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Green transition and industrial relations at workplace: Evidence from Italian firms

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ABSTRACT

Green transition and industrial relations at workplace: Evidence from Italian firms

This paper analyses the role of green investments in employment relations. We verify whether the amounts of these investments affect the adoption of decentralised bargaining (firm-level and territorial agreements), and single aspects negotiated therein. Using new data on a large representative sample of Italian firms, we find that investing in green technologies increases the overall probability of decentralized agreements. Further, green investments lead to an increase in negotiations on performance-related pay, and welfare benefits. These results are robust to an econometric strategy that controls for firm-level observed and unobserved heterogeneity and endogeneity issues. Our is the first micro evidence supporting the hypothesis that the ongoing ecological transformation of productive processes leads to significant changes in industrial labour relations.

KEYWORDS: firms, green technologies, industrial relations
JEL CODES: L2, J3, J53, O33

Questo articolo analizza la relazione che lega l'ammontare degli investimenti in tecnologie green e varie dimensioni degli accordi di contrattazione integrativa nei luoghi di lavoro. Utilizzando i dati della Rilevazione su Imprese e Lavoro (RIL-Inapp), si verificano quindi i seguenti risultati. Primo, l'ammontare degli investimenti in tecnologie green aumenta la probabilità di accordi integrativi del contratto collettivo nazionale. Secondo, gli investimenti green influenzano anche la tipologia di accordi integrativi, favorendo in particolare quelli aventi per oggetto i premi di risultato e i benefici di welfare. Questi risultati sono ottenuti con una strategia empirica che tiene conto dei potenziali problemi di stima legati a eterogeneità non osservata ed endogenità. Nel loro complesso l'analisi conferma l'ipotesi che la transizione ecologica indurrà sostanziali cambiamenti sugli assetti delle relazioni industriali nelle imprese.

PAROLE CHIAVE: *imprese, investimenti in tecnologie 'verdi', relazioni industriali*
CODICI JEL: L2, J3, J53, O33

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1. Introduction

Mitigating global climate change is a priority, and energy-efficiency improvement, besides reducing gas emissions and increasing renewable resources, are key targets to reach climate neutrality by 2050 in EU member states. However, these policy shifts, that induce changes in production modes, also impact work in different ways (Pestel 2019) and may influence management and employment relations.

So far, empirical research has adopted comparative analyses to identify the role of workers' representatives on green transitions and has seen them as "agents of transition or defenders of the status quo" (Kalt 2022). Räthzel and Uzzell (2011), interviewing trade unions of several countries examined how unions perceive the job *versus* environment dilemma and explore how unions "seek strategies to reconcile workers' interests with environmental needs". (Räthzel and Uzzell 2011, 4). Thomas and Doerflinger (2020) propose three typical different union strategies on environmental issues: *opposition*, (outright contrast to decarbonization measures), *hedging* (attitudes to minimize regulation), and support (proactive approaches to green policies). However, available literature has paid limited attention to the influence that cleaner production also plays on transformative changes in labour relations. In recent years Corporate Social Responsibility (CSR) and the commitment to social sustainability is growing, but it should be emphasized CSR can be reached if companies consider all stakeholders, including their employees. Labour equity, supporting the healthcare of employees and their families, and safety, are integral to the concept of sustainability, and "serve as a starting point to establish a comprehensive social footprint for a company" (Hutchins and Sutherland 2008, 1697). Further, CSR is also a source of employer branding that helps to attract potential employees (Yasin *et al.* 2023).

To solve the trade-off between labour and environment it is worth discussing the idea of *Just Transition* defined, according to ILO as "Greening the economy in a way that is as fair and inclusive as possible to everyone concerned, creating decent work opportunities and leaving no one behind"[1]. Following the public debate, interest in the relevance of this approach and its impacts on labour relations is growing.

However, to date, as underlined by Staniškienė and Stankevičiūtė (2018), "the employee perspective when measuring social sustainability in organisation has been largely ignored", whereas "in the matrix of stakeholders, employees should be treated as actors of the highest significance" (Staniškienė and Stankevičiūtė 2018, 709-710). The available empirical research is indeed mainly qualitative, i.e based on policy documents and interviews (Ringqvist 2022) while – to the best of our knowledge – no study based on detailed micro-data has focused on the impact of firms' investment in green technologies on labour relations in a large European economy.

To fill this gap, we take advantage of unique information drawn from a national-wide survey conducted periodically by the National Institute for the Analysis of Public Policy (Inapp) on a large representative sample of Italian firms. In particular, the VI RIL-Inapp survey provides detailed data on

[1] See UNDP <https://bitly.ws/3aGc7>.

i) different types of green technologies adopted and the total monetary amounts of green investments; ii) the main features of industrial relations and collective bargaining, such as the presence of unions, the adoption of decentralised agreements, signed at firm or territorial level, and the main issues bargained therein. In addition to a large set of firms' and management characteristics, our database also allows us to consider the Covid-19 state financial aids and to control for this confounding factor that may have influenced companies' behaviour.

Drawing on *Just Transition* (JT) theory, reviewed by Wang and Lo (2021), our study aims at verifying for the Italian case if those companies that adopt green strategies are themselves agents of transition on the ground of labour relations. More in detail, we test if increases in energy efficiency, implementation of eco-friendly production processes, and circularity, reflect on higher diffusion of second-level negotiations with workers' organizations, that complement first-level contracts signed at sectoral levels. Further, we investigate if green investments lead to a higher diffusion of concessionary bargaining that offers monetary bonuses and guarantee living wages, performance-related pay in motivating employees, wealth benefits, and financing of social services that may reduce workers' vulnerability. This vulnerability may be more likely perceived in phases of structural deindustrialization, as those generated in times of progressive transitions towards alternative energy sources and when workers are more affected by the 'jobs versus environment' dilemma.

