovation (exporting firms and patents). All controls are lagged and therefore predetermined capturing firms features measured in 2015 in order to mitigate issues of reverse causality. We include industry Z_j and regional dummies W_z , while the parameter $\epsilon_{i,t}$ indicates an idiosyncratic error term. The set of lagged controls referring to bargaining institutions, firm-level and employee characteristics, international and past innovation activities have been included in a step-wise fashion in order to check the robustness of relationships. Furthermore, since the linear probability model has a major flaw assuming the conditional probability function to be linear, we estimate equation 1 using both ordinary least squared and and nonlinear function such as Probit and Logit regression.

Table 1 reports the results of the linear probability models. By moving from columns (1) to (5) the number of control variables increases until we get the full specification. In all models, the presence of a firm-level collective contract is positively correlated with investment in R&D and other intangible assets. More precisely, having signed such a contract is associated with between 11.9 and 8.9 percentage points increase in intangible-related investment. This confirms that innovation activities are more frequent in firms where a "voice" mechanism is present. Concerning the other types of bargaining institutions, interesting differences emerge. While having signed a territorial-level collective contract is positively correlated with investment in R&D and other intangibles, neither the coefficient associated with national-level contract nor the one relative to the presence of employee representation are statistically significant. This result suggests that complementary negotiation that is able to account, not only for firm-specific features such as productive structures can be an important drivers of innovation activities within firms. At the same time, the presence of unions, in the form of employee representative bodies as well as centralized wage-setting institutions, does not seem to harm investments in innovation.

Turning now to the other control variables, we notice that firm size plays an important role in explaining investment in R&D, together with other firm-specific characteristics such as belonging to a multinational group and exporting products, as their coefficients are large, positive and always statistically significant. The same result holds for the percentage of workers with tertiary education, while a negative effect is instead associated with the percentage of workers over 50 years. This result can be explained by the fact that, especially in the absence of adequate training, old workers tend to have less competences than younger cohorts of employees in technologies that are complementary to intangible investments, such as ICT. This may in turn reduce incentives to undertake such type of investment. Finally, past patenting activity, both in terms of filing and acquisition, is an important positive predictor of investment in R&D, which confirms the relevance of knowledge cumulativeness in the innovation processes.

As a robustness check, we report in Table 3 the results of estimating the full specification described above (i.e. column 5 of Table 1) through Probit and Logit regressions. Results are very similar across the board. In both models having signed a firm-level collective contract is associated with an increase in the probability of investing in R&D and other intangibles of about 2%. This result confirms once more that complementary negotiation taking place at the firm level is an important driver of innovation activities within firms.

5.2 Mechanisms

Having documented a positive association between firm-level collective bargaining and investments in R&D and other intangibles, we now turn to explore the relevance of the different mechanisms discussed in Section 2. Since the positive effect detected in the baseline estimates is not consistent with the "hold-up hypothesis", which would instead predict a negative association, we focus on the other mechanisms, namely incentive alignment and power relations.

With respect to incentive alignment, the main idea developed here is that the positive impact of firm-level collective agreements could be driven by their ability to align wages and productivity, thus reducing distortions that may discourage investment in the first place. To test the plausibility of this channel we exploit information about whether the firm-level collective contract includes a mechanism to anchor part of the remuneration to levels of production or productivity (performance-related pay). We thus create a dummy variable taking value 1 if such mechanism is present and 0 otherwise. Then, we re-estimate the baseline full specification of the linear probability model described above by adding an interaction term between the performance-related pay dummy and the dummy for firm-level collective contract. If the alignment of productive incentive is indeed an important mechanism driving investments in intangibles, the interaction term should at least partially mediate the impact of firm-level collective contract and pick up its direct effect. Table 4 reports the result of this empirical exercise in column 1. While the coefficient associated with firm-level collective contract remains positive and significant, neither the interaction term with performance-related pay, nor performance-related pay alone is statistically significant. Overall, this result provides very little support for the idea that incentive alignment based on remunerations linked to productivity is a major channel through which complementary negotiation affects investments in R&D and other intangibles.

The alternative mechanism that we consider is the one based on power resource theory and collective voice. In workplaces characterized by an uneven distribution of power between employers and workers, the possibility to engage in collective bargaining makes conflict explicit, favouring the adoption of cooperative solutions. Moreover, the more balanced power relations within firms, the more likely workers can make their own voice heard through collective agreements and induce management to invest in resources such as R&D that relieve competitive pressure on wages. To test the plausibility of this argument we follow the same approach as before and consider firm-level unionization rate (i.e. the share of workers currently enrolled in a union) as a proxy for workers' bargaining power. Once again we check whether the interaction between this variable and the dummy variable selecting companies with firm-level collective bargaining mediates the direct impact of complementary negotiation on investment decisions.

