

# Are unions detrimental to innovation?

## Theory and evidence

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**Abstract:** We study the effect of unions on product and process innovation both theoretically and empirically. We develop a simple Cournot duopoly where turnover costs are allowed to differ across unionized and non-unionized sectors due to collective voice mechanism. Our findings suggest that the traditional hold-up view whereby unions discourage innovation does not necessarily survive, provided that the voice ability of unions is above a critical threshold. In addition, we develop a model’s extension to assess how the asymmetric presence of local bodies of employee organization within a union-dominated industry affects innovation incentives. Under the assumption that the local representation further enhances the voice ability of the central union, we find that local representatives boost both types of incentives, although the effect is stronger for product innovation. Our empirical analysis of a large representative sample of Italian firms supports these last predictions in both pooled OLS, fixed effects and IV.

KEYWORDS: Innovation · labor-unions

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## 1. Introduction

Innovation is a highly idiosyncratic process (Holmstrom, 1989) that results from the combination of multiple factors that include, but are not limited to, the exogenous conditions of the outside economic environment, the firm's investment decisions and the effort of the employees who work in the organization, including those who are not directly involved in R&D. At first blush, one may think that production workers have little to do with the firms' innovation performance. And yet, the resource-based theory of the firm (Barney, 1991) suggests otherwise. Acknowledging organizations as loci of competence accumulation, in fact, ultimately leads to recognize the role of worker effort in the generation of tacit knowledge, that in turn, stands as a key antecedent for the codification of new organizational and technical knowledge (Foss, 1997, 1998; Penrose, 1959). In this framework, innovation depends on the combination of formalized R&D and unformalized on-the-job learning. Grinza and Quattraro (2019: 7) find support to this hypothesis by showing that workers' replacements have a negative effect on the number of patent applications, consistently with the idea whereby "when workers leave, they take with them firm-specific knowledge about competencies and routines, as well as about the potential for resource combination for the creation of novelty."

From here to postulating that workers' organizations may affect innovation – the focus of this article – the step is short, although not devoid of ambiguities. When unions and work councils secure wages above the competitive level, provide blanket protections to all workers regardless of their effort and productivity and impede the dismissal of redundant or loafing personnel, they may hinder the firm innovation performance. Conversely, when they improve the industrial dialogue between managers and workers, boost job-satisfaction and allow employees to voice their grievances, they may reduce labor turnover, and this, in turn, may improve the firms' innovation performances. These sharply different outcomes are related to the ambivalent role of unions, that can be seen as rent-seekers as originally postulated by Grout

(1984) or as voice institutions impacting negatively on labor turnover (Freeman and Medoff, 1984). These contradictory views have been long dividing the (often politically motivated) opinions of economists, separating those who maintain that unions improve working conditions at the expense of profitability, from those who conversely advocate that they have a beneficial effect on firm performance, even after controlling for their rent-seeking behavior. As already recalled by Hirsch (1997: 37), however, “[t]he monopoly and collective voice faces of unionism operate side-by-side, with the importance of each being very much determined by the legal and economic environment in which unions and firms operate”. Given this unsolved puzzle, it comes as no surprise that the effect of workers’ organizations on innovation is still an open issue.

In this paper, we study the effect of unions on innovation both theoretically and empirically. Our contribution to this stream of literature is threefold. First, we follow Bryson and Dale-Olsen (2020) by incorporating a voice effect in the Cournot duopoly of Haucap and Wey (2005) and extend the model’s analysis to the case of product innovation. Second, we focus – both theoretically and empirically – on coordinated systems of collective bargaining, i.e. those that according to Haucap and Wey (2005) are the least conducive to innovation, as well as the least studied in the literature. Third, studying Italy – a typically coordinated wage bargaining country – and using a large and representative sample of private non-agricultural firms, we test the main predictions of the model.

Our theoretical approach differs from that of Bryson and Dale-Olsen (2020) in three important ways. First, while the authors postulate that unions have a direct and positive effect on labor productivity, we stick more closely to Freeman’s and Medoff’s (1994) original argument and assume that unionized employees use the exit option (i.e., quit the firm) less frequently than their non-unionized counterparts.

Second, while Bryson and Dale-Olsen (2020) do not allow for the possibility that firms may invest differentially in product and process innovation, we treat the two as separate strategies, as to show how innovation incentives vary across the latter.

Third, while they consider the case where non-unionized firms directly compete with locally-unionized firms – a situation which seems to be common in the countries they analyze empirically, Norway and the UK – we stick more closely to Haucap’s and Wey’s (2005) original setting and compare the incentives to participate in R&D tournaments across unionized and non-unionized industries. The purpose, in this case, is to assess whether and under which conditions collectively coordinated wages are more inducive of innovation with respect to market wages. As our empirical analysis is based on Italian data, we focus on the unionization regime in Haucap’s and Wey’s classification that best describes the Italian system of industrial relations. In this setting – that Haucap and Wey (2005: 153) call “coordination” – “there is an industry union that coordinates the wage demands so as to maximize the industry wage bill, [...so that] labor supply is completely monopolized, [...] while firm-level wages are adjustable to the firms’ relative competitiveness”.<sup>1</sup> In Haucap’s and Wey’s original model, this regime is the least conducive to innovation and under no circumstances it can perform better than a market where wage determination is competitive. Conversely, when voice mechanisms are allowed into the picture, we find that this may no longer be true, provide that the voice ability of unions is above a critical threshold.

Moreover, and more closely related to our empirical analysis, we account for a common characteristic of many systems of industrial relations by developing a model’s extension (see section 3.5.) where the asymmetric presence of local bodies of employee organizations within a union-dominated industry enhances the employee voice beyond the union level. In many

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<sup>1</sup> Consistently, Haucap and Wey (2005: 153-154) recalls that the coordinated regime reflects “recent trends in continental Europe towards flexible wage setting, while the union’s monopoly power remains largely intact”.

countries (such as Italy, which we analyze empirically), in fact, wages are bargained at the sectoral levels by industry-wide unions, while firm-level organizations fine-tune collective labor agreements to the specific needs of their local employees they represent. In doing so, they are often able to negotiate aspects of workplace experience (e.g., working hours, on-the-job safety, job-design) that go beyond the worker's monetary compensation, but that may have a significant and positive effect on work-related well-being and job retention. In this framework, we find that the presence of a local representation is always conducive to more innovation, and this incentivizing effect is stronger for product than for process innovation. To test these theoretical predictions, we take advantage of the variability across firms and over time of formal workers' representative bodies – by means of which they channel their voice towards employers – and estimate OLS, fixed-effect and IV models of the theoretical hypotheses put forward above. Consistently with the theory, we find that product innovation is doubtlessly growing in the presence of such representative bodies, while process innovation display a less clear-cut relationship with firm-level union representations. In addition, we also show that the voice effect is likely to be heterogeneous across firms of different size.

The remainder of the paper is organized as follows. In section 2, we overview the different theories and associated evidence on the relationship between unions and innovation. In section 3, we depart from Haucap and Wey (2005) and develop our theoretical model. Section 4 outlines the data used for the estimations, along with some descriptive statistics, presents the econometric strategy and the main results. Section 5 comments and concludes.

## **2. Related literature**

### **2.1. Theory**

Theoretically, the effect of unions on innovation is ambiguous – see Table 1 for a summary. A first strand of research sees unions as monopolist institutions that distort market outcomes

through rent-seeking behaviors. The classic reference in this case is Grout (1984).<sup>2</sup> In this view, wage-bargaining reduces the gains from innovation by imposing a sort of a tax on sunk capital, therefore discouraging R&D investments ex-ante. Key to this hold-up mechanism are the degree of asset specificity, the elasticity of substitution between capital and labor and the time horizon of the industrial relations.<sup>3</sup> However, when unions and firms bargain over wages and employment levels as in efficient bargaining models (Oswald and Turnbull, 1985; Layard et al., 1991; and Booth, 1995), the negative relationship between unionization and innovation may be weakened or even disappear, depending on the unions' preferences for wage and employment.<sup>4</sup>

[Insert table 1 about here]

In a second line of research that traces back to Freeman and Medoff (1984) (and expand on Hirschman's (1970) exit-or-voice theory), unions are seen as collective voice institutions that increase the workers' ability to express their grievances and thus, reduce labor turnover. The mechanism is as follows:

In the exit-voice model of the social system [...] individuals react to discrepancies between desired and actual social phenomena in one of two ways: by the traditional free market mechanism of "exiting" from undesirable situations; or by directly expressing their discomfort to decision-makers through "voice". [...] voice is embodied in unionism [...] while exit consists primarily of quits. A major feature of the model is a predicted tradeoff between the two adjustment mechanisms: when workers have a voice institution for expressing discontent,

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<sup>2</sup> For empirical support see Addison et. al (2007) and Card et al. (2014) and the references therein.

<sup>3</sup> When players engage in repeated interactions and abstract from end-game scenarios, the incentives to act uncooperatively weaken or even disappear (Van Der Ploeg, 1987).

<sup>4</sup> Mukherjee and Pennings (2011), for instance, study a Cournot oligopoly where innovation incentives depend on the union's preferences for wage and employment and on the degree of wage centralization.

they should use the exit option less frequently and thus exhibit lower quit rates and longer spells of job tenure with firms (Freemans, 1980: 643).

The reduction of employee-initiated separations that comes along with the voice ability of unions should improve firm performance through a variety of different channels. Directly, it should lower both training and selection costs. Indirectly, it should foster the accumulation of firm-specific human capital. This, in turn, may additionally encourage workers to voice their ideas, improve their learning achievements and ease the flow of intuitions from production to R&D departments, thus facilitating the codification of new organizational and technical knowledge.