Using different econometric models, we find that firm-level greening policies favour a climate of labour relations featuring cooperation, additional wage premiums that supplement industry-level wage setting, and corporate welfare policies that improve the general well-being of companies' employees and their families. These results are robust to a cross-sectional analysis that tackles the potential endogeneity of the adoption of green technologies using the information on the access of green investments to fiscal incentives, i.e., the White Certificate schemes (WhC). These findings are also confirmed in a difference-in-difference framework that controls for unobserved heterogeneity and parallel trends.

Overall, the main contribution of the paper is to provide micro-level evidence, for the whole economy, that there are no penalising trade-offs between environmental and labour protection at the company level. Two dimensions of sustainability (environmental and social) are possible and represent a first step to exploring in future research the wide range of mediating and moderating factors that link cleaner technologies, organizational changes, and employment relations of Italian firms.

The article proceeds as follows. Section 2 discusses the literature review, the Italian institutional setting, and formulates some testable hypotheses. Section 3 introduces our data and presents descriptive statistics. Section 4 illustrates the econometric strategy before presenting and discussing the main results (section 5). Finally, section 6 concludes.

2. Background

2.1 Related literature

Our paper is related to studies on *just transition processes*, which refer to the profound changes associated with the adoption of new environmental technologies and their unequal distribution of

benefits. This area includes among various themes 'a labour-oriented concept'[2], as signalled by the conceptual overview of Wang and Lo (2021). Indeed, green energy policies may exert both positive and negative effects on workers (see also the survey of Pestel 2019). However, as Wang and Lo suggest, so far empirical studies on JT are lacking and this literature would benefit from more evidence to verify how JT may be handled in a real way.

Our study thus refers to the large body of literature on industrial relations but limits our focus on labour relations involved in environmental sustainability, see the reflection on this 'emerging field' of Flanagan and Goods (2022). As these two authors suggest, "Two of the most prominent 'hybrid' environment-labour concepts for industrial relations" are relevant, i.e. sustainability and just transition (p. 481). In our brief discussion, rather than providing an exhaustive overview of these fields of literature, we limit ourselves to shortly present some meaningful ideas and studies and verify their empirical role for our case study.

JT theory represents an alternative paradigm to the 'Treadmill of Production' (ToP) view. According to ToP, as originally maintained by an environmental American sociologist, Allan Schnaiberg (1980), the principle behind collective action adopted by unions in Western capitalism has been inspired by the aims of sustaining the growth model of industrialized economies, that ran for decades on a 'treadmill' but at the expense of environmental degradation. Workers and their representatives, oriented to create new job opportunities and save occupations, have been often allied to capital and political authorities to preserve this self-reinforcing process and thus have contributed to disrupting ecosystems (Obach 2004; Felli 2014; Barca 2019).

However, the principles of JT, included in the Preamble of the Paris Agreement, outline a new road to support the green jobs revolution and guarantee living wages, as well as workplace safety protections and health benefits (UNDP 2022). Hence labour policies such as compensations, retraining, and reskilling of workers should be part of any transition planning, in conformity with principles already introduced in documents negotiated at the Cancun COP (COP16) (Felli 2014, 379).

A case in point is offered by Enel, the Italian largest electricity company and, to date, one of the leading global players in the electricity sector, the second one in Europe. Enel employs approximately 75,000 people worldwide and 36,000 in Italy. As documented by ILO: "Enel has entered into social dialogue on a just transition framework agreement with its Italian union partners. The framework covers retention, redeployment, reskilling, and early retirement for elderly workers. It is an example for a just transition agreement of the power sector" (ILO 2018, 12).

More recently, the principle of JT has inspired EU green cohesion policies, such as the European Green Deal and the Just Transition Fund (JTF), a budget of EUR 19.7 billion "to help the people and places expected to be most affected by the transition to climate neutrality so that no region is left behind". For instance, the JTF plan provides not only SME incentives to support innovative projects for ecological transitions but also resources aimed at sustaining employment and activation measures for all, such as lifelong learning, career transitions as well as active inclusion and employability (European Commission 2023, 25).

[2] Wang and Lo (2021) consider also other perspectives of JT, i.e., a governance strategy, a theory of socio-technical transition, a public perception and an integrated framework for justice.

The extent to which JT may affect workers may also depend on labour relations. So far, existing empirical studies have analysed employment effects (most of them for the German case as surveyed by Pestel 2019); other contributions have examined if individual union members are more pro-environmentally inclined than non-members (Ringqvist 2022). Furthermore, existing research tends to be qualitative, based on interviews and policy documents, while quantitative evidence on the welfare overall effect of employees generated by firms' green strategies is rather limited.

In our investigation, far from offering an exhaustive review of this vast body of studies, we limit ourselves to referring to a field of research that considers the interplay of industrial relations with environmentally friendly practices unfolded within firms, and which may support our research hypotheses. More in detail, we expect that industrial relations and agreements including performance-related pay, working hours, and welfare benefits are functional to innovative cleaner production strategies. For instance, individual and collective bonuses, linking pay to performance, align worker and firm objectives and encourage knowledge sharing and collaborative relationships among employees (see, among others, Kruse *et al.* 2010). These reveal to be strategic practices in cases of transformative processes such as those featuring environmental changes. Furthermore, better working conditions, negotiated in firm-level bargaining, may mitigate workers' and unions' conservative attitudes, often adopted to save jobs (Barca 2019); hence these negotiations induce more responsible behaviour from employees, likely enhancing the positive impact of environmental innovation. In these contexts, "unions can be important actors in transcending – rather than reinforcing – more narrow short-term economic interests, particularly in those occupational sectors most often claimed to be affected by the jobs versus environment dilemma (Ringqvist 2022, 674).

Our article aims to show for a large manufacturing economy, Italy, the impact of the adoption of new energy-efficiency technologies on collective bargaining and welfare benefits offered by companies to their employees.

To conduct our analysis, we first document from our survey the population of private-sector firms that made different types of green investments, that is, i) energy efficiency; ii) technical ecological improvement of their production processes; iii) resource saving; iv) circular economy. Afterward, we use the information on WhC incentive schemes as instruments for the investments above. As we better explain in the next section, we assume that companies may decide to make green investments once they have the possibility to issue a WhC certifying the energy saving and that they can sell to the obliged energy distributors.

