

## WORKING PAPER

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# **Do unions affect innovation in Italy? Evidence from firm-level data**

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*Fabio Berton*  
*Stefano Dughera*  
*Andrea Ricci*

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## **Fabio Berton**

*Department of Economics and Statistics "Cognetti de Martiis", University of Turin, Lungo Dora  
Siena, 100/A – 10153 Turin, Italy*

*LABORatorio R. Revelli – Center for Employment Studies, Piazza Vincenzo Arbarello, 8 – 10122  
Turin, Italy*

## **Stefano Dughera**

*Department of Economics and Statistics "Cognetti de Martiis", University of Turin, Lungo Dora  
Siena, 100/A – 10153 Turin, Italy*

## **Andrea Ricci**

*National Institute for Public Policies Analysis (INAPP), Corso d'Italia, 33 – 00198 Rome, Italy*

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**INAPP - National Institute for Public Policies Analysis**

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Corso d'Italia 33  
00198 Roma, Italia

Tel. +39 06854471  
Email: [urp@inapp.org](mailto:urp@inapp.org)

[www.inapp.org](http://www.inapp.org)

## ABSTRACT

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# Do unions affect innovation in Italy?

## Evidence from firm-level data

We study the unions-innovation correlation using micro-data on Italian non-agricultural firm. The key finding of the paper is that unionized firms have a higher and statistically significant probability of filing patents than their non-union competitors in Italy. While corroborating the evidence that unionisation does not – generally speaking – inhibit innovation in Europe (while the opposite hold true in North America), our study is the first to show that such effect is unambiguously positive in the Italian pre-crisis context and also that it is far more significant than in the rest of Europe. The result is at odds with the de-unionisation path which has characterised Italy over the last decades and thus needs to be interpreted in terms of policy suggestions.

**KEYWORDS:** innovation, labour-unions

**JEL CODES:** J51, O31, O32

## 1. Introduction

Theoretically, the effect that unions have on the innovative activity of firms is a largely debated topic, as it has been conjectured as potentially benign – the voice face of unions (Freeman/Medoff 1984) – adverse – the rent-seeking (Grout 1984) and the Luddist face of union – or somewhere in between depending on the specific features of the bargaining process-strategic R&D (Beath et al. 1989; Ulph/Ulph 2001; Haucap/Weley 2005). The impossibility of building a theoretical consensus around either of the two views (the benign and the adverse) has been further nurtured by the evidence emerged from the existing empirical literature, which unabashedly showed the existence (and persistence) of a significant heterogeneity between North America and Europe (mainly, Germany and the UK)<sup>1</sup>. As a matter of fact, the union-innovation correlation (hereafter, U-I) was found negative and statistically significant in almost all of the US and Canadian studies (with some exceptions [Walsworth 2010]), and either neutral, slightly negative or non-linear – but most of the time lacking of statistical significance – in those dealing with European countries<sup>2</sup>. As a consequence, economists started to interpret the U-I correlation in institutional terms and emphasise the national peculiarities of each system of industrial relations to explain this cross-countries variance. Within this framework, the specific features of the bargaining process are to be related to the laws composing the regulatory framework, to the social norms which contribute to regulate the employment relationship and to the global climate in which union's delegates and managers interact, whether the latter is cooperative or conflictual. The figure which emerges is a complex one, even more so if one considers that the effect that unions have on the firm's propensity to innovate may operate either directly – by (dis)incentivising firms to invest in innovative-enhancing assets – or indirectly – by affecting the employees' effort and participation. Regardless of which of these two mechanisms is actually at work (see section 2 for further discussion), the impact of labour-unions on innovation is something that requires further attention. More specifically, we believe that to improve our understanding of the issue we first and foremost need to broaden the list of countries where the U-I correlation is estimated, as to map the most accurate taxonomy of its geographical variance of and then relate the latter to the institutional specificities of each system of industrial relations.

<sup>1</sup> Menezes-Filho and Van Reenen (2003) review thirty-one studies on the U-I correlation, fourteen of which dealing with R&D intensity, five with the output of R&D and twelve with technology diffusion/adoption. More recent studies – which still confirm the previously emerged divide between North America and Europe – include Bradley et al. (2016) for the US and Addison et al. (2017) for Germany. Fang and Ge (2012) find that the U-I correlation is positively signed in China.