The mechanisms through which employee organizations may reduce quits, in turn, are multiple. On the one hand, when firm-level unions and work councils are actively involved in job-design, they may ease and encourage the introduction of organizational innovations that improve work experience and boost job-satisfaction.<sup>5</sup> On the other hand, they may bargain flexible working hours, improve workplace safety and favor on-the-job training. More generally, employee organizations may engage in a multi-level dialogue with managers that should increase workplace democracy and improve the workers' involvement in the organization, with positive spillover effects on both productivity and quits.<sup>6</sup>

A third strand of research studies the effect of unions on innovation in oligopolistic markets (Beath et al., 1989; Ulph and Ulph, 1994). In this framework, when unions bargain higher employment levels, firms are incentivized to invest in R&D to protect their market shares.<sup>7</sup> Along similar lines, Haucap and Wey (2005) develop a Cournot duopoly model that

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<sup>5</sup> For a review of the related evidence, see below (Bryson et al., 2005; Antonioli, 2011; Holman and Rafferty, 2018).

<sup>6</sup> In both Sweden and Germany, co-determination laws were introduced in 1976. In Sweden, unions were given the right to negotiate the outcome of decision-making at all levels, while German workers achieved near parity representation on supervisory boards. Taking advantage of a subsequent reform that abolished worker-elected directors in certain firms and preserved the mandate in others, Jäger et al. (2021) provide quasi-experimental evidence that voice-oriented governance increase labor productivity.

<sup>7</sup> See Menezes-Filho et al. (1998) for empirical support.

studies how different unionization regimes (centralized, coordinated and decentralized) lead to different innovation incentives. Their key results is that the relationship between unions and innovation is non-monotonic in the degree of wage centralization, as innovation incentives are large under “centralization” – when an industry union bargains a single wage for the entire industry – intermediate under “decentralization” – where firm-level unions set their wages uncooperatively – and low under “coordination” – where a single union maximizes the industry wage bill by adjusting firm-level wages to the firms' relative competitiveness. Under some circumstances, they also show that “centralization” is the only regime that may perform better than a market where wage determination is competitive when it comes to innovation incentives. However, this result follows from the assumption that unions have no effect on labor turnover. The model developed in section 3 relaxes this assumption and shows that, under some circumstances, innovation incentives are larger also under “coordination”.

Finally, the “employee protectionism” hypothesis generates controversial predictions. On the one hand, providing workers with better employment protection may nurture innovation by ensuring tolerance for early failures. On the other hand, union presence could encourage shirking by lowering the probability of being dismissed, thereby reducing the negative consequences for supplying less effort. Manso (2011) develops a principal-agent model where the optimal contract to motivate innovation shows rewards for long-term success and tolerance for short-term failure, while Acharya et al. (2014) proposes a theoretical framework where wrongful discharge laws – i.e., laws which prevent employees to be fired in “bad faith” – boost innovation and new-firms creation. In contrast, Bassanini and Ernst (2002) and Scarpetta and Tressel (2004) find that the difficult or expensive firing of redundant personnel can frustrate labor-saving innovations at the firm level.

In a recent paper that does not directly fall in any of the above categories, Mukherjee and Beladi (2017) show that when firms can subcontract production to an informal sector, an



increase in union power has an ambiguous effect on innovation. Together with the study of Mukherjee and Pennings (2011) that analyzes how licensing incentives vary under different unionization structures, this research suggests that a thorough consideration of the constellation of strategies that firms may adopt to pursue their innovation objectives is in order to properly assess the relationship between unions and innovation.

## **2.2. Empirical evidence**

Given the array of possible effects that unions may have on innovation, it comes as no surprise that the empirical findings in the field are yet to be conclusive. In their review, Menezes-Filho and Van Reenen (2003) highlight a sort of “Atlantic divide”, as the available evidence seems to suggest that unions depress innovation in the US but not in Western Europe. This is consistent with the findings of Addison et al. (2013) and Bradley et al. (2016), who show, respectively, that the effect of unions on innovation is almost null in Germany, while is negative and statistically significant in the US. Doucouliagos and Laroche (2013), in turn, apply a meta-regression analysis to twenty-seven studies on four different countries (UK, US, Canada, Germany) and find a negative correlation between unionization and innovation in all four countries analyzed, despite the effect is declining over time and increasing in the flexibilization of labor markets, which is loosely consistent with the conclusions of Menezes-Filho and Van Reenen (2003). However, all these results seem to suffer from a geographical shortcoming, as “the samples of countries under study [...] are still very Anglo-Saxon biased” (ivi: 329). Hence, a key contribution of our study is to overcome such limitation by extending the samples of countries analyzed in the literature to the case of Italy.

Additional remarks on the relationship between the unions’ monopoly power and innovation have been drawn by Schnabel and Wagner (1994), who find that union density impact positively on R&D only if the union’s monopoly power is not too high. Similarly, Fang

and Ge (2012) suggest that the positive association between union presence and innovation in China can be explained by the poor bargaining power of Chinese trade unions, while Menezes-Filho and Van Reenen (2003), in turn, justify the presence of non-linearities in the relationship between unions and innovation in Europe by claiming that unions have a positive impact on innovation when their bargaining power is low and a negative impact on innovation when their bargaining power is high.

The “employee protectionism” hypothesis, in turn, has been tested by Acharya et al. (2014) using US data. Their findings show that the States adopting wrongful discharge laws as an exception to the employment-at-will doctrine experienced an increase in the annual number of patents and citations by 12.2% and 18.8% respectively. In a companion paper (Acharya et al. 2013), the same authors extend the analysis to other three countries, Germany, UK and France, and provide further evidence to the view whereby more stringent dismissal laws foster innovation, particularly, in knowledge-intensive industries. Finally, Ederer and Manso (2013) find support to Manso’s (2011) principal-agent model by revealing that innovation-motivating contracts ensure rewards for long-term success but also tolerance for early failures.

The available evidence on the threefold relationship between union presence, worker wellbeing and innovation incentives, in turn, is as follows. Bryson et al. (2013) find that union presence mitigates the increase in job-related anxiety due to the introduction of process innovations, thus providing suggestive support to the idea whereby the costs of implementing a piece of innovation are larger in non-unionized than in unionized firms, perhaps, due to voice mechanisms. Holman and Rafferty (2018), in turn, show that the introduction of organizational innovations is greater in more unionized systems of industrial relations (socio-democratic and Nordic systems vis-à-vis liberal and Mediterranean systems), while Antonioli et al. (2011) identify a positive relationship between on-the-job well-being (as dependent variable) and organizational innovation and cooperative industrial relations (as covariates). Finally, Bryson

et al. (2005) use British data on the introduction of HRM practices at the firm-level and find that the positive effect of organizational changes on labor productivity is confined to unionized firms.

While the above pieces of evidence seem somewhat supportive to the idea that the voice ability of unions likely have a positive effect on the firm innovation performance, to the best of our knowledge, no study has directly analyzed the relationship between union voice, employee separations and innovation incentives. The evidence on the negative correlation between union presence and turnover, however, is rather large, although not too recent. Freeman (1980), Freeman and Medoff (1984), Cotton and Tuttle (1986) and Lucifora (1998), in fact, provide empirical support to the view that sees unions as collective voice institutions that lower the probability of employee-initiated separations. More recently, the meta-regression of Havey et al. (2013) analyzed 694 effect sizes drawn from 82 studies, supporting the view whereby unionization is associated with lower turnover rates.

### **3. The model**

In this section, we follow Bryson and Dale-Olsen (2020) and incorporate a voice effect in the Cournot duopoly model of Haucap and Wey (2005). In addition, and always in line with Bryson and Dale-Olsen (2020), we extend Haucap's and Wey's (2005) original framework to account for product innovation. The set of admittedly limiting assumptions described hereafter is the same as in Haucap and Wey (2005). Relaxing any of these assumptions would not alter our results qualitatively, though it would obfuscate the mechanisms at play.

#### **3.1. Setup and assumptions**

Consider a model economy with four firms that compete à-la Cournot in two duopolistic sectors. While the labor market is competitive in one sector, it is monopolized by an industry

union in the other. In what follows, we use  $\rho = U$  (resp.,  $\rho = N$ ) to indicate the unionized (resp., non-unionized) sector, while we index as 1 and 2 the firms competing in the  $U$ -sector, and as 3 and 4 those competing in the  $N$ -sector. To concisely refer to the four firms populating our model economy, we use the index  $k \in \{1,2,3,4\}$ . As we stick to Haucap's and Wey's (2005) original setting, we do not allow for the possibility of intersectoral competition, so that firm 1 competes exclusively with firm 2 and firm 3 competes exclusively with firm 4.

### *Productivity and labor demand*

In each sector, firms operate under constant returns to scale, with labor as the sole factor of production. To produce one unit of the final good, firm  $k$  requires  $\alpha \leq 1$  units of homogeneous labor, so that firm  $k$ 's marginal cost is given by  $\alpha w_k$ , where  $w_k$  denotes the wage rate in firm  $k$  and  $\alpha$  depends on labor productivity, which is assumed to be homogenous across both sectors and firms. Production quantity of firm  $k$ ,  $q_k$ , is related to its labor demand,  $l_k$ , so that  $l_k = \alpha q_k$ . As in Haucap and Wey, we normalize  $\alpha = 1$ .<sup>8</sup>

### *Employee separations and turnover costs*

To model the idea that union presence may decrease the rate of employee-initiated separations through voice mechanism à-la Freeman and Medoff (1984), we assume that each firm  $k$  is characterized by an idiosyncratic probability  $0 \leq p_k \leq 1$  of incurring in an employee-initiated separation, so that  $p_k l_k$  is the share of quitting employees that firm  $k$  has to be replaced in each productive period. To keep things simple, we assume that separating workers are immediately replaced by the firm at a cost  $\tau > 0$  (e.g., training and recruiting costs), and we

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<sup>8</sup> In Bryson's and Dale-Olsen's (2020) version of Haucap's and Wey's (2005) model, the voice ability of unions is allowed to have a positive effect on labor productivity. Analytically, this amounts to assuming that  $\alpha$  is lower in unionized industries. As anticipated, we take Freeman and Medoff (1984) more to the latter by assuming that union presence reduces the rate of employee-initiated separations, thus reducing the firm turnover cost.

further denote  $c_k = \tau p_k$ . In this specification,  $c_k$  measure the unitary cost of replacing a quitting employee incurred by firm  $k$ , while  $c_k l_k$  measures the total turnover costs of firm  $k$ .