The results of this exercise are reported in column 2 of Table 4. We find that when considered alone, unionization rate has a negative and significant impact on R&D and intangible investment. This result is consistent with the idea that, everything else equal, strong unions can alter bargaining positions within firms and possibly discourage investment. However, when we interact unionization rate with the dummy for collective bargaining at the firm level, the coefficient turns to be positive and statistically significant. Even more interestingly, such interaction completely picks up the direct effect of firm-level bargaining, which is not significant anymore. The combination of these results suggests that the bargaining power of unions can indeed be a relevant channel through which firm-level complementary negotiation affects investments in R&D and other intangibles. Rather than operating as a device to align incentives, this type of negotiation provides workers with a voice channel that allows them to influence investment decision. In particular, in a competitive business environment that tends to put strong pressure on costs, investments in innovation-related activities such as R&D are likely to encounter strong support on the side of the workers to shift competitive pressure away from wages. If workers have the strength (unionization rate) and the institutional tools (firm-level collective contracts) to make their voice heard, then this type of investments is more likely to rise. Furthermore, second-level bargaining is the place where work organizational practices are regulated by the

parts, such as training initiatives, job-rotation, employee involvement in upward problem-solving initiatives, all practices that may influence the success of technical change occurring at the level of production departments once R&D labs will provide their inputs.

As a further check on the relevance of this mechanism we report in Table 5 estimates of our baseline model where we split industries according to the Pavitt's taxonomy (Pavitt, 1984). In principle, if the effect of firm-level collective bargaining on R&D and intangible investment is due to a change of competitive strategies induced by power relations, we should expect this effect to be stronger in industries where firms enjoy some degrees of freedom in defining their competitive position. In the Pavitt taxonomy this is less likely to be the case in science based and suppliers dominated industries than in specialized suppliers and scale intensive ones, because in the former the technological regime exerts a relatively strong influence (although for opposite reasons) on the source of competitive advantages. Therefore we should expect the effect of firm-level collective bargaining to be weaker in these industries. Indeed, this is what we find: in specialized suppliers and scale intensive industries the coefficient of firm-level contract remains positive and significant, whereas in science based and suppliers dominated industries it is either weakly significant or not significant at all. This result militates in favour of the idea that firmlevel collective bargaining shifts the probability of undertaking R&D and intangible investments, especially in those industries where such investment can be influenced by the pressure exerted through organized labour.

5.3 Endogeneity

The regression models outlined in the preceding sections do not prevent potential issues related to unobserved heterogeneity and sample selection (endogeneity). Namely, if there are unaccounted factors simultaneously affecting the decision to invest in R&D and other intangibles and the presence of firm-level bargaining institutions, results would be biased. The inclusion of a wide set of controls allows us to minimize issues arising from the presence of omitted variables; while the inclusion of these variables as pre-determined controls helps us to address reverse causality. However, these measures do not completely rule out the risk of biased estimates.

Therefore, we perform a robustness check where we address endogeneity through a Regression Discontinuity Design (RDD).¹¹ In particular, we exploit one specific feature of the Italian legislation, namely the fact that the creation of employee representative bodies and firm-level

¹¹The same methodology has been applied to other studies focusing on trade unions. For instance, both DiNardo and Lee (2004) look at different employment outcomes for American companies where trade unions barely win the elections with respect to those companies where trade unions barely lost the elections (with the vote share threshold below or above the required 50%). Other empirical studies adopting RDD are Betts et al. (2001) and Bradley et al. (2017), respectively on Canadian and Us firms.

bargaining institutions is governed on a size-contingent basis. In fact, according to Law n. 300/70 (also known as the "Statuto dei Lavoratori") and subsequent Protocol Agreements (especially the agreement signed by Government and Social Parties on 23 July 1993) the establishment of both unionized and non-unionized representation (RSA and RSU), is mandatory upon the request of the workers only in firms with more than 15 employees. Below that threshold, the employer can deny the requests of the workers. Since RSA and RSU are the main institutional bodies entitled for firm-level bargaining, such size-contingent legislation automatically introduces a discontinuity also in the formalization of firm-level collective agreements that can be exploited to identify their effect on R&D and intangible investment. The advantage of this approach is that it can support a causal interpretation of the estimated parameters. The disadvantage is that the validity of the results is limited to the firms located around the discontinuity, which in the Italian context still represents a large proportion of the industrial population.