<sup>2</sup> Doucouliagos and Laroche (2013) apply a meta-regression analysis to twenty-seven studies on four different countries (UK, US, Canada, Germany) and find that unions depress innovation in all four countries, despite the effect seems to be declining over time and to be moderated by country differences in industrial relations and regulations. Interestingly, such negative correlation seems also to increase with the flexibilization of labour markets. As such, their study yields quasi-compatible results with the remainder of the literature, compatible in that they also record a significant difference between North America and Europe as far as the magnitude of the U-I effect is concerned; less compatible in that the effect is negatively signed in all four countries.

In this paper, we examine the U-I effect using micro-data on Italian non-agricultural firms. To our knowledge, ours is the first study which tackles such relationship in Italy. Our key finding is that the U-I correlation is unambiguously positive and statistically significant in the Italian context, at least in the period preceding the great recession started in 2007. Although further elaboration is needed before jumping to conclusions, the result seems to suggest that Italian unions have a stronger and less ambiguous effect on innovation than their European counterparts. Furthermore, as endogenous-growth theory (Aghion/Howitt 1992) posits that firm-level innovation fosters country-level economic growth, our finding suggests that de-unionisation path which has characterised Italy over the last decades may have impacted negatively upon the country's economic performance, both at the micro and meso levels – in those firms or industries where union presence declined the most – and on the national system at large, even more so if the spillovers and network effects that characterise knowledge production are taken in consideration (Cowan et al. 2006; Brenner et al. 2011; Aghion/Jaravel 2015).

The remainder of the paper is organised as follows. In section 2, we briefly overview the theory and evidence supporting both views on the U-I correlation. In section 3, we outline the data used for the estimations, along with some descriptive statistics. Section 4 presents the results and robustness checks, while section 5 comments and concludes.

## 2. Previous literature

### 2.1 *The rent-seeking vs the collective face of unions*

From the side of theory, there are at least two routes through which unions may affect the firm's propensity to innovate, a direct and an indirect one. Through the former, unions may hold-up firms by capturing some of the quasi-rents from innovation. In this view, wage-bargaining imposes a sort of tax on sunk capital, therefore discouraging investments ex-ante. The classic reference in this case is Grout (1984)<sup>3</sup>. Through the latter, unions may stimulate workers to exert greater effort by improving their financial conditions and occupational security, and/or they may engage in cooperative industrial relation where union delegates and managers cooperate to find non-conflictual resolutions of the partially divergent objectives of the firm and its workers. This line of reasoning traces back to Freeman and Medoff's collective voice theory (1984) and was recently found complementary with theories supporting the introduction of high-involvement human resources practices (hereafter, HHRP) and new systems of on-the job learning<sup>4</sup>, that is, with the introduction of organisational innovations in general<sup>5</sup>. In this case, unions may either play a role in

<sup>3</sup> The literature on rent-seeking is vast and providing with a thorough review of the latter fairly exceed the scopes of the present paper. Suffice it to say that it provided with results which generally support the view in which unions depress investments, with some exceptions – see, e.g., Addison et. al. (2007).

<sup>4</sup> For instance, discretionary learning. See Holm/Lorenz (2015) for a definition.

<sup>5</sup> As recalled by Antonioli et al. (2011: 68 «international institutions have also recognized the importance of social dialogue in improving the workers' well-being». See Eurofound (2007).

building what Nelson and Winter (1985, 110) call the “organisational truce” or may actively get engaged in job-design to ease the displeasure from exerting effort (or to enhance the system of on-the-job learning) through cooperation with the management of the firm<sup>6,7</sup>. We shall return on this later.

<sup>6</sup> It may be useful to sketch a rough model of these two avenues. Consider a market where a union ( $U$ ) and a non-union ( $NU$ ) firm compete. Both firms have the same probability of filing a patent. We assume that the latter is a function  $p(e)$  of the firm’s (unique) agent’s effort  $e$ , with  $\frac{\partial p}{\partial e} > 0$  and  $\frac{\partial^2 p}{\partial e^2} < 0$ . The firms’ profit function writes:

$$\Pi_i$$

Where  $\gamma > 0$  is the cost of introducing innovations (if the innovation is introduced,  $\gamma = 0$  otherwise),  $R > 0$  is a positive constant and  $i = U, NU$ . Borrowing the modelling strategy from Stark and Hyll (2011), we write the utility function of the representative agent as:

$$u$$

Where  $c_i > 0, i = U, NU$  are parameters measuring the cost of effort. Observe that we allow such costs to differ across the two firms, the unionized and the non-unionized. The agent chooses a level of effort to maximizes (2) given  $w_i$  and  $c_i$ , which gives the optimal effort level:

$$e_i^* = \frac{w_i}{2c_i} \quad (3)$$

Observe that  $\frac{\partial e^*}{\partial w_i} > 0$  and  $\frac{\partial e^*}{\partial c_i} < 0$ , that is, the optimal effort is increasing in wage and decreasing in the displeasure from exerting effort. As noted in the text, unions may have an influence on both  $w$  and  $c$ : on the former, through wage-bargaining, and on the latter, by getting actively involved in job-design. Let us analyze the two cases separately.

*Wage bargaining:* wage is higher in the unionized than in the non-unionized firm, that is,  $w_U > w_{NU}$ . Combining (3) and (1) and defining  $w_U - w_{NU} \equiv \delta > 0$ , we obtain the following condition:

$$\Pi_U > \Pi_{NU} \quad \text{if} \quad p(e_U) - p(e_{NU}) > \frac{\delta}{R}. \quad (4)$$

Where we assume  $R > w_U$  to ensure that  $1 < \frac{\delta}{R} < 0$ .

*Cooperative industrial relations:* union’s delegates cooperate with the managers of the  $U$ -firm and introduce organizational innovations (at a cost  $\gamma > 0$ ). As a consequence, the displeasure of exerting effort is lower in the union than in the non-union firm, that is,  $c_U < c_{NU}$ . *Ceteris paribus*— $w_U = w_{NU}$ —combining (3) and (1), we obtain the following condition:

$$\Pi_U > \Pi_{NU} \quad \text{if} \quad p(e_U) - p(e_{NU}) > \frac{\gamma}{R}. \quad (5)$$

Where we assume  $R > \gamma$  to ensure that  $1 < \frac{\gamma}{R} < 0$ .

<sup>7</sup> Plant-level institutions like the German work councils (*Betriebsrat*.) are in a particularly apt position to engage in this kind of “quality-of-the-job” bargaining, and, more generally, to contribute to qualify the character of the union-firm relationship as cooperative or conflictual. In principle, each institutions with limited bargaining power is more a voice than a monopolist institution and may therefore have some active role in co-determining the non-financial facets of the jobs of its delegates. Fang and Ge (2012, 177) use their finding regarding the fact that the U-I correlation is positively signed in China to suggest that in developing economies – provided that conceptualizing China as a developing economy is correct – where unions do not have enough bargaining power to capture quasi-rent from innovations, the monopoly face of unions is dominated by their collective voice face. The authors’ intuition strengthens when the latter consider the specifically cooperative character of collective bargain in China. In their words «the voice effect of unionization, [operates] through various channels such as the Workers’ Congress system and ‘democratic participation in management’. This is very likely to be the case as Chinese unions tend to work collaboratively with management to achieve common goals of productivity enhancement, employee welfare, and social and political stability».

In an effort to understand and/or to predict which of these two attitudes will prevail within a given and well-defined system of industrial relations, there are several variables that need to be considered. In what follows, we briefly review those affecting the hold-up problem and those affecting the voice face of unions.

## 2.2 *The rent-seeking face*

As trivial as it may seem, the irreversibility of investments and the elasticity of substitution between capital and labour play a major role in limiting the extent to which rent-seeking can actually inhibit innovation. Quite trickier, on the other hand, is the role played by the structure and time-horizon of bargaining. For instance, if unions and firms engage in repeated interactions (which is usually the case) and thus abstract from end-game scenarios, the incentives for acting uncooperatively are likely to weaken or even disappear (Ploeg 1987)<sup>8</sup>. In the same vein, taking union's preferences in consideration, if employment is valued more than wage, unions should in principle reduce their rent-seeking effort and thus leave the incentives to innovation unchanged. Finally, as the literature on strategic R&D has extensively argued (e.g., Beath et al. 1989; Ulph and Ulph 2001), the very manner in which the unionisation regime is structured – whether it is more or less centralized – may alter the incentive for firms to engage in R&D or patent-filing races – especially when the markets are non-competitive. Haucap and Weley (2004), for instance, develop a theoretical model where the incentives for innovation vary with respect to three stylised unionisation structures (coordinated, centralised and decentralised), while Mukherjee and Pennings (2011) study a Cournot-game where the aforementioned incentives depend upon the union's preference for wage and employment and upon the degree of centralisation of the bargaining regime. More recently, Basak and Mukherjee (2018) showed that decentralised (centralised) labour unions and symmetrically differentiated (asymmetrically differentiated) products are complementary in terms of providing incentives for firms to invest in product-innovation.