Following Kalt (2022), several contextual conditions affect the expected results. In conformity with the Power Resource Approach, *associational* power, related to membership and worker participation, and *institutional* power, due to legal and political rights, influence the mobilization of unions and the final gains obtained with the social dialogue. We then illustrate the main features governing the system of industrial relations involved in the social dialogue in Italy.

2.2 The Italian Context and Hypotheses

To consider the context in which unions operate and their 'power resources' we shortly present some specific traits of our case study. The Italian institutional setting for labour relations, introduced with the 1993 Agreement, is characterized by a two-tier bargaining framework, based on national sector-wide agreements (the first bargaining level) and limited recourse to company and territorial

agreements (the second bargaining level). Worker representatives participate in company agreements, the 'unitary workplace union structures' (RSU).

This decentralized bargaining, hierarchically subordinate to the sectoral one, takes the wage sectoral level as a floor and has the possibility of negotiating payments only *in mejus*. Hence, only a fraction of firms, featuring relatively high productivity performances, could afford extra payments, above the sectoral levels.

Part of these additional remunerations paid at the company level are incentive payments, related to profit or productivity results, and represent a commitment device to obtain higher effort and work quality, greater workforce cooperation in facing new technology and organizational changes, lower labour turnover, and longer average tenure (see, among others, Eurofound 2015).

The RIL survey asks specific questions on all these issues: i) the adoption of the second level of negotiations; ii) the payment of variable bonuses, linked to productivity or profit results, ii) the other issues bargained over in these negotiations.

These data permit the verification of those aspects regarding the integration of environmental and labour protection through collective bargaining in Italy, which so far have been analysed along a qualitative perspective (Tomassetti 2020). For a quantitative validation, we propose the following hypotheses.

Hypotheses

The concept of just transition (JT) offers the possibility of including a labour perspective in the transition process toward cleaner production (Wang and Lo 2021; Kalt 2022). This inclusive view allows to assign to corporate social responsibility the same priorities given to environmental and economic dimensions (Staniškienė and Stankevičiūtė 2018).

In our case study, the second bargaining level (SLB), which may complement sectoral agreements, allows Italian firms to sign contracts that grant higher wages (due to add-up properties of the Italian two-tier wage setting). SLB can also be adopted to promote innovative organizational practices, better suited to firms' specific productive changes (D'Amuri and Nizzi 2018). Building on these arguments, we verify the following testable hypotheses:

H1 We expect companies undertaking green investments also show higher propensities to adopt second-level bargaining (SLB).

H2a Firms involved in green investments may negotiate wage bonuses that permit their employees to appropriate part of the rents generated by green investments.

H2b Through SLB agreements, employers also offer welfare benefits to improve the quality of life of employees and their families. These agreements permit strengthening the set of social interactions predicted by the social exchange theory (John *et al.* 2019).

H3 SBL could modify the arrangements of the national sectoral agreements which regulate working hours. Firms involved in significant changes, such as those related to cleaner production, may show a higher probability to adopt SLB to obtain greater flexibility in labour utilization.

3. Data and descriptive statistics

3.1 Data sources and variables

The empirical analysis is based on the surveys conducted by the Italian National Institute for Public Policy Analysis (Inapp) on a large representative sample of partnerships and limited liability firms (*Rilevazione su Imprese e Lavoro* - RIL). The RIL surveys cover about 30,000 firms operating in the non-agricultural private sector and a sizeable subsample (40%) is followed over time, partially providing our dataset with a panel data structure, in the period under study[3]. The surveys collect a rich set of information about management and workforce characteristics, firms' productive specialization and competitive strategies, human resource management and labour relations, new technologies and public policies.

What is worth for our purposes, is that the last RIL survey, now in its 6th edition, adds detail questions related to the adoption of different green technologies and the amounts of green investments over the period 2019-2021. In particular, our preferred measure of firm-level green transition is the total monetary amount financed between 2019 and 2021 for the following categories of activities: i) *energy efficiency* (all the interventions to reduce the consumption of electrical and thermal energy; ii) *technological development* (substantial implementation of eco-friendly equipment and cleaner production processes); iii) *resource-saving* (investments to save inputs and promoting eco-friendly practices among employees); iv) *circular economy* (investments for the re-using of products and the reduction of any wastes).

As for labour relations, RIL data provide information on the adoption of the second level of bargaining (SLB) and the main issues of these agreements: i) the presence of variable wage bonuses linked to profit or productivity results (PRP), ii) the negotiation on hours worked and iii) the provision of welfare benefits; iv) others. These first three aspects are the most important ones among topics of SLB (that also includes training and workers' participation in decision-making)[4] and are provided as binary information (1 Yes, 0 No).

In studying the effect of green investment on labour relations we exploit the richness of the RIL database on a large set of control variables, allowing us to consider several potential confounding factors.

First of all, to study whether green investments affected industrial relations in an extraordinary period (as the one between 2019 and 2021), we control for Covid-19-related subsidies (euros per employee, taken in log) and performance of companies, measured by sales per capita (taken in log). Further, we use information concerning firm characteristics (size, age, ownership), and strategies (adoption of

[3] The RIL sample is stratified by size, industry, geographical area, and the legal form of firms. Inclusion depends on firm size measured by the total number of employees. This choice required the construction of a 'direct estimator' to consider the different probabilities of inclusion of firms belonging to a specific stratum. Using this estimator, the RIL sample reproduces all active firms for each stratum and, simultaneously, the total number of employees in each stratum (size, sector, geographic area, and the legal form). For more details on the RIL questionnaire, its sample design, and all methodological issues see <https://bitly.ws/VqSD>.