In what follows, we will analyze the effect of union voice on innovation in two different ways. First, we will compare the two types of incentives (process vs product) across industries characterized by different labor markets (competitive vs unionized). Formally, we will do so by assuming that  $c_1 = c_2 \leq c_3 = c_4$ , that is, that unionized duopolists have lower turnover costs than their non-unionized counterparts. The purpose, in this case, is to assess whether and under which conditions the reduction of turnover costs stemming from the voice ability of unions provides firms in unionized sectors with greater innovation incentives than firms in competitive labor markets (inter-sectoral incentives).

Second, and more closely related to our empirical analysis, we will analyze a situation where the level of employee voice is heterogeneously distributed among the duopolists competing in the union-dominated industry due to the presence of local bodies of employee representation that operate at the plant level (intra-sectoral incentives). More specifically, we will compare two different scenarios: in the first, the innovation winner has an LR that further enhances the voice ability of the central union, so that  $c_1 \leq c_2$ ; in the second, none of the two duopolists has an LR and thus, have the same turnover costs,  $c_1 = c_2$ . The idea, as anticipated, is that employee organizations operating at the firm-level should be able to fine-tune the collective labor agreements bargained at the sectoral level to the specific needs of their local employees, thus improving job retention and organizational performance.

### **3.2. Timing**

#### *Stage 1: innovation*

Given the above assumptions, we consider the following extended form game: at stage 1, firms decide whether to participate in an innovation race. As anticipated, a key novelty of our

paper with respect to Haucap's and Wey's (2005) original contribution, is that we consider both process and product innovation. As in Haucap and Wey, we assume that firms have the same chance of winning both races ( $= 1/2$ ) and face the same implementation cost, given by  $I(\Delta) > 0$  in the case of process innovation and by  $I(\Theta) > 0$  in the case of product innovation. In addition, we assume that firm 1 (resp., 3) is the innovation winner in the  $U$ -sector (resp.,  $N$ -sector) in both types of R&D tournament. Hence, we impose the following notational convention: innovation winners (resp., losers) are indexed by  $i$  (resp.,  $j$ ), so that  $i = 1$  and  $j = 2$  if  $\rho = U$ , and  $i = 3$  and  $j = 4$  if  $\rho = N$ .

In the case of process innovation, the innovation winner is given the exclusive right over a labor-saving technique that reduces its personnel requirement by  $\Delta \in (0,1)$ . This entails that the labor demand of the process innovation winner is measured by  $l = (1 - \Delta)q$ . In addition, we assume that the products of the two oligopolists are perfect substitutes when neither innovates its products. Hence, the symmetric demand functions of both innovation winners and losers are given by  $p_i = p_j = A - q_i - q_j$ , where  $A \leq q_i + q_j$ .

In the case of product innovation, the R&D tournament provides the innovation winner with the exclusive right over a patent that vertically differentiates the product market, thus increasing the demand of the innovation winner of a factor  $\Theta \in (0,1)$ .<sup>9</sup> In this case, the demand functions of product innovation winners are given by  $p_i = A(1 + \Theta) - q_i - q_j$ , while those of product innovation losers are given by  $p_j = A - q_i - q_j$ .<sup>10</sup> In what follows, we will use  $\Lambda \in \{\Delta, \Theta\}$  to refer concisely to the two types of innovation.

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<sup>9</sup>Basak and Mukherjee (2018) analyze the case of horizontal differentiation and highlight that innovation incentives are higher under decentralized (resp., centralized) union if the products are symmetrically (resp., asymmetrically) differentiated.

<sup>10</sup> The inverse demands functions are derived from a simplified version of Singh's and Vives's original model (1984), which is commonly taken as representing a micro-founded demand system of differentiated products. The derivation is as follows. The representative consumer's utility is a quadratic function of the purchased quantities of two vertically differentiated products. Due to the innovation race, product  $i$  is of high-quality, while product  $j$  is of low-quality. Formally, the demand function is given by  $U(q_i, q_j) = A(1 + \Theta)q_i + Aq_j - q_iq_j - (q_i^2 + q_j^2)/2$ . Utility maximization yields the inverse demand functions  $p_k = \partial U / \partial q_k, k = i, j$ .

### *Stage 2: wage bargaining*

At stage 2, wages are determined, either competitively in the  $N$ -sector – where the equilibrium-wage is driven down to the opportunity cost of labor, given by  $w_0 > 0$ , so that  $w_3 = w_4 = w_0$  – or by the union, which takes employment levels as given according to a classical right-to-manage rule.<sup>11</sup> As anticipated, we consider a “coordinated” wage setting regime where firm-level wages are adjusted to the firm’s relative competitiveness, according to the following rule:  $w_k = \operatorname{argmax} \sum_{k=1}^2 l_k(w_k - w_0)$ ,  $k = 1, 2$ . To make sure that the equilibrium wages bargained by the union are always larger than the competitive wage  $w_0$ , we impose the following restriction upon the set of parameters value:

**Assumption 1**—*The opportunity cost of labor is not so high as to drive the wages in the unionized sector down to the competitive level. Parametrically, this corresponds to:*

$$w_0 \leq \min\{A - c_2; A - (1 - \Delta)c_1; A(1 + \Theta) - c_1\}$$

which also ensures, as in Haucap and Wey, that all firms produce strictly positive outputs in equilibrium.

### *Stage 3: Cournot competition*

At stage 3, firms compete in quantities on the product market and choose their employment levels. As in Haucap and Wey (2005), we restrict our attention to the case where both types of innovation lead to non-drastring productivity improvements, so that the least efficient firms (the innovation losers) remain on the market.

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<sup>11</sup> As recalled by Haucap and Wey (2005: 153) “[w]hile unions usually neither have perfect monopoly power nor do they exclusively care about their members’ wage bill, these simplifying assumptions allow us to concentrate exclusively on the effects of wage setting rigidities”. The same simplification is used, for instance, in Basak and Mukherjee (2018) and in Calabuig and Gonzalez-Maestre (2002).

### *Equilibrium concept*

We derive the subgame perfect equilibrium (consisting in a set of optimal quantities, wages and innovation incentives) by backward induction. As our main focus is on innovation, we report our results concerning the latter in the next section, while the derivation of the equilibrium quantities and wages are given in Appendix A.

### **3.3. Theoretical results: union voice and innovation incentives**

Recalling that we have assumed that both firms have an equal probability = 1/2 of winning the R&D tournament, that firms  $i$  and  $j$  are, respectively, the innovation winners and losers, and that  $\Pi_k = (q_k)^2$  holds in equilibrium, a firm will participate in either of the two races as long as  $\frac{1}{2}[\Pi_i(\Lambda) + \Pi_j(\Lambda)] - I(\Lambda) \geq \Pi_j(\Lambda)$ , that is, as long as the expected profit from participating is higher than the certain profit from unilaterally abstaining – in which case the rival firm obtains the patent for sure. Following Haucap and Wey (2005), we assume that innovation incentives do exist, so that  $\frac{1}{2}[\Pi_i(\Lambda) - \Pi_j(\Lambda)] \geq I(\Lambda)$  is always satisfied. Thus, we can use of the profit differentials  $\psi(\Lambda, \rho) = \Pi_i(\Lambda) - \Pi_j(\Lambda)$  to measure the variability of the two types of innovation incentives. For future reference, it will be handy to put forward the following Lemma:

**Lemma 1**—*Across the different labor market structures (coordinated vs competitive), process and product innovation incentives are given, respectively by:*

$$\psi(\Delta, \rho) = v(\rho)[\Delta(w_0 + c_i) + c_j - c_i][2(A - w_0) + \Delta(w_0 + c_i) - c_i - c_j] \quad (1)$$

$$\psi(\Theta, \rho) = v(\rho)(\Theta A + c_j - c_i)[2(A - w_0) + \Theta A - c_i - c_j] \quad (2)$$

where  $v(U) = 1/12$  and  $v(N) = 1/3$ .



### 3.4. Intra-sectoral incentives

Our first goal is to compare the innovation performances of firms operating in different labor markets (coordinated vs competitive), as to assess if and under which conditions firms in union-dominated industries have greater innovation incentives than their non-unionized counterparts. Formally, this requires comparing  $\psi(\Delta, U)$  vs  $\psi(\Delta, N)$  and  $\psi(\Theta, U)$  vs  $\psi(\Theta, N)$ . Preliminarily, it is interesting to observe that:

**Remark 1**—*In the absence of voice mechanisms,  $c_i = c_j \forall \rho \in \{U, N\}$ , the hold-up effect resulting from the union's rent-seeking behavior is such that innovation incentives from firms in competitive labor markets are four times larger than those in union-dominated industries, and this is true for both process and product innovation.*

The key implication of Remark 1 is that in the absence of union voice mechanisms, competitive labor markets always outperform coordinated industries when it comes to providing innovation incentives, as already put forward by Haucap and Wey (2005). To analyze the effect of union voice, we proceed by assuming that the rate of employee-initiated separations is industry-specific, so that  $c_1 = c_2$  and  $c_3 = c_4$ . To model the idea that union voice reduces labor turnover, in turn, we assume that  $c_1 \leq c_3$ . To simplify notation (but without loss of generality), we normalize  $c_1 = 0$  and  $c_3 = c \geq 0$ . In this specification, the parameter  $c$  turns out to be a measure of the voice ability of unions, as it captures the difference in the unitary cost of replacing a quitting employee between unionized and non-unionized sectors,  $c_3 - c_1$ . Indeed, the larger is  $c$ , the stronger is the voice ability of unions.

**Proposition 1**—*For all  $\Delta > 0$  and  $\Theta > 0$ , coordinated systems of wage bargaining provides greater innovation incentives than competitive labor markets if the voice ability of unions is above a critical threshold, formally, iff  $c \geq \bar{c}(\Delta)$  (process innovation) and  $c \geq \bar{c}(\Theta)$  (product innovation).*

Proof: See Appendix B.