In their review, Menezes-Filho and Van Reenen (2003) use the insights from this stream of literature to justify the massive evidence concerning the presence of non-linearities in the U-I correlation in Europe, that is, to provide with a rationale to the fact that unions have a positive impact on innovation when their bargaining power is low and a negative impact when their bargaining power is high<sup>9</sup>. Moreover, as Fang and Ge (2012) suggested for the Chinese context, the voice face and the bargaining power of unions are likely to be inversely correlated, so that, when union power is low, it is more rational for unions to set their action in a voice-enhancing way and, simultaneously, it is less likely that firms fight their requests.

<sup>8</sup> Another factor which may affect (lower) the rate at which unions discount the future is the great influence of senior members. Furthermore, as union-membership does not bestow any property right over the association upon its affiliates, unions are likely to discount the future more than other shareholders, i.e., they are rationally myopic.

<sup>9</sup> Schnabel and Wagner (1994), for instance, find that works councils (union density) impact positively (negatively) on R&D.

### 2.3 *The voice face*

Whether giving voice to employees and/or improving their on-the-job well-being actually foster innovation depends on several factors. To start with and quite straightforwardly, greater employees' participation affects the propensity to innovate only in knowledge-intensive and/or non-routine frameworks, that is, in situations where production depends more on the skill-content of labour – and on its versatility and capability to adapt – than on the “memory of the organisation” (Nelson/Winter 1982, 99-102). Within such contexts, the design of devices that spur workers to engage in innovative-enhancing activity is vital for the survival of the firm<sup>10</sup>. In a highly cited paper, Manso (2011) developed a principal-agent model where he studies the efficiency-contract to motivate employees to exert innovative effort. In his framework, the optimal incentive scheme not only exhibits rewards for success in the long-run, but also tolerance for short-term failure and commitment to a long-term compensation plan. Lately, in a co-authored study, he found empirical support to this theory (Ederer/Manso 2013). Acharya et al. (2014) present an affine model where wrongful discharge laws – that is, laws which prevent employees to be fired in “bad faith” – incentivise innovation and new-firms creation and then calibrate the model on US data. In a companion paper (Acharya et al. 2013), the same authors extend their empirical analysis to three European countries (Germany, UK and France) and unambiguously find that more stringent dismissal laws foster innovation, particularly in knowledge-intensive industries. Altogether, the above findings suggest that the quality of occupational experiences – here understood in terms of job-security and compensation only – is likely to be affected by a multiplicity of (possibly co-varying) institutional elements, which include, but are not limited to, the role of trade-unions.

In addition, there is a second path through which unions may foster innovation: by improving its members' non-financial on-the-job well-being. Indeed, despite monetary rewards and job security surely have a major weight in affecting the workers' satisfaction, they do not exhaust the overall perception of the latter. It is our contention that the levels of job-discretion, the systems of on-the-job learning, the human resource practices, the management of teams and so forth – in short, the organisational setting as a whole – are also pivotal in determining the actual (dis)pleasure of performing a given task or set of tasks. Within the broader field of research which investigated the wave of organizational change which has followed from the contraction of the traditional Fordist/Taylorist paradigm<sup>11</sup>, the literature on the connection between organizational innovation and worker's well-being is vast and quite contradictory. The debate has been indeed built around (and sought evidence to demonstrate) two conflicting theses: the intensification

<sup>10</sup> Routine-biased-technological change theory (Goos/Salomons 2014; Consoli et al. 2016) has recently shown how nowadays' technical processes are eliminating routine-labour in those occupations where technology and skills are substitutes (usually located at the top and in the middle of the occupational ladder) while leaving the number of jobs unchanged in those occupations where technology and skills are complements (usually located at the bottom of the occupational ladder). The broader picture then, seems to suggest that the fine-tuning of human resource practices is more vital than ever in fostering economic growth.