[4] Training and workers' participation in decision-making are issues negotiated by less than 2% of companies in Italy. For this reason, we excluded these items from our analysis. Comprehensive descriptive statistics on all issues negotiated in second-level bargaining are available upon request.

digital technologies, internationalisation), personnel policies, and workforce characteristics (the shares of executives, white collars, and female workers, fixed-term and part-time contracts) and management characteristics (the composition of managers by education and gender (share of female managers). All these characteristics may play an important role in shaping industrial relations and SLB. Notice that our data for the green investments refer to the period between 2019 and 2021, while industrial relations refer to the year of the survey (2021); however, we cannot exclude that companies anticipate changes in industrial relations to favour green investments (reverse causality), or that specific unobservable variables (managerial innate ability or soft skills), simultaneously correlate to dependent variables and covariates, thus generating endogeneity problems. These concerns lead us to further exploit the richness of the RIL questionnaire that asks enterprises whether they have benefited from environmental incentives, such as White Certificates; we then introduced in our estimates this information and use WhC as an instrument for green investments.

The white certificate mechanism is the main tool for promoting energy efficiency in Italy. WhC adopted also in the UK and France, are tradable securities that certify the achievement of energy savings (European Commission 2015). The system provides primary energy savings obligations for electricity and natural gas distributors with more than 50,000 end customers (the 'Obligated Parties') and assigns targets for each year to be achieved.

Other voluntary parties (VPs) may undertake energy saving. WhC are used to certify these savings and the obliged parties can obtain them directly or buy them from VPs. VPs that prove to have saved energy can issue a WhC and sell it to the obliged distributor through a dedicated platform managed by the energy market authority (GME) or with bilateral agreements over the counter[5]. The system allows that several types of companies may issue WhC and a very large number of energy efficiency projects in almost all sectors is allowed, with particular emphasis on the industrial sector.

According to the functioning of the system and given the risk for VPs of unsold WhC, we assume that among the potential VPs (operating across all industries), only those companies that have previous informal relationships with energy distributors may exploit their 'prior information' advantage, and minimize the risk of unsold WhC, thus gaining remuneration for their green investments through WhC incentives. This argument supports our strategy to identify WhC as a valid instrument that affects the industrial relations of companies only through the decision of green investments. We further underpin this explanation by using collateral information about firms declaring they would have not made green investments without the possibility of issuing WhC. We assume these firms have had previous information on WhC, and thus benefit from monetary incentives. We called this variable WhC-counterfactual and used it as an alternative instrument when we control for endogeneity.

We excluded micro-firms (those with less than ten employees) to retain companies with a minimum level of internal organization and employment relations. Once deleting observations with missing values for the main variables, our cross-sectional sample reduces to 13,262 companies. Concerning the longitudinal analysis, our restricted samples amount to 6,712 companies observed in the RIL surveys 2018 and 2021 (t=2) and to 4,065 companies continuously observed in the RIL surveys 2015, 2018, and 2021 (t=3).

[5] See the online document Di Santo and Biele (2017).

3.2 Descriptive statistics

Summary statistics of the variables used in the empirical analysis are shown in table 1 which reports separate summary statistics for i) the whole sample (13,262 companies with more than 9 employees operating in the private non-agricultural sector) and ii) the sub-group of firms that adopted at least one green type of green investments (3,991 Green Investments Firms, GIF).

Our whole sample reflects the structure of the Italian economy, where small firms with family ownership are dominant (45 employees is the average size and 81% is the fraction of family-owned companies). The profile of human capital of managers shows that only 30% showed a tertiary educational attainment and only 17% of them are female executives. The composition of the workforce shows that temporary workers are ten percent of total employees.

The GIF firms, that introduced at least one type of green investment, were one out of four companies. Most of them (66%) made investments to improve energy efficiency or to implement eco-friendly technological improvements (52%)[6]. On average, the monetary amount of all per capita green investments was 1,453 euros (that is 7.28 in logarithms). It is worth noting that GIF firms were slightly bigger companies, compared to the ones in the whole sample (74 employees on average vs 45), recorded better performances in terms of i) ln(sales per capita) (11.87 vs 11.73), and ii) exported sales (14% vs 10% their share on total sales). Also, highly educated managers (tertiary educational attainment) were more frequent (36% vs 30%).

Concerning our dependent variables, for the whole sample, we observe that in 2021, i.e., in a pandemic period, only ten percent of companies were involved in second-level bargaining (SLB) and six percent introduced a performance-related pay scheme (PRP) within these agreements. Notice that before the Covid crisis, these figures had reached 20% and 13%, respectively, (CNEL 2022; D'Amuri and Nizzi 2018). The firms that negotiated agreements on working hours and welfare services were 3% and 2.7%, respectively.

The GIF firms showed a higher diffusion of SLB and PRP agreements (15% and 11%) and agreements on working hours and welfare services (5%). Notice also that investments of GIF firms in digital technologies were more important (61% of companies, vs. 38%) and they more benefited from the Covid-19 State aids, which amounted to 11.55 log points (vs 11.47), which is more than 103,000 euros per employee (close to sales per capita, 11.87 log points and about 143,000 euros per employee, respectively)[7].

Results from summary statistics tell us that to isolate the partial effect of green investments on industrial relations, we should in our econometric strategy use the information above as controls. At the same time, due to differences between firms performing green investments and the rest, we adopt econometric methods to reduce endogeneity and self-selection problems.

[6] Many companies made more than one green investment during the period of interest; for this reason, the percentages in both GIF and the whole sample do not sum to 100.

[7] The Temporary Framework alone, admittedly allowed for rather generous amounts of aid for companies (Bouchagiar 2021). Another type of aid from the European Union and Italian government was added to Temporary Framework funds. In October 2020 the European Investment Bank made available 1 billion funds for Italian businesses. With these funds, it was possible to finance up to 100% of new investments and projects, with a maximum of € 12.5 million for each leasing operation <https://bitly.ws/3aHbg>.