Formally, the standard RDD approach consists of estimating the following model:

$$Y_{i,t} = \beta_0 + \beta_1 \mathbb{1}(Size_{i,t-1} > c) + f(Size_{i,t-1}) + \varepsilon_{i,t-1}$$

$$\tag{2}$$

where $Y_{i,t}$ is the outcome of interest, $\mathbb{1}(Size_{i,t-1} > c)$ is an indicator function taking value one for firms above the size threshold (c) that is relevant to trigger firm-level bargaining rights and zero otherwise, $f(Size_i)$ is a continuous function in firm size on each side of c. In our setting, we normalize the running variable so that for firms employing just 15 employees the cutoff value is equal zero. In line with the baseline model described above, the outcome variable is measured in 2018, while firm size is measured in 2015. To account for the fact that our forcing variable (size) is discrete and has few mass points (i.e. values of the variable that are shared by many units) in its support, we rely on a local randomization approach to RDD, which stipulates that treatment assignment may be approximated by a local random experiment near the cutoff c (for a similar approach see Belloc et al., 2022b).

The first step in the RDD estimation procedure is to select the window around the size cutoff where the presence of ER can be plausibly assumed to have been as-if randomly assigned. To do this, we follow Cattaneo et al. (2015) and use a data-driven window selection approach based on "balance tests" of covariates. The optimal window is determined based on the following covariates: firm age, share of fixed-term workers, share of workers with tertiary education, share of workers over 50 years, presence of female manager and dummy variables for exporting firms, manufacturing firms, and firms that are part of a business group. All these variables are measured in 2015. Figure 3 reports the results of the window selection procedure, including randomization-based p-values from balance tests. We consider all symmetric windows around

the cutoff between [-1, 1] and [-15, 15] in increments of one employee. In each window, we perform randomization-based tests (difference-in-means tests) of the null hypothesis of no treatment effect for each of the covariates. Results indicate that the p-values are above 0.15 in all windows between [-1, 1] and [-5, 5]. Then, the p-value drops below the suggested 0.15 threshold. Therefore, we perform the local randomization analysis in the chosen window [-5, 5].

Once the optimal window is selected, the next step is to check whether a discontinuity in the incidence of firm-level collective bargaining is indeed present around the cutoff. Figure 4 provides some first preliminary evidence that this is indeed the case: the presence of both employee representative bodies and firm-level collective contracts is discontinuous at the cutoff point. In columns (1) and (2) of Table 6 (panel A) we report a mean difference of 9.3 percentage points in the incidence of employee representation between treatment and control firms within the chosen window. Such difference reduces to 1.6 percentage points when we consider the presence of firm-level collective contracts, which is still a sizable difference if we consider the low incidence of complementary negotiation in small firms (less than 1% in firms below the 15-size threshold). With respect to the latter, the null hypothesis of no treatment effect is rejected with p-value of 0.005.

On this basis, we can now turn to our outcome of interest, i.e. investments in R&D and other intangibles. Visual inspection from Figure 5 suggests a small but potentially positive effect. The latter is confirmed by the results reported in Table 6, which shows in column (3) (panel A) a positive mean difference of roughly 2.1 percentage points in R&D investments between treatment and control units. This effect is equivalent to a 8% of one standard deviation of the share of firms investing in R&D and other intangibles in the control group (i.e. 0.021/0.259). The null hypothesis of no treatment effect is rejected with p-value of 0.058.

We run a series of falsification tests to assess the validity of our RDD results. First, we check for systematic differences in the covariates around the cutoff. In particular, we test the hypothesis that the treatment effect is zero for all the variables used as part of the window selection procedure. Results are reported in Figure $6.^{12}$ Reassuringly, we find no evidence of treatment effects for any of these variables. Second, we analyze the density of the forcing variable within our selected window [-5, 5], i.e. whether the number of establishments just above the cutoff is similar to the number of establishments just below it. Sorting around the cutoff may occur if firms manipulate their size in order to block employees' attempts to trigger collective rights. The number of control firms immediately below the cutoff (1242) and treatment firms above the cutoff (1170) is slightly unbalanced. However, a binomial test that the probability of

¹²Point estimates are available upon request

being treated is 0.5 does not reject the null (p-value=0.148), indicating no evidence of sorting (Cattaneo et al., 2017). Third, we check whether the results are affected by potential misreporting of information about firm size due to the fact that companies have productions allocated across different establishments. More specifically, we replicate the RDD estimates by limiting the analysis to single-site firms. Results are reported in panel B of Table 5. The discontinuity in the incidence of employee representation and establishment-level contracts is confirmed as well as the positive mean difference in R&D investments between treated and control groups.

