INAPP

ISTITUTO NAZIONALE PER L'ANALISI DELLE POLITICHE PUBBLICHE

WORKING PAPER

INAPP WP n. 123

Green investments, training costs and performance-related pay: Are small and medium-large firms different?

Mirella Damiani
Fabrizio Pompei
Francesco Quatraro
Andrea Ricci

ISSN 2784-8701

LUGLIO 2024

Green investments, training costs and performance-related pay: Are small and medium-large firms different?

Mirella Damiani
Università degli Studi di Perugia, Dipartimento di Scienze Politiche, Perugia, Italia
mirella.damiani@gmail.com

Fabrizio Pompei
Università degli Studi di Perugia, Dipartimento di Economia, Perugia, Italia
fabrizio.pompei@unipg.it

Francesco Quatraro
Università di Torino, Dipartimento di Economia e Statistica "Cognetti de Martiis", Torino, Italia
BRICK, Collegio Carlo Alberto, Torino, Italia
francesco.quatraro@unito.it

Andrea Ricci
Istituto nazionale per l'analisi delle politiche pubbliche (INAPP), Roma, Italia
an.ricci@inapp.gov.it

LUGLIO 2024

Il working paper è stato realizzato nell'ambito del PTA Inapp 2022-2024, con riferimento alle linee di attività afferenti alla Struttura Imprese e lavoro.

INAPP – Istituto nazionale per l'analisi delle politiche pubbliche

Corso d'Italia 33	Tel. +39 06854471	
00198 Roma, Italia	Email: urp@inapp.gov.it	www.inapp.gov.it

ABSTRACT

Green investments, training costs and performance-related pay: Are small and medium-large firms different?

This paper analyzes the effect of green investment on workplace training and performance-related pay in small businesses. At this aim, we take advantage of microdata from a large representative survey of Italian firms. Using different econometrics models, we find the following results. First, the amount of expenditures on green technologies increases the probability of Performance-related pay especially in firms with more than 50 employees, even though a positive effect is also found in small firms. Conversely, green expenditures significantly increase the amount of training investment in small firms, while no effect is found in larger ones. Further, we show that different green technologies influence performance-related pay and training investments according to the firm size. These findings are robust to unobserved heterogeneity and endogeneity concerns. Finally, we discuss policy implications.

KEYWORDS: green investments, training, incentives
JEL CODES: 03, E24; M54

Lo studio analizza l'effetto dell'adozione di tecnologie 'verdi' sull'investimento in formazione professionale e sulla erogazione di premi salariali legati alla performance. Applicando diverse metodologie econometriche ai microdati forniti dalla Rilevazione su Imprese e lavoro (RIL), si ottengono i seguenti risultati. Primo, l'ammontare degli investimenti in tecnologie 'verdi' è associato a un incremento della probabilità di erogare premi salariali, soprattutto nelle imprese medio-grandi. Secondo, l'adozione delle tecnologie 'verdi' si accompagna a un aumento dell'investimento in formazione professionale specificamente nelle piccole imprese, mentre non si registra un effetto significativo nelle grandi realtà produttive. Tali evidenze si confermano quando si tiene conto di eventuali distorsioni legate a eterogeneità non osservata ed endogenità delle relazioni oggetto di studio. Infine, sono discusse le possibili implicazioni di politica economica.

PAROLE CHIAVE: *investimenti green, formazione, incentivi*
CODICI JEL: 03, E24; M54

DOI: 10.53223/InappWP_2024-123

Cite as:
Damiani M., Pompei F., Quatraro F., Ricci A. (2024), *Green investments, training costs and performance-related pay: Are small and medium-large firms different?*, Inapp Working Paper n.123, Roma, Inapp