Table 1. Descriptive statistics

	Whole Sample		*Sub-sample: green investments firms*	
	Mean	**Std dev**	**Mean**	**Std dev**
	II level bargaining (SLB)			
Total	0.103	0.304	*0.147*	*0.354*
Performance related pay (PRP)	0.062	0.241	*0.111*	*0.314*
Worked hours	0.030	0.171	*0.052*	*0.222*
Welfare services	0.027	0.162	*0.050*	*0.219*
	Green investment			
At least one green tech (2019-21)	0.242	0.428	*1*	*0*
Energy efficiency	*0.159*	*0.366*	*0.660*	*0.474*
Technological development	*0.125*	*0.331*	*0.520*	*0.500*
Resource saving	*0.080*	*0.271*	*0.332*	*0.471*
Circularity	*0.045*	*0.208*	*0.188*	*0.390*
Ln(Amount of green invest. per capita)*	5.859	7.478	7.282	8.123
	Incentives			
White certificates	0.003	0.056	0.011	0.105
Counterfactual white certificate	0.001	0.031	0.003	0.058
	Firm characteristics			
Ln(Sales per capita)*	11.725	1.246	*11.870*	*1.315*
Ln(Covid public financial aids per capita)*	11.472	0.821	11.548	0.867
Digital technologies	0.376	0.484	0.607	0.489
Export sales (share)	0.096	0.218	0.139	0.254
Vacancies	0.336	0.472	0.468	0.499
Public procurement	0.322	0.467	0.362	0.481
N of employees	44.564	329.669	74.102	353.172
Firms age (in years)	26.847	16.721	29.196	17.617
Family ownership	0.811	0.391	0.788	0.409
	Management characteristics			
Tertiary education	0.294	0.455	0.361	0.480
Upper secondary education	0.530	0.499	0.506	0.500
Lower secondary educ	0.177	0.382	0.133	0.340
Female	0.166	0.372	0.149	0.356
	Workforce characteristics			
Share of executives	0.035	0.081	0.043	0.085
Share of white collars	0.334	0.295	0.352	0.284
Share of blue collars	0.631	0.318	0.605	0.307
Share of fixed term contracts	0.100	0.184	0.100	0.192
Share of females	0.298	0.246	0.287	0.224
N of companies	13,262		*3,991*	

Note: sampling weights applied. With exception of figures in logarithm of euros (*), firm's size and age (number of employees and years, respectively), all variables for firm level bargaining, investments, incentives and other firm characteristics are share of companies on the total sample. *Total* refers to the share of companies involved in SLB. Management characteristics are shares on the group of firm level managers, while workforce composition refers to the shares on the firm level total employees.
Source: Authors' elaborations on RIL 2021

4. Econometric analysis

To easily interpret the coefficients and avoid complications generated by using non-linear models, we base our empirical strategy on different types of linear probability models[8].

Our baseline specification is a cross-section (OLS regression) where the probability to introduce i) SLB, ii) performance-related pay, iii) contracts on working hours, and iv) welfare benefits are explained by the amount of green investment per capita and a large set of control variables. Our first regression reads as follows:

$$Y_{i,t} = \alpha + \beta \text{Ln (green inv. pc)}_{i,t} + \vartheta F_{i,t} + \gamma M_{i,t} + \delta W_{i,t} + \eta_j + \zeta_r + \varepsilon_{i,t} \quad [1]$$

where, *i= 1, …13,262* companies and *t* only equals 2021 in this equation (that is, a cross-section). Y is a binary variable that alternatively stands for the four dependent variables. Ln(green inv. pc) are the green investments (in euros) per capita taken in log[9], $\boldsymbol{F}$, , and $\boldsymbol{W}$ are vectors including firms, management, and workforce characteristics (see table 1), η_j and ζ_r are industry and region fixed effects. We use the more feasible and computationally efficient estimator proposed by Correia (2016), that overcomes problems arising for multiple levels of fixed effects.

Important concerns for the cross-section shown in equation [1] rely on potential reverse causality and omitted variables problems that generate endogeneity between industrial relations (Y) and green investments, as already anticipated in section 3.1. We try to attenuate this potential endogeneity problem by instrumenting green investments with the adhesion of companies to an incentive scheme based on white certificates (WhC). Since there is no guarantee for firms issuing WhC to concretely gain incentive by selling this tradable certificate to the obliged parties (see the discussion reported in section 3.1), we assume that only those companies that in previous years have established informal relationships with the obliged energy providers comply with this scheme. It means that this kind of networking with energy providers should be correlated to the type of industrial relations only through green investments and, therefore WhC should be a good instrument. In other terms, decisions referring to WhC are prior decisions to those related to firm-level bargaining agreements (our dependent variables) and the endogeneity problems should be reduced.

We also exploit information from a survey question that asks about firms' behaviour in the absence of the Whc incentives and use as an alternative instrument only those WhC enterprises that in the absence of the incentive would not have carried out investments in energy savings (we call them WhC - Counterfactual). The first stage of the IV estimation reads as follows:

$$\text{Ln (green inv. pc)}_{i,t} = \alpha^I + \omega WhC_{i,t} + \vartheta^I F_{i,t} + \gamma^I M_{i,t} + \delta^I W_{i,t} + \eta_j + \zeta_r + \varepsilon_{i,t} \quad [2]$$

[8] According to Wooldridge (2010) and many other econometricians, the linear probability model could produce biased coefficients if the predicted value for the probability to adopt SLB and other issues negotiated therein is out of the [0-1] range. This is not our case for the baseline OLS estimation reported in table 2, as most predictions for our dependent variables fall in this range (only for 910 out of 13,262 observations, the predictions are out of the [0-1] range). Results from this test are available upon request.

[9] The usual transformation, obtained by adding 1 to all numerical values of *green inv.pc* in order to avoid missing values once the log is taken, applies.

where *i=1, …13,262* companies and *t* only equals 2021 as in equation [1]; WhC is a white certificate (or alternatively WhC-Counterfactual), the other covariates are those discussed above, and the subscript *I* means that their coefficients refer to the first stage.