<sup>11</sup> Seminal papers include Aoki (1995), Lindbeck/Snowder (2000), Caroli et al. (2001).



thesis, claiming that the introduction of organizational changes yield substantial costs to the workers in terms of physical and psychological stress (Ramsay et al. 2000; Green/McIntosh 2001; Askenazy 2004; Green 2004; Greenan et al. 2013), and the empowerment thesis, according to which reconfigured organizations provide workers with higher levels of job satisfaction and sense of self-fulfillment (Freeman/Kleiner 2000; Handel/Levine 2004; Askenazy/Caroli 2010; Antonioli 2011). In the latter view, the introduction of organizational innovations is beneficial for workers, who are therefore likely to reciprocate by exerting higher effort and thus, to foster the invention of new technologies.

Advocates of both theories however, recognized that the introduction of new organisational practices – regardless of the effect that the latter has on the workers' well-being – has a positive and unambiguous impact on the worker's learning achievements, so that it is cautiously presumable that their overall effect on innovation is positive as well. As such, if unions are in a position to directly affect the choice of the organizational setting (see footnote 7, *infra*: 4) rather than "limiting" their action to the improvement of their affiliates' financial conditions, their role in fostering innovation may follow a twofold path. Of course, to untangle such dual effect and identify which of the two routes is actually at work, is not an easy task. Holman and Raferty (2018) find partial support to the hypothesis that the introduction of organisational innovations (in their case, job discretion) is correlated with more unionised system of industrial relations (socio-democratic and Nordic systems vis-à-vis liberal and Mediterranean systems), while Antonioli et al. (2011) explicitly tested the linkage between on-the-job well-being, as dependent variable, organisational innovation and cooperative industrial relations, as covariates. Their study is worth recalling because it engages in a particular effort to qualify the character of the industrial relations, whether the latter is cooperative or conflictual.

The above discussion seems to suggest that the U-I correlation loses much of its opaqueness when the character of the industrial relations – whether they are more or less conflictual – enters the stage. As such, we believe that studies like ours, which directly tackle the U-I effect, would greatly benefit from complementary research into such qualification.

### **3. Data and descriptive statistics**

#### **3.1 Data**

Our analysis focuses on Italian non-agricultural firms. The dataset has been obtained by merging two sources of information. To measure innovation, we draw from the PATSTAT database (april 2011) which record worldwide patent-applications to the European Patent Office (EPO). The idea of focusing on patent filing rather than R&D expenditures (that is, on innovative output rather

than input) has the advantage of considering successful innovations only, although it raises further issues regarding the degree of successfulness – and thus, of comparability – of each application<sup>12</sup>.

Our second source of information is the Employer and Employee Survey (RIL) conducted by Inapp in 2005 and 2007 on a representative sample of partnerships and limited liability firms operating in the non-agricultural private sector. The RIL survey collects a rich set of information about personnel organisation, industrial relations and investments which allow us to control for many variables that may be related to our innovation measure, such as the ratio between temporary and non-temporary workers, the presence of on-the-job training, the hours of strike per year and so forth (see table 1). Furthermore, it is stratified by size, sector, geographic area and the legal form of firms and it comprises a longitudinal dimension which can be exploited to control for fixed effects and time trends.

Consistently with the approach used by Quatraro et al. (2014), we merge the two datasets using the harmonized matching tables described by Thoma et al. (2010) and combine the EPO and the RIL datasets on the basis of the firm identification code. For each observation in  $t$ , we use patent data on  $t$  and  $t + 1$ , that is, we estimate the correlation between firm  $i$ 's characteristics observed in, say, 2005 (2007) and her patent applications in 2005 and 2006 (2007 and 2008).

Table 1 presents descriptive statistics. In our sample, only 0.86 % of firms filed  $\geq 1$  patent(s) in either of the two years of observation.

The statistics comes as no surprise: when we look in the way in which firms are distributed by size (see footnote 13), we see that more than a half of our observations have  $\leq 10$  employees, i.e., they are micro-firms. It is worth noticing that the incidence of the latter in Italy is the highest in Europe – in 2008, their share of total value added was approximately 33%, 14 percentage points higher than the European average (Bank of Italy, 2013). Further, we see that 13.07% of the firms in our sample is unionized (meaning that union representatives are present in the firm) and the majority of them additionally engaged in company-level bargaining.

Before proceeding, a methodological remark is worth drawing as concerns our choice of the time for our estimates. As a matter of fact, although the RIL survey counts now four waves, we decided to use the 2005 and 2007 waves only to focus on the pre-crisis context. Beyond the trivial reasons for which the U-I correlation may exhibit non-usual behaviour during and after an economic recession, there are other, perhaps more subtle avenues through which a stagnating economy is likely to record significant anomalies in the U-I effect.