The interpretation of Proposition 1 is straightforward. When the voice ability of unions is sufficiently strong to outweigh the hold-up effect resulting from wage-bargaining by the union, firms in coordinated markets have greater innovation incentives than their non-unionized competitors, and this is true for both process and product innovation incentives. The result has a simple though important implication for the long-lasting controversy about the role of employee organizations: when the distortive effects of wage-bargaining outweigh the voice ability of unions, unionism will have a negative effect on firm performance, and by extension, on innovation. This will not be true, however, when the opposite holds true. Hence, whether unions are to be seen as distortive rent-seekers as originally postulated by Grout (1984) or as voice institutions as claimed by Freeman and Medoff (1984) is largely an empirical question.

In this framework, the plea for deregulation that has characterized the policy debate over the last three decades or so may be misplaced in countries when the reduction of turnover costs due to union presence are significant enough. Indeed, while the model in Haucap and Wey (2005) suggests that centralization is the only unionization regime that can, under some circumstances, outperform a competitive labor markets when it comes to innovation incentives, our results suggest a more cautious take on the relationship between unionization structures and innovation, highlighting the voice ability of unions has a limiting factor to the classical hold-up mechanism postulated by Grout (1984). In addition:

**Corollary 1**—*For comparable productivity gains,  $\Delta = \Theta$ , the increase in product innovation incentives resulting from an increase in the voice ability of unions is always larger than the increase in process innovation incentives.*

Proof: See Appendix B.

The result in Corollary 1 can be rationalized as follows. The productivity gains of introducing a labor saving technique are fundamentally related to the reduction in labor costs (consisting in wages and turnover costs) following the R&D tournament. In oligopolistic markets, these gains are further increased by an “imperfect competition” effect, since innovation winners seize a larger share of the market thanks to their enhanced competitiveness. In this framework, the higher is the rate of employee-initiated separations, the greater is the incentive for oligopolists to reduce their labor requirements. The upshot is that firms in competitive labor markets have an extra process innovation incentive with respect to their unionized counterparts, whose turnover costs are already low due to the voice ability of unions.

### 3.5. Inter-sectoral incentives

Our second goal is to analyze how the asymmetric presence of local bodies of employee representation within a union-dominated industry may affect innovation incentives. As anticipated, this requires comparing a situation where both duopolists have the same turnover costs ( $c_1 = c_2$ ) to another scenario where the innovation winner has a lower rate of employee-initiated separations due to the presence of a local representation ( $c_1 \leq c_2$ ). In the first case, we normalize  $c_1 = 0$  and  $c_2 = c > 0$ ; in the second,  $c_1 = c_2 = c > 0$ . As before, the parameter  $c$  turns out to be a measure of the voice ability of the local representation, as it captures the difference in turnover costs between the firm having an LR and that which does not have it,  $c_2 - c_1$ .

**Proposition 2**—*For all  $\Delta > 0$  and  $\Theta > 0$ , the asymmetric presence of local bodies of employee representation within a union-dominated industry increases both process and innovation incentives, and this is true  $\forall c \geq 0$ .*

Proof: See Appendix B.

The result in Proposition 2 is straightforward: when the innovation-discouraging effect of wage-bargaining by the union affects all firms homogeneously (differently from what happens when comparing the innovation performance of unionized vs non-unionized firms), the asymmetric presence of local bodies of employee representation has an unambiguously positive effect on both process and product innovation. This comes as no surprise: given that the effect of employee organizations on innovation depends on the relative size of the hold-up and the voice effects, absent the former, unions cannot but impact positively on innovation. In addition:

**Corollary 2**—*For comparable productivity gains,  $\Delta = \Theta$ , the asymmetric presence of local bodies of employee representation provides greater product innovation incentives than process innovation incentives, and this is true for all  $c > 0$ .*

Proof: See Appendix B.

The interpretation of the result in Corollary 2 is similar to that already put forward in Corollary 1: since the productivity gains of introducing a labor-saving technique are increasing in turnover costs, the higher is the pre-innovation rate of employee-initiated separations, the higher is the incentive to participate in a process innovation race. Given this, the asymmetric presence of local bodies of employee organizations has a stronger effect on product innovation.

### **3. Empirical analysis**

#### **3.2. From theory to data**

Our theoretical model makes two broad testable predictions about the relationship between unions and innovation. First, it postulates that coordinated system of wage bargaining provide greater innovation incentives than competitive labor markets when the reduction in

turnover costs due to union voice mechanisms is large enough to outweigh the distortive effects of wage bargaining. To test this prediction, one should either analyze a country with sufficient variability in union presence across sectors, or, when union coverage is widespread at the national level, confront the innovation performance of economic systems characterized by strikingly different degree of unionization. Disentangling the effect of a specific labor market institution through international comparisons, however, is often unfeasible, as these institutions, within each country, are strictly related one to the others (Bentolila et al., 2020).

The second prediction conveyed by our theoretical model is that the asymmetric presence of local bodies of employee representation within union-dominated industries should have a positive effect on both types of innovation, and that this should be stronger for product than for process innovation. To test this prediction, one should analyze an industry (or set of industries) where wages are coordinated by a central union, as to check whether the innovative performance of firms that additionally have a local body of employee representation is actually superior than those who do not have it. This is what we do in the present section, where we take Italy as our case-study for three reasons mainly.

First, the Italian system of wage bargaining is coordinated in the sense assumed by our theoretical model. Second, the existence of local bodies of employee representation operating at the establishment level creates variability at the micro level in space and over time in the voice capacity of the different types of employee organizations. Third, the available data allows to keep track of the existence of such bodies, and to distinguish between product and process innovation.

While our deterministic theoretical model predicts that a firm will participate in an innovation race as long as  $\frac{1}{2}[\Pi_i(\Lambda) - \Pi_j(\Lambda)] \geq I(\Lambda)$ , a number of unobserved factors may affect the share of innovators in the economy at large. First, as already recalled by Bryson and Dale-Olsen (2020), our theoretical model stick to Haucap and Wey (2005) in assuming that all firms

have an equal probability of 1/2 of winning the race and that the productivity-enhancing effects of the two types of innovations, measured by  $\Delta$  and  $\Theta$ , are equal for all innovating firms. In reality, both the probability of winning the race, the degrees of innovation and other unobserved characteristics (expressed by a normally distribute error term) may differ across establishments depending on factors that are unrelated to the voice ability of their union representatives.

Second, and more closely related to the long-lasting questions of “what do unions do?”, our model assumes that the innovation-specific costs  $I(\Lambda)$  that must be borne to participate in both types of R&D tournaments are independent from the unions’ behavior. In real-life, however, since unions care about employment levels, they may find it rational to ostracize the introduction of labor-saving techniques that reduce the firms’ labor requirements, while they may ease the introduction of product innovations that conversely increase their labor demand.<sup>12</sup> Formally, this may be modelled by assuming that  $I(\Delta) \geq I(\Theta)$ . Combining this with the unobserved heterogeneity recalled in the above and the fact that product innovation incentives are always larger than those related to the introduction of labor-saving techniques (see Corollary 2), not only we may reasonably expect to have some variability in the share of innovators, but also, that the effect of employee organization on process innovation may be not too significant.

In the remainder of this empirical section, we first describe the data and outline some descriptive statistics, then we introduce the econometric strategy, and last, we comment our results.

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<sup>12</sup> The union preferences over employment and wages likely play a crucial role in this mechanism. Analytically, these could be studied by assuming that the coordinated union maximizes a Stone-Geary utility function of the form  $l_k(w_k - w_0)^\beta$ , where  $\beta > 0$  is a parameter capturing the union’s preference. The closer  $\beta$  is to zero, the more the union values employment over wage levels. Even when this channel is taken into account, however, none of our results would change analytically.

### 3.2. Data and descriptive statistics

The empirical analysis is based on the last three waves of the *Rilevazione su Imprese e Lavoro* (RIL) conducted by INAPP (the Italian National Institute for Public Policy Analysis) in 2010, 2015 and 2018 on a large representative sample of partnerships and limited liability firms operating in Italy.<sup>13</sup> Each wave of the survey covers over 25,000 firms from the non-agricultural private sector. A subsample of the included firms (over 35%) is followed over time, making the RIL dataset partially panel over the period under study.

Each wave of the RIL questionnaire provides a rich set of information. Most important to our purposes, RIL data allows to separate information on whether during the current year or in the past two years before the interview the firm introduced product or process innovation.<sup>14</sup> Moreover, we know whether in the workplace there is an elected workers' representative body (RSU or RSA).<sup>15</sup>

As for the explanatory variables we take advantage from the rich set of information provided by the RIL survey on management and corporate governance, workforce characteristics and firms productive specialization. In particular, we have data on the demographic profile of the entrepreneurs, on the ownership structure and on external or dynastic recruitment of the management. This information offers the great advantage of controlling for important sources of firm heterogeneity, as emphasized in the previous literature (Bloom and van Reenen, 2011).

[Insert Table 2 about here]

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<sup>13</sup> For more details on sample design, methodological issues and procedures for requesting data related to RIL, see: <http://www.inapp.org/it/ril>

<sup>14</sup> See the Community Innovation Survey: <https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey>.

<sup>15</sup> The *Company Union Representation* (RSA, in Italian) protects all workers members of a specific trade union within a company, not participating in firm level bargaining. The *Unitary Representation Bodies* (RSU), on the other hand, involves all the workers of a company, regardless of whether they are members of a trade union or not.

Further we add information about workforce structure (education, age, professional status, gender, contractual arrangements, citizenship, hiring), firm characteristics (size, sales per employees, foreign trade, multinational, private funded training investment, start-up status) and other categorical variables describing economic activities (Nace Rev.2 aggregations of 2 digit sectors) and regions (NUTS1). Table C1 in Appendix C shows more detailed definitions of all variables used in the empirical analysis. Out of the overall data source, we excluded firms with less than 10 employees, where both union and innovation activities are relatively unstructured.