The fitted value of $\mathrm{Ln}\,(\mathrm{green\ inv.\,pc})$ is then used as a key explanatory variable in the second stage, which maintains the same form and estimator of the equation [1].

The second strategy adopted to reduce the potential endogeneity bias relies on using very short panel data so that with the only exception of green investments, we can exploit information for the other variables of the equation [1] for two years (t=2) and three years (t= 3). The short panel data specification for t=2 reads as follows:

$$Y_{i,t} = \alpha_i + \kappa Year2021 + \lambda(\mathrm{Ln\ green\ inv.\,pc} \cdot Year2021) + \vartheta^{pd2} \cdot F_{i,t} + \gamma^{pd2} \cdot M_{i,t} + \delta^{pd2} \cdot W_{i,t} + \varepsilon_{i,t} \quad [3]$$

where i=1, …6,712 companies and t=2018 and 2021 years, α_i is a company level fixed effect also absorbing the green investment as standing alone term (as we have only information in 2021 for this variable); $(Ln\ green\ inv.pc \cdot Year2021)$ is the interaction term between green investments and the dummy 2021 and the subscript 'pd2' means that the coefficients of our usual control variables refer now to the panel data model with t=2.

Two points are worth noting for equation [3]. The first one relates to the notable shrinking in the sample size, as the number of companies is almost halved (from 13,262 to 6,712). Hence, besides controlling for unobserved heterogeneity, the panel data estimation allows us to perform a sensitivity analysis, as we test the effect of green investments on this reduced sample.

Second, the variable of interest now is the interaction term $(Ln\ green\ inv.pc \cdot Year2021)$, and the coefficient λ should capture the variation between 2018 and 2021 of our dependent variables caused by the number of euros for green investments. In other words, this specification is similar to the simplest case of difference-in-difference set-up with only two periods (2018 and 2021) and continuous treatment, that is, *Ln green inv.pc.*

The most important concern with a short panel t=2 is that we cannot control for what happens to the probability to adopt SLB, and other issues negotiated therein, in years before the period of interest. In other words, if the probability to implement decentralised bargaining was also changing before the period of interest, we cannot guarantee that green investments are the only cause for that. Since we have information dating back to 2015 for all variables used in our empirical analysis, except for green investments, we perform a *common trend test* on a further restricted sample of companies including 3 years. The short panel data specification for t=3 reads as follows:

$$Y_{i,t} = \alpha_i + \kappa Year2021 + \lambda(\mathrm{Ln\ green\ inv.\,pc} \cdot Year2021) + \tau Year2018 + \xi(\mathrm{Ln\ green\ inv.\,pc} \cdot Year2018) + \vartheta^{pd3} \cdot F_{i,t} + \gamma^{pd3} \cdot M_{i,t} + \delta^{pd3} \cdot W_{i,t} + \varepsilon_{i,t} \quad [4]$$

where i=1, …4,065 companies and t=2015, 2018 and 2021 years. All other variables are similar to those reported in equation [3], with the exception of an additional year dummy (2018) and the interacted term $(\mathrm{Ln\ green\ inv.\,pc} \cdot Year2018)$. Non-statistically significance of the coefficient ξ, signals that for firms investing in green technologies the probability to change industrial relations was not affected by other factors in the years 2015-2018, that is, before our period of interest. In other words, this additional interaction term allows us to perform a *common trend test*.

5. Results

5.1 Baseline specification

Estimates for the baseline OLS regressions described by equation [1] are reported in table 2. Besides the variable of interest (green investments per capita, *Ln green pc*), in this table we show the effects of selected control variables capturing important confounding factors that may have interfered with changes in industrial relations during the period of interest (2019-2021). However, all the control variables about firm, management, and workforce characteristics, which we have already discussed in descriptive statistics (table 1), have been included in this regression, besides industry-, and region-fixed effects. This guarantees that we control for a great number of potential confounding factors and that the model, overall, is well specified. To make table 2 readable, we have just omitted all these controls that remain available upon request.

As for our key explanatory variable, table 2 informs us that one log point increase in the green investment per capita significantly increases the probability to adopt SLB by 0.011. This result remains stable when we focus on the most important aspect negotiated in these agreements, that is, green investments also increase the probability to adopt performance pay schemes by 0.012. This is the first preliminary sign that our conjectures H1 and H2.a are confirmed. In other words, environment-friendly behaviours across businesses seem to be associated with changes in industrial relations, especially those related to wage incentives that play the most important role in firm-based negotiations with the workforce. In addition, the adjustments required for a just transition are not only limited to monetary incentives but also concern welfare benefits (H.2b) and working time arrangements (H3), even though the magnitude of these impacts is more limited (0.007 and 0.008 respectively)[10].

Importantly, the results discussed above for our key explanatory variable hold controlling for confounding factors that significantly contributed to explaining industrial relations with the expected signs. For example, investing in at least one I4.0 technology (*digital tech*) significantly increases the probability to adopt SLB; more in detail, we obtain that the effective implementation of digital technologies that require more participation from workers is obtained with negotiations on monetary incentives and non-monetary issues that likely affect job quality (Berg *et al.* 2023; Lévesque *et al.* 2020). Independently from specific I4.0 technologies, a similar positive role is played by the intensity of Covid-19 State aids. Indeed, the importance of this subsidy was strictly related to the possibility to improve employee involvement at the workplace level in an extraordinary period, through aspects negotiated in the second level bargaining, such as rearranging worker compensations, working time, and welfare benefits (Biasi 2020).

[10] All results above and their statistical significance are also confirmed if we use a dummy variable for green investments (1/0) instead of their monetary amount. Tables for these findings are available upon request.