Finally, we conduct a confirmatory analysis aimed at testing the relevance of the underlying mechanisms driving the relationship between organized labour and R&D investments identified above, namely incentive alignment and power relation. In particular, we check whether the inclusion of performance-related pay in collective agreements and unionization rate are discontinuous around the cutoff (to facilitate the comparison we limit the analysis to establishments whether an employee representative body is present). Results are reported in Table 7. While for performance-related pay we find no significant mean difference between firms just above the cutoff and firm just below it, unionization rate is 8.0 percentage points higher in the treated groups than in the control groups. This confirms that the strength of employee's bargaining power, as captured by their unionization rate, can potentially be an important channel orienting firms toward sustaining investment in R&D and other intangibles.

6 Conclusions

The economic impact of "organized labor" – intended both as unionized workforce and collective bargaining - has been a highly debated topic in economic and sociological literature between 80s and 90s. Progressively pushed into oblivion in a context characterized by worsening wage dynamics and widespread adoption of neo-liberal agenda (Baccaro and Howell, 2017), the role of trade unions at the workplace has, nevertheless, recently came back into vogue. While international organizations, such as the OECD, start discussing again the role of industrial relations in promoting economic growth and social equality (Cazes et al., 2019), Nordic models of codetermination have become object of special interest (Jäger et al., 2021; Harju et al., 2021; Belloc et al., 2022a), as they offer solutions that can partially tamper conflicts between diverse stakeholders populating modern firms (Rodrik, 2020).

With this paper we aim to contribute to this research revival by focusing on the interplay between firm-level collective bargaining and investments in R&D. By making use of a rich and representative survey of Italian non-agricultural firms we document that organized labour at the workplace does not discourage investment. Rather, firms that are engaged in firmlevel bargaining are significantly more likely to invest in R&D and other intangible assets than firms that are not. This result does not seem to be driven by an incentive mechanism, i.e. decentralized collective agreements favouring the alignment of workers and capitalist interests. On the contrary, it is consistent with the fact that participatory mechanisms (such as firmlevel collective bargaining) can mediate opposing interests within unbalanced power relations, thus favouring the orientation of firm strategies towards conducts that are more favourable to labour, i.e. less focused on wage compression, relying more on value creation through innovation and therefore pursuing 'high-road' paths. These results are robust to different econometric specifications and survive also in a regression discontinuity design expressly aimed at tackling endogeneity-related issues.

It is worth acknowledging some limitations of our study. First, our analysis focuses only on one country. Although firm-level collective bargaining is an institution that exits in many advanced capitalist economies, each industrial relation system tends to be characterized by specific political and social-institutional features that affect collective bargaining and thus make our results difficult to generalize. In this sense, it can well be that in other contexts, for instance characterized by larger or smaller domains of decentralized negotiation, the results turn out to be different. As discussed above, the early literature on the interplay between unions and innovation clearly outlined an "Atlantic divide" (i.e. negative effect of unions on innovation in the US but null or weakly positive effect in Europe) that could still be valid even when we dig into the detail of specific labour institutions. We leave to future research the task to assess whether this is indeed the case.

Second, the data prevents us from obtaining a generalized causal inference about the relationship under investigation. Although, our RDD estimates allows us to partially deal with this issue, it should be reminded that the latter are valid only locally, that is around the sizecutoff. For larger firms we do not have data to infer a causal interpretation of the results. Moreover, we lack data measuring R&D and intangible intensities, which limits our ability to take adequately into account the heterogeneity of investments across firms. While being conscious of these limitations, we are reassured of the validity of our results because a consistent picture emerges when using different estimation strategies. Moreover, we are able to obtain some sharper evidence for the segment of firms that, in Italy, seem to play a crucial role in the production system, namely small firms. This, if anything, reinforces our policy implications.