After excluding also firms with missing information for our key variables, we obtain an unbalanced panel with more than 5,000 firms appearing at least twice over the triple 2010-2015-2018.<sup>16</sup>

Table 2 reports some descriptive statistics. For the sake of conciseness, we focus here on our variables of interest, and some main firms' characteristics. Both product and process innovation show a rather remarkable downward trend between 2010 (over 40% of firms reporting they underwent some innovation) and 2015 (38.7% and 35.5% respectively) – not surprising during an economic downturn – while afterwards they both appear stabler. In 2010 18% of firms report hosting a union representation body, either an RSA or RSU; this share looks stable in 2015 and grows to more than 21% in 2018. Over the observed period, the average firm employs twenty workers and produces a per-employee value of sales of around 120,000€. The share of blue-collar workers is decreasing over time and around 60%, while that of white collars slightly grows to more than 36%. Females represent more than 33% of the employed workforce, while immigrants are 6%. The share of temporary workers first falls from 13% to

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<sup>16</sup> Our RIL unbalanced sample maximizes the number of observations and hence increases the external validity of our results. However similar evidence is found when the analysis is performed on the balanced panel – available upon request.



10%, then grows again to almost 16%. The large majority of firms is located in the North of the country.

### 3.3. The econometric analysis

The extremely wide set of information available in the RIL-AIDA data downplays the possibility that the presence of unobserved heterogeneity plays a crucial role. We begin with the estimation of a simple pooled OLS model of the following type:

$$Y_{it} = \beta U_{it} + \alpha M_{it} + \delta F_{it} + \gamma X_{it} + t + \sigma_s + \lambda r + \varepsilon_{it} \quad (3)$$

- where  $i$  and  $t = \{2010, 2015, 2018\}$  are the indexes for firms and years respectively,  $Y_{it}$  is a dummy for product or process innovation,  $U_{it}$  is a dummy taking the value of one if firm  $i$  in wave  $t$  is recorded as having a formal union representation (RSA or RSU) at the workplace level. Vectors  $M_{it}$ ,  $F_{it}$  and  $X_{it}$  formalize controls for corporate governance and management characteristics, workforce composition and firm productive specialization, respectively (see Table 2 and Table C.1 in Appendix C). All these covariates should minimize the main concerns about spurious correlation bias, for instance because higher profits allow, on the one hand, to invest more in innovation and, on the other, may stimulate the formation of workers' representative bodies attracted by rent sharing (see Berton et al., 2017, for a review). Furthermore,  $t$  is a time dummy indicator,  $\sigma_s$  captures sector specific effects, while  $\lambda r$  formalizes regional (NUTS1 level) effects. Finally,  $\varepsilon_{it}$  is the error term capturing the idiosyncratic component of the dependent variable.

Of course, we cannot rule out endogeneity concerns completely. For this reason, we take advantage of the panel structure of the RIL data to estimate a fixed-effect model of the following type:

$$Y_{it} = \beta U_{it} + \alpha M_{it} + \delta F_{it} + \gamma X_{it} + t + \sigma_s + \lambda r + \mu_i + \theta_{it} \quad (4)$$

where  $\mu_i$  controls also for time-invariant firm-specific observed and unobserved components. The main limitation of the strategy under (4) is that identification of our parameter of interest – namely  $\beta$  – relies on within-firm variability only which, when it comes to the presence of a union representation – appears rather limited (see Table 2). In addition, we still cannot prevent that reverse causality issues are driving our results, for instance because the introduction of innovative processes or products may require organizational changes that in turn stimulate workers to organize themselves into unions at the local level. This potential bias is in our data increased by the retrospective nature of questions in the RIL questionnaire, where respondents are often interviewed about the last years, and information about innovation is in this perspective no exception (see data description above). We therefore follow Devicienti et al. (2017) and use the lagged (2010) union incidence averaged at the two-digit sector by four classes of firm size as an instrument for current presence of union’s representatives at the firm level. We hence estimate:

$$U_{it} = \theta \bar{U}_{s,2010} + \alpha M_{it} + \delta F_{it} + \gamma X_{it} + t + \sigma s + \lambda r + \epsilon_{it} \quad (5)$$

where  $s$  stands for NACE two-digit sectors and  $\bar{U}_{s,2010}$  is the average incidence of the presence of union’s representatives at the workplace level in 2010 and  $t = \{2015, 2018\}$ . As standard in two-stage least squares procedure, the predicted values of  $U_{it}$  from equation (5) – call them  $\hat{U}_{it}$  – replace  $U_{it}$  in equation (4). Through lags and sector- and size-class level averages, we grant (higher) exogeneity of the presence of union’s representatives to the individual firm’s specific dynamics, and hence also to workplace innovative investments. The price to pay is a shorter panel length, as the first year of the series is used to build our instrument.

### 3.4. Estimate results

Table 3 reports our main results. The left panel shows those on product innovation, the right one those on process innovation. Estimates from model (3) are in first columns, from model (4) in second columns, from model (5) in third ones. All the models are linear, hence coefficients must be read as the variation in the probability to undergo a product or process innovation at the establishment level as a consequence of having established a formal workers' representative body. Standard errors are clustered at the firm level. For the sake of simplicity, we only report the parameters of interest.<sup>17</sup>

[Insert Table 3 about here]

Let us first focus on product innovation. According to pooled OLS estimates, the presence of a voice mechanism, as captured by formal workers' representative bodies, increases the establishment's propensity to innovate their products by 1.5 percentage points. By further controlling for other unobserved establishment-specific time-invariant determinants of innovation, the estimated effect grows to 3.5 percentage points. Eventually, IV estimates, that also remove potential reverse-causality biases, suggest a much larger impact of 23 percentage points, i.e. around a half of the average propensity to invest in new products (Table 2). A very sizeable effect indeed. All results are statistically significant at conventional levels, and the estimated  $\hat{\theta}$  and the first-stage F-statistics are reassuring of the relevance of our instrument.

Two comments are in order. First, consistently with our theoretical model, the presence of a voice mechanism raises the firm's propensity to innovate in products; neglecting for the moment on the magnitude of the effect, it is reassuring to find that this result is robust to different estimation strategies, and hence identification hypotheses. Second, one may argue that the very sizeable effect we find with IV is suspect. We can explain this "jump" with three

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<sup>17</sup> Full parameter estimates remain available upon request to the authors.

arguments: (i) pooled OLS and FE may actually suffer from a negative reverse causality bias, as workers employed in firms with a high propensity to product (typically labor-augmenting) innovations are less keen to establish formal representation bodies. (ii) Our instrument – i.e. the lagged presence of voice mechanisms at the local and sectoral level – may partially capture the independent effect on product innovation of being in a well-established context of industrial relations; if, on the one hand, this formally represents a violation of the exclusion restriction, on the other – and from a more economic point of view – it still suggests that one of the messages from our model holds true: within a context of coordinated wage bargaining, a well-functioning voice mechanism enhances – rather than hindering – the positive effect of unions on product innovation. (iii) Since Italy, as anticipated above, is usually represented as a country where unions are powerful institutions, a sizeable effect on product innovation is exactly what the model predicts. If this is actually the case, the effect on process innovation should be instead much weaker. The right panel of Table 3 suggests exactly so. According to pooled OLS estimates, the presence of workers’ representation body increases also process innovation, namely by 1.9 percentage points. However, this result does not survive to more robust approaches, as both fixed-effects and two-stages least squares suggest that the effect is statistically negligible. This is again consistent with what our theoretical model predicts where unions play a crucial role.

To further dig into the causal mechanism put forward by our model, we deem useful to admit that the actual voice capacity of a workers’ representation body might not be constant across firms’ characteristics and might vary with them. In this perspective, a prominent candidate to affect voice capacity is firm size (O’Toole and Lawler, 2006). In Table 4 we replicate our analysis after splitting the sample in SMEs (sized less than 250: upper panel) and large firms (250 or more: lower panel). Results for SMEs almost perfectly mirror those reported in Table 3 on the aggregate sample. The picture changes rather dramatically, however, when large firms are considered. The positive effect on product innovation disappears, while that on

process innovation emerges in pooled OLS and fixed-effects, but not when we use an IV approach where, also due to smaller sample size, the first-stage F-statistics does not pass the critical value of 10 suggested by Staiger and Stock (1997) to avoid the weak instrument bias. Assuming our theoretical model is a good representation of the relationship between unions and innovation, the results in the lower panel of Table 4 suggest that workers' representative bodies have a low-to-moderate voice capacity in large firms. This is consistent with O'Toole and Lawler (2006). A possible explanation is that when firm size is beyond a certain threshold, workers may feel that the distance to the firm's governing body is too wide, and their chance to speak up – even in the presence of a formal union representation – too low, with a negative feedback in terms of productivity (Machin, 1991). We are now in a position to draw some concluding remarks.

#### **4. Conclusions**

In this article, we study the relationship between unions and innovation, from both a theoretical and an empirical point of view. From the theoretical standpoint, we propose a model capable of providing a rationale for the possibly ambiguous effect – confirmed by the international empirical literature – of unions on innovation. The intuition is that the traditional rent sharing/hold-up view can be more than compensated by the voice ability of unions to reduce labor turnover and increase job retention. More specifically, our model predicts that a coordinated wage bargaining system – i.e. one in which a single union maximizes the industry wage bill by adjusting firm-level wages to the firm's relative competitiveness – is more inducive of product innovations than a system in which wages are set at their competitive level when the voice capacity of workers' representative bodies is above a critical threshold.

To test the model's main predictions, we use a large representative sample of Italian firms and take advantage of the existence of establishment-level workers' representative bodies to

capture the variability of workers' voice capacity across firms and over time. Consistently with the theory, we find that the presence of a workers' representation within the firm enhances the propensity to innovate the products by up to 23 percentage points when we use an IV approach. This suggests that workers' voice instruments are on average very effective, Heterogeneity analysis suggests that – beyond formal representation – the actual voice power of workers varies across firms, and that tends to vanish beyond a certain firm size.

Our analysis has strong policy implications. Deregulation has been a hallmark of labor market policies since the early nineties, thereby including industrial relations (IMF, 1999; OECD, 1994). The general advice was that collective bargaining should be moved from the national/sectoral level to the local/firm one, to better match productivity. In other words, industrial relations should mimic the market more closely. With this article, we suggest that this is not necessarily beneficial to innovation. Indeed, we show that a system where bargaining occurs at the sectoral level and the voice capacity of unions is preserved outperforms the market with respect to both product and process innovation. Local or firm agreements should therefore combine rather than substitute a more overarching bargaining system.