Table 2. OLS estimates (linear probability model)

	II level bargaining (SLB)			
	Total	**PRP**	**Worked hours**	**Welfare services**
Ln (green pc)	0.011***	0.012***	0.008***	0.007***
	(0.002)	(0.001)	(0.001)	(0.001)
Digital tech	0.047***	0.052***	0.028***	0.032***
	(0.007)	(0.007)	(0.006)	(0.005)
Covid State aids (pc)	0.032***	0.023***	0.022***	0.008**
	(0.005)	(0.004)	(0.004)	(0.004)
Ln(Sales per capita)	0.001	0.002	-0.001	0.006***
	(0.003)	(0.002)	(0.002)	(0.002)
Other Firm controls	*Yes*	*Yes*	*Yes*	*Yes*
Management controls	*Yes*	*Yes*	*Yes*	*Yes*
Workforce and firm controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry and Region FEs	*Yes*	*Yes*	*Yes*	*Yes*
Obs	13262	13262	13262	13262
R2	0.192	0.221	0.109	0.118

Note: all dependent variables are binary (0/1). Total refers to firms adopting SLB, whereas PRP, worked hours, and welfare services, are firms negotiating performance-related pay, hours, and welfare benefits, respectively. Other Firm Characteristics, Management characteristics, and Workforce and firm size controls include all variables reported in table 1, firm size (N employee), and its quadratic term. Industry and Region FEs include 2-digit industry and 110 province fixed effects. All OLS estimates were performed with Correia's Multi-Way fixed effect estimator (2016). Robust standard errors are in parentheses. Statistical significance: *** at 1%, ** at 5%, and * at 10%.
Source: Authors' elaborations on RIL 2022 data

5.2 Tackling endogeneity issues

Despite the large set of control variables, there is no guarantee that the estimated coefficients of green investments are not biased by reverse causality and other endogeneity problems. The results for the IV-2SLS strategy discussed in section 4 are reported in table 3, where green investments per capita have been instrumented with firms issuing WhC (Panel a) or with firms declaring they would have not made investments without the possibility to issue a WhC (that is, the WhC-Counterfactual in Panel b). All control variables used in the baseline regression are also used in the IV regression, even though they have been omitted from table 3 to improve the readability of the latter. All results for control variables are available upon request.

First, the first-stage statistics show that both instruments are strongly correlated with the endogenous variable (*Ln green pc*) and pass the first-stage F -statistic used to test for the weakness of instruments and weak identification (F statistics above 10). Second, all the estimated coefficients for the variable of interest *Ln green pc* remain significant with the expected sign and quite consistent, in their magnitude, with what we observed in the OLS regressions. For example, one log point increase in green investments boosts the probability to introduce SLB by 0.087-0.089 and, in line with previous estimates, the performance pay scheme remains the most important aspect favoured by this investment activity, as the probability to implement PRP increases by 0.078-0.077, while working time arrangements and welfare services effects are 0.042-0.057 and 0.057-0.033, respectively.

Table 3. Cross-sectional IV-2SLS estimates (linear probability model)

Panel a: Instrument WhC	**II level bargaining (SLB)**			
	Total	**PRP**	**Worked hours**	**Welfare services**
Ln (green pc)	0.087*** (0.015)	0.078*** (0.014)	0.042*** (0.013)	0.057*** (0.013)
Other Controls	Yes	Yes	Yes	Yes
Industry and Region FEs	Yes	Yes	Yes	Yes
Obs	13262	13262	13262	13262
	First stage statistics			
Instrument				
WhC	*3.050*** *[0.000]*			
Kleibergen-Paap F	*98.141*			

Panel b: Instrument WhC	**II level bargaining (SLB)**			
	Total	**PRP**	**Worked hours**	**Welfare services**
Ln (green pc)	0.089*** (0.027)	0.077*** (0.026)	0.057** (0.024)	0.033* (0.019)
Other Controls	Yes	Yes	Yes	Yes
Industry and Region FEs	Yes	Yes	Yes	Yes
Obs	13262	13262	13262	13262
	First stage statistics			
Instrument				
WhC-Counterfactual	*2.946*** *[0.000]*			
Kleibergen-Paap F	*25.063*			

Note: all dependent variables are binary (0/1). Total refers to firms adopting SLB, whereas PRP, worked hours, and welfare services, are firms negotiating performance-related pay, hours, and welfare benefits, respectively. *Other controls* include all covariates already used for OLS baseline regression (see tables 1 and 2). Industry and Region FEs include 2-digit industry and 110 province fixed effects. All IV-2SLS estimates performed with the Correia's Multi-Way fixed effect estimator (2016). In *Panel a,* Ln (green pc) has been instrumented with firms issuing white certificates (*WhC*), whereas in *Panel b* we used as instrument companies having declared they would have not made green investments without issuing white certificates (*WhC-Counterfactual).* First stage statistics only report the coefficients for excluded instruments (*WhC* and *WhC-Counterfactual)*, while results for all other covariates (*Other controls)* have been omitted to improve the table readability and are available under request. *Kleibergen-Paap F statistics* above 10 is a good sign for no weak identification and therefore inform us about the relevance of the instruments (Baum *et al*. 2003). Robust standard errors are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2021 data

5.3 Panel data estimation

In the last step of our empirical analysis, we perform further robustness checks by testing if green investments significantly changed the probability to adopt SLB and single aspects negotiated therein between 2018 and 2021 (equation 3), and we performed a common trend test by extending back the period to 2015 (equation 4). As already explained in section 4, we use in this case two restricted samples (6,712 and 4,065 companies in equations 3 and 4, respectively, instead of 13,262) allowing us to exploit short panel data structures. The results reported in table 4 refer to equation 3 (6,712 companies) and show that one log point increase in green investments boosts the probability to adopt