Finally, although we provide a detailed analysis of the effect of organized labour on innovation inputs, we do not discuss the extent to which this translates also in innovation outputs, i.e. actual innovations. Although we expect that higher investment in R&D are likely to rise the chances of innovative breakthroughs, we cannot exclude the possibility that bottlenecks can occur at later stages of the innovation process given the complex nature of the innovative activity and eventual resistance put in place by trade unions at the workshop level. However previous studies have suggested that stronger unions are in a better position than weaker unions to attain workplace cooperation and that when the workforce is organised by means of a cohesive trade union, this enables the firm to better appropriate the gains of technological and organisational improvements (Haipeter, 2020; Cirillo et al., 2020). Indeed, the new wave of digital and automation technologies has paved the way for a revitalized role of trade unions envisaging a major involvement of workers on both organizational aspects as well as investments decisions. From this point of view, Italy represents a peculiar case since involvement of trade unions in technological and investment decisions has only recently gained a renewed attention even in the union strategies. Qualitative type of research revealed that this usually takes place among a small niche of technologically advanced and in general dynamic firms (Cirillo et al., 2020).

Assessing the linkage between collective bargaining and investments in intangible assets can contribute to the debate on the role of social dialogue and trade unions in fostering labor productivity and improving firms' innovative capabilities.

Overall, the results of our study have important policy implications. In a conjuncture characterized by declining policy support for unions, we suggest that organized labour (and cooperative industrial relations) can be an important driver of innovation-related investments. At the broader level these findings can inform the design of innovation policy, which has tended to relegate labour institutions to a second-order role compared to other policy levers such as academic-industry relations and/or intellectual property protection. Rather than being a substitute for them, labour institutions and in particular collective bargaining may operate as important complement that help to orient firms towards competitive strategies based on larger investments on R&D. Moreover, at a more specific level, our results highlight the importance of the balancing of power relations within workplaces as a crucial channel through which organized labour can positively affect firms' capability to generate new knowledge and therefore foster innovation. This may open new avenues of research and policy debate about the most adequate set of capital-labour relations in the knowledge economy.

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Figures and Tables

Figure 1: Business R&D expenditure in Purchasing power standard (PPS) per inhabitant at constant 2005 prices(OECD)



Notes: Own elaborations on OECD data.



Figure 2: Researchers in R&D per million people, 1996 to 2014 (UNESCO)

Notes: Own elaborations on UNESCO data.



Figure 3: R&D and other intangible investments, firm-level bargaining and firm size.

Notes: Pooled data from the INAPP-RIL survey. Sample weights are used.



Figure 4: R&D and other intangible investments, firm-level bargaining and firm size by industry.

Notes: Pooled data from the European Company Survey 2019. Sample weights are used.



Figure 5: RDD plot: window selection, minimum p-value from covariate test.

Notes: rdwinselect plot using 2015-2018 RIL-INAPP panel of Italian firms. The dotted lone corresponds to p-value = 0.15.



Figure 6: RDD plots: employee representation and firm-level bargaining.

Notes: rdplots of the incidence of employee representation using 2015-2018 RIL-INAPP panel of Italian firms. Normalized employment is reported on the horizontal axis, i.e. zero corresponds to the firm size threshold of 15 employees. RD-plots restricted to the window[-10, 10] with polynomial degree = 0 and a uniform kernel.





Notes: rdplots of the incidence of employee representation using 2015-2018 RIL-INAPP panel of Italian firms. Normalized employment is reported on the horizontal axis, i.e. zero corresponds to the firm size threshold of 15 employees. RD-plots restricted to the window[-10, 10] with polynomial degree = 0 and a uniform kernel.



Notes: rdplots of the incidence of employee representation using 2015-2018 RIL-INAPP panel of Italian firms. Normalized employment is reported on the horizontal axis, i.e. zero corresponds to the firm size threshold of 15 employees. RD-plots restricted to the window[-10, 10] with polynomial degree = 0 and a uniform kernel.