## References

- Acharya, V.V., Baghai, R.P. and Subramanian, K.V. (2013) Labor laws and innovation. *The Journal of Law & Economics* 56(4): 997-1037.
- Acharya, V.V., Baghai, R.P. and Subramanian, K.V. (2014) Wrongful discharge laws and innovation. *The Review of Financial Studies*, 2014, Vol. 27(1): 301-346.
- Addison, J.T., Schank, T., Schnabel, C. and Wagner, J. (2007) Do Works Councils Inhibit Investment? *Industrial and Labor Relations Review* 60: 187-203.
- Addison, J.T., Teixeira, P., Evers, K. and Bellmann, L. (2103) Collective bargaining and innovation in Germany: a case of cooperative industrial relations? *Industrial Relations* 56(1): 73-121.
- Aghion, P. And Howitt, P. (1992) A model of growth through creative destruction. *Econometrica* 60: 323-51.
- Antonioni, D., Massanti, M. and Pini, P (2011) Innovation, industrial relations and employee outcomes: evidence from Italy. *The Journal of Economic Studies* 38(1): 66-90.
- Barney, J. (1991) Firm resources and sustained competitive advantage. *Journal of Management* 17 (1): 99-120.
- Basak, D. and Mukherjee, A. (2018) *International Review of Economics and Finance* 55: 98-110.
- Bassanini, A. and Ernst, E (2002) Labor market regulation, industrial relations and technological regimes: a tale of comparative advantage. *Industrial Relations* 11: 391-426.
- Beath, J., Katsoulacos, D. and Ulph D. (1989) Strategic R&D policy. *The Economic Journal* 99 (395): 74-83.
- Bentolila, S., Dolado, J.J. and Jimeno, J.F. (2020) Dual labour markets revisited. *Oxford Encyclopedia of Economics and Finance*
- Berton, F. and Carreri, A. and Devicienti, F. (2017) Rent-sharing, sindacato e contrattazione di secondo livello: il caso italiano. in C. Dell'Aringa, C. Lucifora and T. Treu (eds.) *Salari, produttività e disuguaglianze*, Bologna: Il Mulino
- Bloom, N. and van Reenen, J. (2011) Human resource management and productivity. In O. Ashenfelter and D. Card (eds.) *Handbook of Labor Economics* 4B (Chapter 19), 1697-1767. Amsterdam: Elsevier.
- Böckerman, P. and Ilmakunnas, P. (2012) The job satisfaction-productivity nexus: a study using matched survey and register data. *Industrial and Labor Relations Review*, 65(2): 244-262.
- Booth, A.L. (1995) *The economics of the trade union*. Cambridge: Cambridge University Press
- Bradley, D. and Kim, I. Xuan, T. (2016) Do unions affect innovation? *Management Science* 63(7): 2251-2271.
- Bryson, A. and Dale-Dale-Olsen, H. (2020) Unions, tripartite competition and innovation. IZA DP No. 13015.

- Bryson, A., Barth, E. and Dale-Dale-Olsen, H. (2013) The effects of organizational change on worker wellbeing and the moderating role of trade unions. *Industrial and Labor Relations Review* 66, 4: 989-1011.
- Bryson, A., Forth, J. and Kirby, S. (2005) High-performance practices, trade union representation and workplace performance in Britain. *Scottish Journal of Political Economy* 53 (3): 451-491.
- Calabuig, V., & Gonzalez-Maestre, M. (2002). Union structure and incentives for innovation. *European Journal of Political Economy*, 18, 177–192.
- Card, D. And Devicienti, F., and Maida, A. (2014) Rent-sharing, holdup, and wages: evidence from matched panel data. *Review of Economic Studies*, 81: 84–11.
- Cotton, J. L., and Tuttle, J.M. (1986) Employee turnover: A meta-analysis and review with implications for research. *Academy of Management Review*, 11(1), 55-70.
- Devicienti, F. And Naticchioni, P. and Ricci, A. (2017) Temporary employment, demand volatility, and unions: firm-level evidence. *Industrial and Labor Relations Review* 71(1): 174-207.
- Doucouliafos, H. and Laroche P. (2013) Unions and innovation: new insights from the cross-country evidence. *Industrial Relations* 52(2): 467–91.
- Ederer, F. and Manso, G. (2013) Is Pay for Performance Detrimental to Innovation? *Management Science* 59(7): 1496-1513.
- Fang, T. and Ge, Y. (2012) Unions and Firm Innovation in China: Synergy or Strife? *China Economic Review* 23: 170–180.
- Foss, N.J. (1997) Resources and strategy: problems, open issues, and ways ahead. In: Foss, N.J. (Ed.) *Resources, Firms and Strategies: A Reader in the Resource-Based Perspective*. Oxford University Press, Oxford, UK: 345–365.
- Foss, N.J. (1998) The resource-based perspective: an assessment and diagnosis of problems. *Scandinavian Journal of Management* 14 (3), 133–149.
- Freeman, R.B. (1980) The exit-voice tradeoff in the labor market: unionism, job tenure, quits, and separations. *Quarterly Journal of Economics* 94(4), 643-673.
- Freeman, R.B., and Medoff, J.L. (1984) *What do unions do?* New York: Blackwell Publisher.
- Grinza, E. and Quatraro, F. (2019) Workers' replacements and firms' innovation dynamics: New evidence from Italian matched longitudinal data. *Research Policy* 48(9): 1-18.
- Grout, P.A. (1984) Investment and wages in the absence of binding contracts: a nash bargaining approach. *Econometrica* 52: 449–460.
- Haucap, J. and C. Wey (2004) Unionisation structures and innovation incentives. *Economic Journal* 114: 149 -165.
- Heavey, A. L., Holwerda, J. A., and Hausknecht, J. P. (2013) Causes and consequences of collective turnover: A meta-analytic review. *Journal of Applied Psychology*, 98(3), 412.
- Hirschman, A. (1970) *Exit, Voice, and Loyalty* Cambridge: Harvard University Press.



- Hirsch, B.T. (1997) *Unionization and Economic Performance: Evidence on Productivity, Profits, Investment, and Growth*. Vancouver: Fraser Institute.
- Holman, D. and Rafferty A. (2018) The convergence and divergence of job discretion between occupations and institutional regimes in Europe from 1995 to 2010. *Journal of Management Studies* 55(4): 619-647.
- Holmstrom, B. (1989) Agency costs and innovation. *Journal of Economics Behavior and Organization* 12: 305-327.
- IMF (1999) *Chronic unemployment in the Euro area: causes and cures*. World Economic Outlook, Washington D.C.
- Jäger, S., Schoefer, B. and Heining, J. (2020) Labor in the boardroom, *Quarterly Journal of Economics* 163(2): 669-725.
- Layard, R., Nickell, S. and Jackman, R. (1991) *Unemployment, macroeconomic performance and the labour market*. Oxford: Oxford University Press.
- Lucifora, C. (1998), The impact of unions on labour turnover in Italy: Evidence from establishment level data. *International Journal of Industrial Organization* 16: 353-376.
- Machin, S.J. (1991) The productivity effects of unionization and firm size in British engineering firms, *Economica*, 58(232): 479-490
- Manso G. (2011) Motivating innovation. *Journal of Finance* 66: 1823-60.
- Menezes-Filho, N. and Van Reenen, J. (2003) Unions and innovation: a survey of the theory and empirical evidence. In *International Handbook of Trade Unions*, Addison, J.T. and Schnabel, C. (eds), Cheltenham, UK: Edward Elgar, pp. 293-334.
- Menezes-Filho, N. and Van Reenen, J. (2003) Unions and innovation: a survey of the theory and empirical evidence. In *International handbook of trade unions*, Addison, J.T. and Schnabel, C. (eds), Cheltenham, UK: Edward Elgar, pp. 293-334.
- Mukherjee, A. and Pennings, E. (2011) Unionisation structure, licensing and innovation. *International Journal of Industrial Organization* 29: 232-241.
- Mukherjee, A. and Beladi, H. (2017) Union bargaining power, subcontracting and innovation. *Journal of Economic Behavior & Organization* 137 (2017) 90-104
- O'Toole, J. and Lawler, E.E. III (2006) *The new American workplace*, New York: Palgrave MacMillan
- OECD (1994) *OECD Jobs Study: evidence and explanations*. Paris, OECD.
- Oswald, A.J. (1985) The economic theory of trade unions: an introductory survey. *The Scandinavian Journal of Economics* 87(2): 160-193.
- Oswald, A.J. and Turnbull, P. (1985) Pay and employment determination in Britain: What are labour contracts really like? *Oxford Review of Economic Policy* 1: 80-97.
- Penrose, E. (1959) *The theory of the growth of the firm*. Blackwell Publishing, Oxford, UK.

- Scarpetta, S. and Tressel, T. (2004) Boosting Productivity via innovation and adoption of new technologies: any role for labour market institutions? Policy Research Working Paper Series no. 3273, World Bank.
- Schnabel, C. and Wagner, J. (1994) Industrial Relations and Trade Union effects on Innovation in Germany. *Labour* 8(3) 489-503.
- Singh, N. and Xavier Vives, X. (1984) Price and quantity competition in a differentiated duopoly. *The RAND Journal of Economics* 15(4): 546-554.
- Staiger, D, and Stock, J.H. (1997) Instrumental variable regression with weak instruments. *Econometrica*, 65: 557-586.
- Ulph, A. and Ulph, D. (1994) labor Markets and Innovation: Ex Post Bargaining'. *European Economic Review* 38(3-5), 195-210
- Van Der Ploeg, F. (1987) Trade unions, investment, and employment: A non-cooperative approach. *European Economic Review* 31(7): 1465-1492.