The study of Walrave et al. (2017), for instance, has shown that successfully navigating an economic downturn requires senior managers to focus on the exploration of new knowledge, while leveraging the subsequent recovery demand more attention to exploitation, which suggests that the optimal innovation policy (at the firm's level) is countercyclical. As such, one may expect fully rational and sufficiently forward-looking firms to expand (contract) their innovative activity during (after) any period of economic crisis. However, as Holm and Lorenz (2015, 1183) put it «research indicates that firms tend to focus more on the short term during a recession and that

<sup>12</sup> The problem, as Menezes and Van Reenen (2003, 14) put it: «is one of 'apples and oranges' – are we comparing like with like when we add up the patent numbers?». See below for further discussion.

this entails limiting investments in general [...] The observed short-termism is in contrast with the prescriptive business cycle [...] the most profitable strategy is to increase investments during a recession».

**Table 1.** Definitions and descriptive statistics

Variable	Definition	Statistics
<i>Innovation</i>		
$PATS_i$	A dummy variable that equals 1 if firm $i$ files $\geq 1$ patents in $t$ or $t + 1$	0.86 %
$N\_PATS_i$	A continuous variable indicating the number of patents filed by firm in $t$ or $t + 1$	(min, max) = (0, 38)
<i>Unionization</i>		
$UNION_i$	A dummy variable that equals 1 if firm $i$ is unionized in $t$ or $t + 1$	13.07 %
$UNION2_i$	A dummy variable that equals 1 if firm $i$ uses company-level collective agreement in $t$ or $t + 1$	10.83 %
<i>Firm characteristics</i>		
$SIZE_i$	A continuous variable indicating the number of employees in firm $i$ in $t$ or $t + 1$	$\in (0, 59980)^{13}$ Mean $\approx 43$ St dev $\approx 513$
$(SIZE_i)^2$	The square of variable $SIZE_i$	
$TRAINING_i$	A dummy variable that equals 1 if firm $i$ employs on-the-job training in $t$ or $t + 1$	28.83 %
$NORTHWEST_i$	A dummy variable that equals 1 if firm $i$ is in the North West	30.46 %
$NORTHEAST_i$	A dummy variable that equals 1 if firm $i$ is in the North East	24.04 %
$CENTER_i$	A dummy variable that equals 1 if firm $i$ is in the Center	19.84 %
$SOUTH_i$	A dummy variable that equals 1 if firm $i$ is in the South	24.66 %
$INVESTMENT_i$	A dummy variable that equals 1 if firm $i$ invested in $t$ or $t + 1$	46.17 %
$H\_STRIKE_i$	A continuous variable indicating the number of hours of strike in firm $i$ in $t + 1$	(min, max) = (0, 417432)
$\%\_TEMPORARY_i$	The percentage of temporary workers over the total workforce of firm $i$	Mean = 0.14 St dev = 0.24
$INDUSTRY_i$	A dummy variable that equals 1 if firm $i$ is in the heavy industry	38.31 %
$TRANS\_BUILD\_ENER_i$	A dummy variable that equals 1 if firm $i$ is in transport building or energy	18.1 %
$SERVICE_i$	A dummy variable that equals 1 if firm $i$ is	39.72 %
$HEALTH_i$	A dummy variable that equals 1 if firm $i$ is in the health sector	3.87 %

<sup>13</sup> The following table provides with a more accurate view of how Italian firms are distributed by firm size.

N. employees	%
1 - 2	19.37
3 - 5	20.15
6 - 10	18.83
11 - 15	13.42
16 - 50	17.12
>50	5.109

Therefore, regardless of whether firms respond in a rational or myopic fashion to the economic deterioration of the surrounding environment, we presume that their innovative activity is likely to register atypical behaviour during periods of economic stagnation, which are therefore kept out of our analysis.