| Variable | Description | Obs | Mean | Std. Dev. | Min | Max |
|---------------------------------|---|-------|-------|-----------|-----|-------|
| | | | | | | |
| R&D and other intangibles | The firm has invested in R&D, patents, licences, trademarks, software in the last year (yes/no) | 9,051 | 0.141 | 0.348 | 0 | 1 |
| Firm-level contract | The firm has signed a complementary collective contract at the firm level | 9,051 | 0.101 | 0.301 | 0 | 1 |
| Territorial-level contract | The firm has signed a complementary collective contract at the territorial level | 9,051 | 0.011 | 0.102 | 0 | 1 |
| National-level contract | The firm applies one or more national collective contracts | 9,051 | 0.896 | 0.307 | 0 | 1 |
| Employee representation | An official employee representation currently exists in the firm (yes/no) | 9,051 | 0.272 | 0.445 | 0 | 1 |
| Log(Size) | Log of the number of employees currently working at the firm | 9,051 | 2.909 | 1.556 | 0 | 9.188 |
| Log(Age) | Log of the number of years since the firm has been carrying out its activity | 9,051 | 3.228 | 0.579 | 0 | 6.919 |
| % 50+ employees | % employees more than 50 years old | 9,051 | 0.242 | 0.227 | 0 | 1 |
| % Emp. with tertiary edu. | % employees with tertiary education | 9,051 | 0.591 | 0.334 | 0 | 1 |
| % Emp. with fixed-term contract | % employees with a fixed-term contract | 9,051 | 0.072 | 0.138 | 0 | 0.989 |
| % Directors and middle-managers | % of employees with the role of director or middle-manager | 9,051 | 0.041 | 0.102 | 0 | 1 |
| % Clerks | % of employees with the role of clerk | 9,051 | 0.379 | 0.319 | 0 | 1 |
| Business group | The firm belongs to a national or foreign business group (yes/no) | 9,051 | 0.152 | 0.359 | 0 | 1 |
| Multi-establishment | The establishment is one of a number of establishments belonging to the same company (yes/no) | 9,051 | 0.511 | 0.499 | 0 | 1 |
| Female manager | The CEO or the controlling manager is female (yes/no) | 9,051 | 0.121 | 0.326 | 0 | 1 |
| Exporting firm | The firm export goods or services abroad(yes/no) | 9,051 | 0.332 | 0.471 | 0 | 1 |
| Multinational enterprise | The firm has carried out FDI or acquisition of foreign companies in the last 2 years (yes/no) | 9,051 | 0.041 | 0.199 | 0 | 1 |
| Patents | The firm has filed or acquired patents during the last 3 years (yes/no) | 9,051 | 0.071 | 0.257 | 0 | 1 |

Table 1: Descriptive statistics.

Notes: Data from RIL 2015 and RIL 2018. For R&D and other intangibles the statistics are computed using RIL 2018. For all the other variables the statistics are computed using RIL 2015.

| | (1) | (2) | (3) | (4) | (5) |
|---------------------------------|---------------|---------------|---------------|---------------|---------------|
| | . , | | . / | . / | |
| Firm-level contract | 0.119^{***} | 0.106^{***} | 0.103^{***} | 0.097^{***} | 0.089*** |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.019) |
| Territorial-level contract | 0.099^{**} | 0.107^{**} | 0.105^{**} | 0.107^{**} | 0.105^{**} |
| | (0.048) | (0.048) | (0.048) | (0.048) | (0.047) |
| National-level contract | -0.006 | -0.003 | -0.002 | -0.004 | -0.005 |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| Employee representation | -0.003 | 0.002 | 0.002 | 0.005 | 0.004 |
| | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) |
| Log(Size) | 0.061^{***} | 0.062^{***} | 0.060^{***} | 0.052^{***} | 0.049^{***} |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Log(Age) | 0.001 | 0.003 | 0.003 | 0.001 | 0.001 |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| % 50+ Employees | | -0.026** | -0.026** | -0.026** | -0.022** |
| | | (0.011) | (0.011) | (0.011) | (0.011) |
| % Emp. with tertiary edu. | | 0.052^{***} | 0.051^{***} | 0.047^{***} | 0.047^{***} |
| | | (0.010) | (0.010) | (0.010) | (0.010) |
| % Emp. with fixed-term contract | | 0.004 | 0.007 | 0.005 | 0.002 |
| | | (0.022) | (0.022) | (0.022) | (0.021) |
| % Directors and middle-managers | | 0.048 | 0.040 | 0.030 | 0.022 |
| | | (0.030) | (0.030) | (0.030) | (0.030) |
| % Clerks | | 0.098^{***} | 0.095^{***} | 0.082^{***} | 0.075^{***} |
| | | (0.012) | (0.012) | (0.012) | (0.012) |
| Business group | | | 0.017 | 0.007 | 0.001 |
| | | | (0.014) | (0.014) | (0.013) |
| Multi-establishments | | | 0.005 | 0.003 | 0.003 |
| | | | (0.007) | (0.007) | (0.007) |
| Female manager | | | -0.005 | -0.003 | -0.005 |
| | | | (0.009) | (0.009) | (0.009) |
| Exporting firms | | | | 0.065^{***} | 0.049*** |
| | | | | (0.009) | (0.009) |
| Multinational enterprise | | | | 0.127*** | 0.097*** |
| - | | | | (0.025) | (0.024) |
| Patents | | | | | 0.204*** |
| | | | | | (0.020) |
| Constant | -0 125*** | -0 101*** | -0 101*** | -0 159*** | -0 145*** |
| | (0.024) | (0.025) | (0.025) | (0.025) | (0.025) |
| | (0.021) | (0.020) | (0.020) | (0.020) | (0.020) |
| Region & Industry FE | Yes | Yes | Yes | Yes | Yes |
| Observations | $9,\!051$ | $9,\!051$ | $9,\!051$ | $9,\!051$ | $9,\!051$ |
| R-squared | 0.173 | 0.185 | 0.185 | 0.196 | 0.215 |