1. Introduction

The debate about the labor market impacts of the green transition has gained momentum in the most recent years, both in academic and policy circles. The scholarly literature has stressed that the growing policy concern about climate change's dramatic consequences has engendered a significant shock for economic systems locked into carbon-based production technologies (Unruh 2000). Firms' creative response to this shock has led to increased investments in the adoption, and eventually in the generation, of green technologies following the established induced innovation dynamics (Ghisetti and Quatraro 2013; Johnstone *et al.* 2010; Schumpeter 1947; Barbieri *et al.* 2016; Rennings 2000).
More recently, following the contributions by Acemoglu and Autor (2011), an increasing number of studies have enquired into the skill-biased nature of green technological change (Vona *et al.* 2018; Consoli *et al.* 2016). Results show that, in fact, green occupations rely on high and medium technical and engineering skills, as well as on additional on-the-job training (Vona *et al.* 2018; Marin and Vona 2019; Saussay *et al.* 2022). This evidence raises important concerns about possible distributional effects generated by shifting directions in labor demand, leading to wage differentials and possible displacement effects for brown occupations (Vona 2023).
In this context, academic contributions have focused mostly on the detection of links between green transition and employment dynamics and on the possible policy implications, stressing that in the long run, the net effects can be positive due to job-creation effects (Gagliardi *et al.* 2016; Horbach and Janser 2016). In addition, empirical evidence has shown that brown occupations are not too far in the skills space from green occupations, suggesting that training and reskilling can be viable solutions to cope with the threat of displacement effects (Popp *et al.* 2022; Saussay *et al.* 2022).
This literature suggests that from the firm's viewpoint, addressing the skill bias engendered by green innovative investments can rely on two main approaches to strategic human resources management whereby the renewal of internal capabilities is based, on the one hand, on labor markets and new hirings or, on the other hand, on the reskilling and upskilling of the extant workforce. Yet, to the best of the authors' knowledge, there is no empirical literature exploring how firms manage their human resources when they decide to align to the ecological transition by means of new investments.
This paper aims to fill this gap by looking at how firms' green investments drive the use of two important tools firms may leverage either to attract new skilled workers in the labor market or to update the skills set of workers that are already within their boundaries. These tools are, respectively, performance-related pay (PRP) schemes and vocational training expenditures. In investigating these relationships, we posit that small firms are expected to differ from medium-large ones because of the different structure of employer-employee relations in terms of social proximity (Coetzer *et al.* 2023; Deshpande and Golhar 1994; Lähdesmäki *et al.* 2019). These differences led us to hypothesize that green investments drive training investments in small firms, while medium-large firms are expected to rely on PRP schemes more than small ones.
The analysis is based on the three last available waves of the RIL survey (2015, 2018, and 2021) conducted by the National Institute for Public Policy Analysis (Inapp) on a representative sample of partnerships and limited liability Italian firms. Our results show that green investments induce the use of PRP in both small and medium-large firms, though the magnitude of the effect is very low, while

they induce training investments exclusively in small firms, the effect being ten times higher than that observed for PRP. We also dig into the heterogeneity of green investments, finding that investments in new technologies drive the adoption of PRP schemes. While all the considered types of green investments show a positive relationship with firms' training costs, the highest elasticities can be observed in the case of circular economy and energy-efficiency investments.

The contribution of this paper to the literature is twofold. On the one hand, we add to the literature on the distributional effects of the green transition by investigating the response to the skill bias from the firm's perspective. On the other hand, we provide evidence of differential effects in small vis-à-vis medium-large firms, pointing to the need for customized policies supporting training investments for the reskilling of skilled workforce.

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. Theoretical framework

An increasing body of literature has investigated the labor market implications of the green transition. Some studies have dealt with the impact of employment, focusing on the effects of stringency in environmental regulations and the introduction of eco-innovations. These studies report mixed evidence, which points in some cases to positive and significant effects, while in other cases, the impact is found to be negative or not statistically significant. The main reason behind such heterogeneity of findings can lie in the differences among sectors in terms of the prevalence of job creation and job destruction effects (Yi 2014; Horbach 2010; Consoli *et al.* 2016; Gagliardi *et al.* 2016). Besides the quantitative appraisal of the nexus between innovation, environment, and employment, other research has dug into the assessment of the changes induced in qualitative dimensions of employment. Based on the well-established task-based approach, extant literature has investigated the skill bias that characterizes the green transition and eco-innovation strategies. It has been shown that green occupations mainly require high and medium technical and engineering skills and additional on-the-job training. Brown skills, though not too far from the green ones in the skill space, are unsuitable for immediate reuse and adaptation to accompany firms' decisions to align with the dictates of the environmental turn (Vona *et al.* 2015; Consoli *et al.* 2016; Vona *et al.* 2018; Popp *et al.* 2022; Buyukyazici and Quatraro 2024).

This evidence casts important doubts on the capacity of firms to effectively manage eco-innovation without the necessary complementary skills that feature green occupations. Green investments may, hence, turn out to be ineffective due to the difficulties in integrating new green routines and technologies within contexts locked into carbon-based capabilities. Extant literature on skill shortages and mismatch has stressed that firms' responses can be heterogeneous. On the one hand, firms can decide to substitute up-to-date skills for obsolete ones by resorting to the labour market. This translates into increased churning rates for skilled and highly skilled workers and requires the capacity to offer appealing remuneration schemes. On the other hand, firms can decide to upgrade the existing skill bundle to make it coherent with the requirements of new technologies and routines. This translates into offering dedicated training schemes and reskilling programs (Black and Lynch 2001; Bauer and Bender 2004; Cappelli 2015; Bosworth 1993; Healy *et al.* 2015).