SLB by 0.3 percent (at the ten percent level of statistical significance). Also performing the *common trend test* as established in equation 4 (see the results referring to 4,065 companies in table 5) does not change our main result for SLB. In this case, one log point increase in green investments significantly boosts the probability for SLB by 0.6 percent (see the coefficient of $\mathrm{Ln\ green\ inv.\ pc} \cdot Year2021$), whereas nothing was changing in this probability between 2015 and 2018, given the no statistical significance for the coefficient of $\mathrm{Ln\ green\ inv.\ pc} \cdot Year2018$. Thus, H1 is confirmed also when the unobserved heterogeneity of companies is considered. We do not only investigate what happens between 2018 and 2021 in the same firms but also control that between 2015 and 2018 there were no confounding factors that invalidated this result. Interestingly, both the results for pecuniary incentives (PRP) and other welfare benefits (H2.a and H2.b) find confirmation and were revealed to be crucially explained by green investments, as their probability to be adopted increased by 0.5 and 0.4 percent, respectively (see table 4). This occurs despite the Covid crisis (captured by the dummy *year 2021*) having an opposite impact on industrial relations, i.e., it depressed the implementation of wage bonuses, as expected, while favoured welfare benefit provisions, for example, those related to work-life balance settings and required by smart working. These latter results also have been confirmed by the *common trend test* and the sensitivity analysis, as they are statistically significant with the expected sign in the short panel data regression (t=3) performed in the smaller subsample (table 5).

By contrast, our conjecture H3, related to the positive effects of green investments on working hours negotiated in SLB, has not been confirmed in the panel data specifications (tables 4 and 5). This result probably suggests that multidimensional issues such as those negotiated for welfare benefits, besides pecuniary incentives, were more important than simpler provisions, such as arrangements in working hours. It is likely also because in the Italian context SLB may modify aspects linked to working hours, but only within the perimeters set by the sectoral national contracts. Derogations from these national contracts, by exploiting the Article 8 of the Law 148/2011 (D'Amuri and Nizzi 2018), have favoured mainly the adoption of temporary contracts, rather than adjustments in working time (Damiani *et al.* 2020).

Table 4. Difference in difference estimates with fixed effects

	II level bargaining (SLB)			
	Total	**PRP**	**Worked hours**	**Welfare services**
Ln (green pc) *2021	0.003* (0.002)	0.005*** (0.002)	0.001 (0.002)	0.004** (0.002)
year 2021	-0.008 (0.007)	-0.016*** (0.005)	-0.003 (0.005)	0.011** (0.005)
Other controls	Yes	Yes	Yes	Yes
Firms fixed effects	Yes	Yes	Yes	Yes
N. of firms	6712	6712	6712	6712
R2	0.643	0.684	0.443	0.423

Note: all dependent variables are binary (0/1). Total refers to firms adopting SLB, whereas PRP, worked hours, and welfare services, are firms negotiating performance-related pay, hours, and welfare benefits, respectively. *Other controls* include all covariates already used for OLS baseline regression (see tables 1 and 2) with the exception of Industry and Region FEs, due to their no-time-varying nature. Robust standard errors (clustered at the firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5%, and * at 10%.
Source: Authors' elaborations on RIL 2021-2018 longitudinal data

Table 5. Difference in difference estimates with fixed effects and common trend test

	II level bargaining (SLB)			
	Total	**PRP**	**Worked hours**	**Welfare services**
Ln (green pc) *2021	0.006**	0.008*	0.002	0.006*
	(0.003)	(0.002)	(0.002)	(0.002)
Ln (green pc) *2018	0.004	0.006	-0.001	0.004
	(0.003)	(0.002)	(0.002)	(0.002)
year 2021	0.007	-0.020	0.005	0.045**
	(0.009)	(0.007)	(0.006)	(0.008)
year 2018	0.017**	-0.008	0.005	0.024*
	(0.008)	(0.006)	(0.004)	(0.006)
Other controls	*Yes*	*Yes*	*Yes*	*Yes*
Firms fixed effects	*Yes*	*Yes*	*Yes*	*Yes*
N. of firms	4065	4065	4065	4065
R2	0.649	0.641	0.442	0.332

Note: all dependent variables are binary (0/1). Total refers to firms adopting SLB, whereas PRP, worked hours, and welfare services, are firms negotiating performance-related pay, hours, and welfare benefits, respectively. *Other controls* include all covariates already used for OLS baseline regression (see tables 1 and 2) with the exception of Industry and Region FEs, due to their no-time-varying nature. No statistical significance for the coefficient *Ln (green pc) *2018*, that is, a common trend test, informs us about the absence of other factors driving the probability to adopt SLB and aspects negotiated therein before the period of interest. Robust standard errors (clustered at the firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2021-2018-2015 longitudinal data

6. Conclusions

This study has started to reply to the research demand regarding the influence of green strategies on the quality of labour relations. We find that companies adopting environmental investments differ and they give significantly more space to collective decentralised bargaining. These contracts, signed with the intermediation of trade union bodies, offer wage premiums, welfare services, and agreements on working hours that likely enable organizational changes. Thus, our results are a first step to measuring social sustainability for the Italian economy and prove that the ecological and social dimensions of CSR are both feasible (Staniškienė and Stankevičiūtė 2018).

These findings have been obtained by exploiting our rich data set that offers information for different clean strategies adopted by the Italian firms and measured by the monetary amount disbursed between 2019 and 2021 for distinct categories of green investments to implement energy efficiency and savings, adoption of eco-friendly equipment, and circular economy.

The interest in the Italian case study relies on the consideration that this country is the second largest manufacturing country in Europe and that manufacturing, with respect to services, is a sector more populated by energy-intensive businesses (hard-to-abate companies). At the same time, Italy also features an old tradition of collective bargaining mediated by unions that has been mainly investigated from the industry-level perspective, which is the first level of bargaining (Berton *et al*. 2023). Our evidence related to the second-level agreements (at firm and territorial levels) indirectly shows that unions favour decentralised negotiations when they are triggered by green investments. It means that unions may not only be ‘defenders of the status quo’, but mediators of agreements that allow employees to participate in ‘just transition' processes.

Our research could benefit from additional evidence coming from other countries that may allow the generalizability of our results. Also, additional hypotheses and estimates could be useful to confirm the benefits of green investments on firm performance and the positive role of organizational changes on the productivity effects of green investments (Hottenrott *et al.* 2016; Rahko 2023).

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