## 4. Econometric analysis

### 4.1 Strategy

We begin our econometric analyses by estimating different specifications of the following equation:

$$PATS_{i(t,t+1)} = \alpha \cdot UNION_{it} + \beta \cdot UNION2_{it} + \delta_Y \cdot YEAR_{Yit} + \gamma \cdot X_{it} + \varepsilon_{it} \quad (1)$$

where the dependent variable  $PATS_{i(t,t+1)}$  is a dummy variable indicating whether firm  $i$  filed  $\geq 1$  patents in either  $t$  or  $t + 1$ ,  $UNION_{it}$  is a dummy variable indicating whether firm  $i$  is unionized in  $t$ ,  $UNION2_{it}$  is another dummy indicating whether the national collective agreement is complemented by firm-level bargaining in  $t$ ,  $YEAR_{Yit} = 2005, 2007$  are two dummy variables controlling for year effects,  $X_{it}$  is a vector of firm characteristics (for details, see Table 1) also observed at time in  $t$  and  $\varepsilon_{it}$  is an idiosyncratic error term.

**Table 2.** OLS, Logit and Probit estimates of patent-filing (dummy dependent variable)

OLS				
	Model 1		Model 2 (no $UNION2_i$ )	
	Coef	Robust st. er.	Coef	Robust st. er.
$UNION_i$	.008***	.002	.02***	.002
Logit				
	Model 1		Model 2 (no $UNION2_i$ )	
	dy/dx	dy/dx	dy/dx	Robust st. er.
$UNION_i$	.009***	.001	.009***	.001
Probit				
	Model 1		Model 2 (no $UNION2_i$ )	
	dy/dx	dy/dx	dy/dx	Robust st. er.
$UNION_i$	.007***	.001	.008***	.001

\* Statistical significance at 10%

\*\* Statistical significance at 5%

\*\*\* Statistical significance at 1%

A linear probability model is used to estimate different specifications of Eq. (1), as suggested by Angrist and Pischke (2008). In addition, we estimate Probit and Logit specifications of Eq. (1) to account for the dichotomous nature of the  $PATS_i$  variable (Wooldridge 2010). In this way, we may

also verify whether the results of the OLS estimations differ (in magnitude and statistical significance) from the Average Marginal Effects (AME) obtained using the Probit and Logit model. Moreover, we check whether our estimates hold by substituting the dummy  $PATS_{i(t,t+1)}$  with a continuous variable  $N\_PATS_{i(t,t+1)}$  that simply sums the number of patents filed by firm  $i$  in 2005 and 2007, which is to say, we estimate various specifications of the following model:

$$N\_PATS_{i(t,t+1)} = \alpha \cdot UNION_{it} + \beta \cdot UNION2_{it} + \delta_Y \cdot YEAR_{Yit} + \gamma \cdot X_{it} + \varepsilon_{it} \quad (2)$$

The findings for our estimates, reported in Table 2 and 3, indicate that the probability of filing a patent (at the firm's level) is significantly and positively associated with union presence, despite the magnitude of the effect is not too large: the full specification, i.e. including a control for firm-level bargaining, shows a positive marginal effect of unions on the probability to innovate of 0.7 to 0.9 percentage points using model (1), irrespective of the chosen estimation strategy (i.e. linear or non-linear). Exclusion of local-level bargaining does not affect the marginal effects from the logit and the Probit specifications, while the linear probability model suggests that the effect more than doubles. When using model (2) only the linear model can be estimated. The magnitude of the effect is not very much affected, consistently with the evidence that most of firms issue either zero or one patent.

**Table 3.** OLS estimates of patent-filing (dependent variable continuous)

OLS				
	Model 1		Model 2 (no $UNION2_{it}$ )	
	Coef	Robust st. er.	Coef	Robust st. er.
$UNION_{it}$	.008***	.002	.02***	.002

\* Statistical significance at 10%

\*\* Statistical significance at 5%

\*\*\* Statistical significance at 1%

## 5. Conclusions and future research

All in all, this preliminary evidence seems to suggest that unions foster innovation in Italy and, in addition, that such effect is far less ambiguous than in the rest of Europe and diametrically contrary to what the previous literature found for the US and Canada. However, much remains to be done, both in theoretical and econometric terms. From the side of theory, we now lack a clear understanding of which particular institutional channel (or sum of channels) above those listed above mostly affects the U-I correlation in Italy. From the quantitative viewpoint, the issues of heterogeneity and endogeneity remains to be solved. Problems concern firms' unobserved heterogeneity and endogeneity issues. In particular, if there are unobservable factors that influence both unionisation and the propensity to innovate, all our estimates might suffer from omitted variables bias. The next step will be to find suitable instruments for unionization, that is,

instrumental-variables that can predict whether firm  $i$  is unionised or not without directly affecting her probability of filing patents.

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