## Tables & Figures

**Table 1:** Theory summary

Theoretical view	Effect on innovation	Mechanism
Monopoly power	↓	↑ wages = ↓ innovation gains (e.g., Grout, 1984)
Collective voice	↑	↓ worker grievances/turnover = ↑ productivity (e.g., Freeman and Medoff, 1984)
Strategic R&D	↑	↑ market share = ↑ R&D investments (e.g., Beath et al., 1989)
Employment protection	↓	↑ long-term commitment = ↑ greater worker effort (e.g., Acharya et al., 2014)
Employment protection	↑	↓ dismissal probability = ↓ labor effort (e.g., Bassanini and Ernst, 2002)

**Table 2:** Descriptive statistics

	2010		2015		2018	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Product inn. (0/1)	0.475	0.499	0.387	0.487	0.388	0.487
Process inn. (0/1)	0.410	0.492	0.355	0.479	0.364	0.481
Union (0/1)	0.182	0.386	0.187	0.390	0.213	0.409
Strike density	0.060	0.431	1.098	9.259	0.008	0.093
			<i>Management characteristics</i>			
Tertiary edu.	0.255	0.436	0.254	0.436	0.284	0.451
Upper sec. edu.	0.531	0.499	0.546	0.498	0.516	0.500
Lower sec. edu.	0.214	0.410	0.200	0.400	0.200	0.400
Female (0/1)	0.119	0.324	0.129	0.335	0.139	0.346
Age > 54	0.320	0.466	0.346	0.476	0.321	0.467
34 < age < 55	0.292	0.455	0.236	0.425	0.199	0.399
Family ownership (0/1)	0.870	0.337	0.846	0.361	0.843	0.364
External manag. (0/1)	0.031	0.174	0.043	0.202	0.039	0.193
			<i>Workforce characteristics</i>			
Share w. tertiary edu.	0.080	0.153	0.101	0.168	0.139	0.217
Share w. upper sec. edu.	0.435	0.281	0.466	0.272	0.476	0.287
Share w. lower sec. edu.	0.485	0.318	0.433	0.306	0.385	0.318
Share of female	0.338	0.264	0.332	0.257	0.338	0.253
Share aged > 54	0.177	0.154	0.239	0.179	0.293	0.207
34 < share aged < 55	0.491	0.204	0.491	0.194	0.448	0.200
Share aged < 34	0.332	0.229	0.270	0.206	0.259	0.215
Share of executives	0.037	0.077	0.035	0.079	0.040	0.091
Share of white collars	0.345	0.292	0.374	0.295	0.364	0.295
Share of blue collars	0.618	0.313	0.591	0.313	0.596	0.319
Share of temporary workers	0.129	0.192	0.097	0.162	0.158	0.220
Share of immigrants	0.059	0.119	0.054	0.114	0.062	0.123
Hiring (0/1)	0.599	0.490	0.566	0.496	0.693	0.461
			<i>Firms' characteristics</i>			
Foreign trade (0/1)	0.322	0.467	0.383	0.486	0.356	0.479
Multinational (0/1)	0.024	0.152	0.022	0.146	0.029	0.167
Training from own funds (0/1)	0.320	0.467	0.373	0.484	0.448	0.497
Start up (0/1)	0.145	0.353	0.095	0.293	0.035	0.184
Log of sales per empl. (€)	11.676	1.226	11.810	1.229	11.793	1.246
Log of no. of employees	2.974	0.739	3.022	0.804	3.065	0.813
North-West	0.325	0.468	0.403	0.491	0.365	0.481
North-East	0.279	0.449	0.286	0.452	0.293	0.455
Center	0.208	0.406	0.168	0.374	0.173	0.379
South	0.188	0.391	0.143	0.350	0.168	0.374
Number of observations	4,077		6,509		6,047	

**Source:** own computations on RIL data. Notes: sampling weights applied. Statistics by 2-digit NACE sector are available upon request.

**Table 3:** Main results

	Product innovation			Process innovation		
	<i>Pooled OLS</i>	<i>FE</i>	<i>IV-2SLS</i>	<i>Pooled OLS</i>	<i>FE</i>	<i>IV-2SLS</i>
$\hat{\beta}$	0.015*	0.035**	0.228**	0.019**	0.017	0.010
	(0.009)	(0.017)	(0.102)	(0.009)	(0.017)	(0.095)
# obs.	19,988	19,988	15,523	19,988	19,988	15,523
R <sup>2</sup>	0.161	0.025	0.117	0.171	0.022	0.170
First-stage F	-	-	115.1	-	-	115.1
$\hat{\theta}$	-	-	0.031***	-	-	0.031***

**Source:** own computations on RIL data. Notes: clustered standard errors in second lines; \*\*\*: 1% significant; \*\*: 5% significant; \*: 10% significant.

**Table 4:** Results by firm size

	Product innovation			Process innovation		
	<i>Pooled OLS</i>	<i>FE</i>	<i>IV-2SLS</i>	<i>Pooled OLS</i>	<i>FE</i>	<i>IV-2SLS</i>
<i>Less than 250 workers</i>						
$\hat{\beta}$	0.016*	0.034**	0.236**	0.017*	0.010	-0.025
	(0.009)	(0.017)	(0.105)	(0.009)	(0.017)	(0.096)
# obs.	18,420	18,420	14,255	18,420	18,420	14,255
R <sup>2</sup>	0.143	0.024	0.094	0.152	0.024	0.146
First-stage F	-	-	103.6	-	-	103.6
$\hat{\theta}$	-	-	0.352***	-	-	0.352***
<i>250 workers or more</i>						
$\hat{\beta}$	0.022	0.052	-0.561	0.064*	0.147*	0.289
	(0.037)	(0.087)	(0.576)	(0.037)	(0.081)	(0.582)
# obs.	1,568	1,568	1,268	1,568	1,568	1,268
R <sup>2</sup>	0.278	0.082	0.126	0.288	0.076	0.268
First-stage F	-	-	6.5	-	-	6.5
$\hat{\theta}$	-	-	0.160**	-	-	0.160**

**Source:** own computations on RIL data. Notes: clustered standard errors in second lines; \*\*\*: 1% significant; \*\*: 5% significant; \*: 10% significant.

## Appendix A: Equilibrium quantities and wages

### 1. Process innovation

The firms' problem in the case of process innovation is given by:

$$\max_{q_i} \Pi_i = (A - q_i - q_j)q_i - (w_i + c_i)(1 - \Delta)q_i$$

$$\max_{q_j} \Pi_j = (A - q_i - q_j)q_j - (w_j + c_j)q_j$$

which yields the following system of best-response functions:

$$q_i(\Delta, w_i, w_j, q_i, q_j) = \frac{A + w_j + c_j - 2(1 - \Delta)(w_i + c_i)}{3} \quad (\text{A.1.1})$$

$$q_j(\Delta, w_i, w_j, q_i, q_j) = \frac{A + (1 - \Delta)(w_i + c_i) - 2(w_j + c_j)}{3} \quad (\text{A.1.2})$$

To derive the equilibrium wage in the  $U$ -sector, the coordinated union solve:

$$\max_{w_1, w_2} q_1(1 - \Delta)(w_1 - w_0) + q_2(w_2 - w_0)$$

which yields:

**Lemma A1**—*For all  $\Delta > 0$ , the equilibrium wages of firms 1 and 2 in the case of process innovation are given by:*

$$w_1(\Delta, c_1) = \frac{A + (1 - \Delta)(w_0 - c_1)}{2(1 - \Delta)} \quad (\text{A.1.3})$$

$$w_2(\Delta, c_2) = \frac{A + w_0 - c_2}{2} \quad (\text{A.1.4})$$

Inserting the optimal wages derived in equations (A. 1.3) and (A. 1.4) back in equations (A. 1.1) and (A. 1.2) and recalling that  $w_3 = w_4 = w_0$ , yields:

**Lemma A2**—For all  $\Delta > 0$ , the equilibrium quantities of firms 1, 2, 3 and 4 in the case of process innovation are given by:

$$q_1(\Delta, c_1, c_2) = \frac{A + c_2 - (1 - 2\Delta)w_0 - 2(1 - \Delta)c_1}{6}$$

$$q_2(\Delta, c_1, c_2) = \frac{A + (1 - \Delta)c_1 - (1 + \Delta)w_0 - 2c_2}{6}$$

$$q_3(\Delta, c_3, c_4) = \frac{A + c_4 - (1 - 2\Delta)w_0 - 2(1 - \Delta)c_3}{3}$$

$$q_4(\Delta, c_3, c_4) = \frac{A + (1 - \Delta)c_3 - (1 + \Delta)w_0 - 2c_4}{3}$$

## 2. Product innovation

The firms' problem in the case of process innovation is given by:

$$\max_{q_i} \Pi_i = [(1 + \Theta)A - q_i - q_j]q_i - (w_i + c_i)q_i$$

$$\max_{q_j} \Pi_j = (A - q_i - q_j)q_j - (w_j + c_j)q_j$$

which yields the following system of best-response functions:

$$q_i(\Theta, w_i, w_j, q_i, q_j) = \frac{(1 + 2\Theta)A + w_j + c_j - 2(w_i + c_i)}{3} \quad (\text{A. 2.1})$$

$$q_j(\Theta, w_i, w_j, q_i, q_j) = \frac{(1 - \Theta)A + w_i + c_i - 2(w_j + c_j)}{3} \quad (\text{A. 2.1})$$

To derive the equilibrium wage in the  $U$ -sector, the coordinated union solve:



$$\max_{w_1, w_2} q_1(w_1 - w_0) + q_2(w_2 - w_0)$$

which yields:

**Lemma A3**—For all  $\Theta > 0$ , the equilibrium wages of firms 1 and 2 in the case of product innovation are given by:

$$w_1(\Theta, c_1) = \frac{A(1 + \Theta) + w_0 - c_1}{2} \quad (\text{A. 2.3})$$

$$w_2(\Theta, c_2) = \frac{A + w_0 - c_2}{2} \quad (\text{A. 2.3})$$

Comparing Lemma A1 and A3 yields:

**Remark A1**—Innovation winners pay higher equilibrium wages than product innovation winners. Formally,  $w_1(\Delta, c_1) - w_1(\Theta, c_1) = A\Delta^2 > 0$ .