Table 2: Firm-level collective bargaining and investments in R&D and other intangibles.

Notes: Estimates obtained from LPM models with robust standard errors in parentheses. In columns (1)-(5), the dependent variable is a dummy variable indicating whether the firm has invested in R&D and/or other types of intangibles such as licences, trademarks and software. *** p < 0.01, ** p < 0.05, * p < 0.1.

| | (1) | (2) | (3) | (4) | |
|----------------------------|-------------------------|-------------------------|------------------------|------------------------|--|
| | Pro | obit | Lo | git | |
| | Beta | dy/dx | Beta | dy/dx | |
| Firm-level contract | 0.139^{**} (0.066) | 0.025^{**} (0.012) | 0.200^{*} (0.116) | 0.020^{*} (0.012) | |
| Bargaining institutions | Y | es | Y | es | |
| Firm-level characteristics | Yes | | Yes | | |
| Employee characteristics | Yes | | Yes | | |
| International activities | Yes | | Yes | | |
| Past innovation activities | Yes | | Yes | | |
| Region & Industry FE | Yes | | Yes | | |
| Observations | 9,051 | | 9,051 | | |

Table 3: Robustness checks: probit and logit estimates.

Notes: Estimates obtained from probit and logit models with robust standard errors in parentheses. In columns (1)-(4), the dependent variable is a dummy variable indicating whether the firm has invested in R&D and/or other types of intangibles such as licences, trademarks and software. Bargaining institutions: presence of territorial-level contract, national-level contract, employee representation. Firm-level characteristics: firm size (in log), firm age (in logs), being part of business groups, being multi-establishment firms and having a female manager. International activities: being an exporting firms, being a multinational firm. Past innovation activities: the firm has acquired patents during the last 3 years. *** p<0.01, ** p<0.05, * p<0.1.

| | (1) | (2) |
|--|-----------------------------|-------------------------|
| Firm-level contract | 0.073*** | 0.040 |
| Performance-related | (0.025) -0.120 | (0.027) |
| Firm-level contract \times Performance-related pay | (0.093) 0.144 (0.098) | |
| Unionization rate | (0.000) | -0.075** |
| Firm-level contract \times Unionization rate | | (0.024) 0.162^{**} |
| | | (0.080) |
| Bargaining institutions | Yes | Yes |
| Firm-level characteristics | Yes | Yes |
| Employee characteristics | Yes | Yes |
| International activities | Yes | Yes |
| Past innovation activities | Yes | Yes |
| Region & Industry FE | Yes | Yes |
| Observations | $9,\!051$ | 8,912 |
| R-squared | 0.216 | 0.217 |

Table 4: Firm-level collective bargaining, R&D and other intangibles: mechanisms.

Notes: Estimates obtained from LPM models with robust standard errors in parentheses. In columns (1)-(3), the dependent variable is a dummy variable indicating whether the firm has invested in R&D and/or other types of intangibles such as licences, trademarks and software. Performance-related pay is a dummy equal 1 if the firm-level contract includes mechanisms linking wages to production or productivity. Unionization rate is the ratio of unionized employees over total employment. Bargaining institutions: presence of territorial-level contract, national-level contract, employee representation. Firm-level characteristics: firm size (in log), firm age (in logs), being part of business groups, being multi-establishment firms and having a female manager. International activities: being an exporting firms, being a multinational firm. Past innovation activities: the firm has acquired patents during the last 3 years. *** p<0.01, ** p<0.05, * p<0.1.

| | (1) | (2) | (3) | (4) |
|----------------------------|-------------|--------------|---------------|-----------|
| | Science | Specialized | Scale | Suppliers |
| | based | suppliers | intensive | dominated |
| | | | | |
| Firm-level contract | 0.088^{*} | 0.119^{**} | 0.101^{***} | 0.037 |
| | (0.053) | (0.059) | (0.039) | (0.037) |
| | | | | |
| Bargaining institutions | Yes | Yes | Yes | Yes |
| Firm-level characteristics | Yes | Yes | Yes | Yes |
| Employee characteristics | Yes | Yes | Yes | Yes |
| International activities | Yes | Yes | Yes | Yes |
| Past innovation activities | Yes | Yes | Yes | Yes |
| Region & Industry FE | Yes | Yes | Yes | Yes |
| Observations | $1,\!199$ | 1,075 | $1,\!657$ | 1,968 |

Table 5: Heterogeneity across Pavitt industries.

Notes: Estimates obtained from LPM models with robust standard errors in parentheses. In columns (1)-(4), the dependent variable is a dummy variable indicating whether the firm has invested in R&D and/or other types of intangibles such as licences, trademarks and software. Column (1), (2), (3) and (4) report estimates for the sub-sample of firms belonging to industries classified respectively as science based, specialized suppliers, scale intensive and suppliers dominated following the Pavitt's taxonomy. Bargaining institutions: presence of territorial-level contract, national-level contract, employee representation. Firm-level characteristics: firm size (in log), firm age (in logs), being part of business groups, being multi-establishment firms and having a female manager. International activities: being an exporting firms, being a multinational firm. Past innovation activities: the firm has acquired patents during the last 3 years. *** p<0.01, ** p<0.05, * p<0.1.

| | (1) | (2) | (3) |
|-----------------------|---------------|---------------|-----------|
| | \mathbf{ER} | \mathbf{FC} | R&D |
| A. All establishments | | | |
| Point estimate | 0.093 | 0.016 | 0.021 |
| p-value | 0.000 | 0.005 | 0.058 |
| Window | [-5, 5] | [-5, 5] | [-5, 5] |
| Polynomial degree | 0 | 0 | 0 |
| Sample sized treated | $1,\!157$ | $1,\!134$ | $1,\!154$ |
| Sample sized control | $1,\!221$ | $1,\!194$ | $1,\!233$ |
| B. Single-site firms | | | |
| Point estimate | 0.102 | 0.018 | 0.042 |
| p-value | 0.000 | 0.030 | 0.007 |
| Window | [-5, 5] | [-5, 5] | [-5, 5] |
| Polynomial degree | 0 | 0 | 0 |
| Sample sized treated | 571 | 561 | 565 |
| Sample sized control | 659 | 645 | 664 |

Table 6: Randomization-based approach: main outcomes.

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Notes: RDD estimates using a local randomization approach with an analysis window of [5,5]. In column (1) the outcome variable is a dummy variable indicating whether an employee representative (ER) body (either RSA or RSU) is present at the firm. In column (2) the outcome variable is a dummy variable indicating whether an firm-level contract (FC) has been signed. In column (3), the outcome variable is a dummy variable indicating whether the firm invests in R&D and other intangibles. Optimal window determined based on the following covariates: firm age, share of fixed-term workers, share of workers with tertiary education, share of workers aged 50+ years old, presence of female manager and dummy variables for exporting firms, manufacturing firms, and firms that are part of a business group. All these variables are measured in 2015.

| | (1) | (2) | (3) |
|----------------------|-----------------|-------------------|-----|
| | Perfrelated pay | Unionization rate | |
| Point estimate | 0.019 | 0.080 | |
| p-value | 0.522 | 0.028 | |
| Window | [-5, 5] | [-5, 5] | |
| Polynomial degree | 0 | 0 | |
| Sample sized treated | 192 | 202 | |
| Sample sized control | 86 | 86 | |

Table 7: Randomization-based approach: mechanisms.

Notes: RDD estimates using a local randomization approach with an analysis window of [5,5] for firms where an employee representative body is present. In column (1) the outcome variable is a dummy variable indicating whether an employee representative (ER) body (either RSA or RSU) is present at the establishment. In column (2) the outcome variable is a dummy variable indicating whether an firm-level contract (FC) has been signed. In column (3), the outcome variable is a dummy variable indicating whether the firm invests in R&D and other intangibles. Optimal window determined based on the following covariates: firm age, share of fixed-term workers, share of workers with tertiary education, share of workers aged 50+ years old, presence of female manager and dummy variables for exporting firms, manufacturing firms, and firms that are part of a business group. All these variables are measured in 2015.