Inserting the optimal wages derived in equations (A. 2.3) and (A. 2.4) back in equations (A2.1) and (A. 2.2) and recalling that  $w_3 = w_4 = w_0$ , yields:

**Lemma A4**—For all  $\Theta > 0$ , the equilibrium quantities of firms 1, 2, 3 and 4 in the case of product innovation are given by:

$$q_1(\Theta, c_1, c_2) = \frac{(1 + 2\Theta)A + c_2 - w_0 - 2c_1}{6}$$

$$q_2(\Theta, c_1, c_2) = \frac{(1 - \Theta)A + c_1 - w_0 - 2c_2}{6}$$

$$q_3(\Theta, c_3, c_4) = \frac{(1 + 2\Theta)A + c_4 - w_0 - 2c_3}{3}$$

$$q_4(\Theta, c_3, c_4) = \frac{(1 - \Theta)A + c_3 - w_0 - 2c_4}{3}$$

## Appendix B: Proofs

### 1. Proof of Proposition 1

Under the assumption that  $c_1 = c_2 = 0$  and  $c_3 = c_4 = c > 0$ , the exact expressions of process innovation incentives are given by:

$$\psi(\Delta, U) = \frac{\Delta w_0}{12} [2(A - w_0) + \Delta w_0]$$

$$\psi(\Delta, N) = \frac{\Delta(w_0 + c)}{3} [2(A - w_0 - c) + \Delta(w_0 + c)]$$

Taking the difference  $\psi(\Delta, U) - \psi(\Delta, N) \geq 0$ , defining  $A/(2 - \Delta) = \tilde{A}$  and rearranging, yields:

$$4c^2 - 8(\tilde{A} - w_0)c - 3(\tilde{A} - w_0)w_0 \geq 0$$

which is satisfied iff:

$$c \geq \tilde{A} - w_0 + \left[ (\tilde{A} - w_0)^2 + \frac{3}{4}(2\tilde{A} - w_0) \right]^{1/2} \equiv \bar{c}(\Delta)$$

Or iff:

$$c \leq \tilde{A} - w_0 - \left[ (\tilde{A} - w_0)^2 + \frac{3}{4}(2\tilde{A} - w_0) \right]^{1/2} \equiv \underline{c}(\Delta)$$

Observe, however, that the second root,  $\underline{c}(\Delta)$ , is always  $< 0$ , and since  $c > 0$  by assumption, the second inequality is never satisfied, which proves the first statement in Proposition 1. Following identical steps, the exact expressions of product innovation incentives when  $c_1 = c_2 = 0$  and  $c_3 = c_4 = c$  are given by:

$$\psi(\Theta, U) = \frac{\Theta A}{12} [2(A - w_0) + \Theta w_0]$$

$$\psi(\Theta, N) = \frac{\Theta A}{3} [2(A - w_0 - c) + \Theta(w_0 + c)]$$

Taking the difference  $\psi(\Theta, U) - \psi(\Theta, N) \geq 0$  and rearranging yields:

$$-3[2(A - w_0) + xA] + 8c \geq 0$$

which is satisfied iff:

$$c \geq \frac{3[2(A - w_0) + \Theta A]}{8} \equiv \bar{c}(\Theta)$$

which proves the second statement in Proposition 2 ■

## 2. Proof of Corollary 1

Under the assumption that  $c_1 = c_2 = 0, c_3 = c_4 = c > 0$  and  $\Delta = \Theta$ , a change in the voice ability of unions affect process and product innovation incentives across sectors in the following way:

$$\frac{\partial[\psi(\Delta, U) - \psi(\Delta, N)]}{\partial c} = -\frac{2\Delta[A - 2(1 - \Delta)(w_0 + c)]}{3}$$

$$\frac{\partial[\psi(\Theta, U) - \psi(\Theta, N)]}{\partial c} = \frac{2\Delta A}{3}$$

from which it is straightforward to see that:

$$\frac{\partial[\psi(\Theta, U) - \psi(\Theta, N)]}{\partial c} - \frac{\partial[\psi(\Delta, U) - \psi(\Delta, N)]}{\partial c} = A - (1 - \Delta)(w_0 + c)$$

which is always larger than zero according to Assumption 1 ■

### 3. Proof of Proposition 2

Under the assumption that  $c_1 = c_2 = c$  (no local representation), the exact expression of process innovation incentives is given by:

$$\psi(\Delta, U) = \frac{\Delta(w_0 + c)}{12} [2(A - w_0 - c) + \Delta(w_0 + c)]$$

Similarly, under the assumption that  $c_1 = 0$  and  $c_2 = c$  (the innovation winner has a local representation), the exact expression of process innovation incentives is given by:

$$\psi(\Delta, LR) = \frac{\Delta w_0 + c}{12} [2(A - w_0) + \Delta w_0 - c]$$

Taking the difference  $\psi(\Delta, LR) - \psi(\Delta, U) \geq 0$  and rearranging, we see that this is satisfied iff:

iff:

$$2[A - (1 - \Delta)w_0] - (1 - \Delta)c \geq 0 \tag{B.1}$$

Observe that the assumption that innovation incentives do exist,  $\Pi_1(\Delta) - \Pi_2(\Delta) \geq 0$ , implies that  $2(A - w_0 - c) + \Delta(w_0 - c) \geq 0$ . Hence, a sufficient condition for  $\psi(\Delta, LR) - \psi(\Delta, U) \geq 0$  is that:

$$2[A - (1 - \Delta)w_0] - (1 - \Delta)c \geq 2(A - w_0 - c) + \Delta(w_0 + c)$$

which clearly, is satisfied  $\forall c \geq 0$ . This proves the first statement in Proposition 2. Following identical steps, under the assumption that  $c_1 = c_2 = c$  (no local representation), the exact expression of product innovation incentives is given by:

$$\psi(\Theta, U) = \frac{\Theta A}{12} [2(A - w_0) + \Theta A - 2c]$$

while, under the assumption that  $c_1 = 0$  and  $c_2 = c$  (the innovation winner has a local representation), the exact expression of product innovation incentives is given by:

$$\psi(\Theta, LR) = \frac{\Theta A - c}{12} [2(A - w_0) + \Theta A - c]$$

Taking the difference  $\psi(\Theta, LR) - \psi(\Theta, U) \geq 0$  and rearranging, we see that this is satisfied iff:

$$2[A(1 + \Theta) - w_0] - c \geq 0 \tag{B.2}$$

As before, the assumption that innovation incentives do exist,  $\Pi_1(\Theta) - \Pi_2(\Theta) \geq 0$ , implies that  $2[A(1 + \Theta) - w_0 - c] \geq 0$ . Hence, a sufficient condition for  $\psi(\Theta, LR) - \psi(\Theta, U) \geq 0$  is that:

$$2[A(1 + \Theta) - w_0] - c \geq 2[A(1 + \Theta) - w_0 - c]$$

which clearly, is satisfied  $\forall c \geq 0$ , which proves the second statement in Proposition 2 ■

#### 4. Poof of Corollary 2

Taking the difference between the expressions in equations (B.2) and (B.1) under the assumption that  $\Delta = \Theta$ , we see that the asymmetric presence of local bodies of employee representation provides greater product than process innovation incentives iff:

$$2(A - w_0) - c \geq 0$$

which is always satisfied according to Assumption 1 ■

## Appendix C: definition of variables

**Table C1:** Definition of variables

Variables	Description
	<i>Innovation and industrial relations</i>
Product innovation	Dummy variable that equals to 1 if the firm has invested in product innovation in the current year and/or during the past two years before the survey, 0 otherwise
Process innovation	Dummy variable that equals to 1 if the firm has invested in process innovation in the current year and/or during the past two years before the survey, 0 otherwise
Union	Dummy variable that equals to 1 if a trade union association (both RSA or RSU employees representation) are found at workplace, 0 otherwise
Strike density	Share of total hours struck on the total number of firms' employees
	<i>Management and corporate governance</i>
Education	Three dummy variables that equals to 1 whether the educational level of the employers/managers who run the firm is, respectively: i) tertiary; ii) upper secondary iii) lower secondary or no education (0 otherwise)
Age	Three dummy variables that equals to 1 whether the age cohort to which the employer/managers who run the firm belong to is respectively: i) <35 years ii) 34< years<55 iii) >54 years
Female	Dummy variable that equals to 1 if the manager/employer who run the firm is female, 0 otherwise
Family ownership	Dummy variable that equals to 1 if the ownership of the firm is held by a family, 0 otherwise
external management	Dummy variable that equals to 1 if firm is run by an external manager which has been recruited on the labor market, i.e outside dynastic ties with firms ownership, 0 otherwise
	<i>Workforce characteristics</i>
Educational composition	Three variables indicating the share of employees (on the firms' total number of employees) with: i- tertiary education; ii- upper secondary education; iii- lower secondary, primary or no education
Age composition	Three variables indicating the share of employees (on the firms' total number of employees) with: i- less than 35 years old; ii- between 34 and 50 years old; iii- more than 49 years old
Professional composition	Three variables indicating the share of employees (on the firms' total number of employees) who are: i- executives; ii- white collars; iii- blue collars
Share of temporary workers	Share of employees with fixed term contract (on the firms total number of employees)
Share of female workers	Share of female employees (on the firms' total number of employees)
Share of immigrants	Share of immigrant employee on the firms total number of employees)
	<i>Firms' characteristics</i>
Log of sales per employee	(log of) the sales on the total number of employees. The amount of the sales is deflated relying on sectoral (2-digit NACE) deflators of production prices.
Log of size	(log of) total number of employees. Alternatively we use four dummy variables

Privately funded training	Dummy variable that equals to 1 if firms financed workplace training with their own funds, 0 otherwise (i.e public financed training)
Foreign trade	Dummy variable that equals to 1 if firm operates (selling or buying products or services) on international trade markets, 0 otherwise
Multinational	Dummy variable that equals to 1 if firm is a multinational, 0 otherwise
Start-up	Dummy variable that equals to 1 if firm has less than 10 years since its entry on the market, 0 otherwise
Geographical localization	20 dummies variables indicating Italian Nuts 2 regions
Sector of activity	45 dummies variables indicating the 2-digit NACE sectors: Electricity, Gas water distribution, Food, textile, tobacco; chemistry, metallurgy mechanics and other manufacturing goods; Construction; retail and wholesale, tourism, hotels and restaurants transportation; insurance and financial intermediation, information and communication; other business services; healthcare, educational and social services, others.

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**Source:** RIL data