Regarding the relationship between skills and remunerations, extant literature focuses on workers' educational attainment, showing the existence of a wage premium for skilled employees (Walker and Zhu 2008; van der Velden and Bijlsma 2016). Consistently, it has been found that workers in green-intensive jobs earn, on average, 7% more than workers in pollution-intensive jobs (Bluedorn *et al.* 2023). The wage setting dynamics play hence an important role in firms' strategies to attract skilled workers, even when green skills are at stake. In this direction, sorting effects may be induced by using human resource management practices affecting individual wages. The performance-related pay (PRP) allows workers to receive a part of their salary based on individual, team or firm performance, and firms use this kind of incentive to attract, and retain the most able employees, widening the wage gap between skilled and unskilled workers. The adoption of PRP practices, therefore represents one of the most widespread strategies firms adopt to accommodate the need for a skilled labor force and to contrast poaching (Prendergast 1999; Cadsby *et al.* 2007; Holmström 2017; Lazear 2000; 2018).

The intersection of the wage-skills relationship with the evidence about the heterogeneity of wages across firms' size distribution raises the question of whether small and large firms differ as far as the capacity to attract skilled workers is concerned. Several studies, in fact, report evidence of wage gaps associated with firms' size, showing that large firms are likely to play supernormal wages, as compared to small firms. Though several reasons are proposed to explain this stylized fact, the most credited explanations refer to the higher productivity of large firms and their attractiveness for skilled workers due to better working conditions and benefits (Oi and Idson 1999; Fox 2009; Haltiwanger *et al.* 2018; Winter-Ebmer and Zweimüller 1999; López Novella and Sissoko 2013).

These arguments have been proposed as rationale for explaining differences between large and small firms in terms of exploitation of PRP incentives. Large firms may decide to offer PRP schemes because they need the most talented and skilled workers to keep their productivity at the highest levels possible (Helpman *et al.* 2010; Schmidt and Zimmermann 1991; Gabaix and Landier 2008; González *et al.* 2022). In view of the discussion conducted so far, we can spell out our first working hypothesis as it follows:

H1: PRP schemes are used more by large than by small firms to match investments in the green domain.

Human resources management practices are crucial to cope with changing production and organizational environments in the wake of the green transition. While monetary incentives like PRP schemes are effective in attracting and retaining the most skilled and productive workers, they have no clear impact on employees' skill sets. This implies that when radical industrial and technological transformations occur, firms, especially large ones, are expected to use monetary incentives to cope with skills mismatches by hiring new workers and triggering worker turnover.

Yet, monetary incentives represent only one of the possible human resources management levers that a firm can use in these contexts. A rather wide body of literature has stressed that small firms are substantially different from their large counterparts also concerning the selection of practices from such a broader range of options. In particular, small firms are expected to show a weaker attitude toward worker turnover than large firms. This is due to the specific characteristics of the working environment, which in small firms is characterized by a stronger sense of community, social proximity and job embeddedness. In these contexts, small firms tend to reduce the odds of separation (Kotey and Slade 2005; Marlow *et al.* 2010; Storey *et al.* 2010; Coetzer *et al.* 2017; Mitchell *et al.* 2001; Coetzer *et al.* 2019; Josefy *et al.* 2015).

Even though some studies have stressed that small firms may underspend in formalized training because of financial constraints and of the poaching risk on trained workers, an increasing body of literature has stressed that most successful small firms provide more training than the average (Kotey and Folker 2007; Cardon and Valentin 2017; Kotey and Slade 2005; Coetzer *et al.* 2023; Coetzer and Perry 2008).

To cope with skill-biased changing economic conditions and preserve incumbent workers from job displacement dynamics, small firms are therefore expected to adopt human resources development strategies based on informal learning and formalized training activities. Training represents, indeed, a strategic lever to integrate and upgrade workers' knowledge and align skills with new requirements induced by organizational and technological changes. Training investments, in this respect, turn out to be more effective than any other human resource management strategy (Ahadi and Jacobs 2017; Jacobs 2014; Campbell and Kuncel 2002; Fan and Wei 2010).

In view of these arguments, we can spell out our second working hypothesis as follows:

H2: Training investments are borne more by small than large firms to match investments in the green domain.

3. Empirical setting

3.1 Data

Our analysis is based on the RIL survey conducted by Inapp on a representative sample of partnerships and limited liability firms. Each survey covers over 30,000 firms operating in the non-agricultural private sector. It collects a rich set of information about management and workforce characteristics, firms' productive specialization and strategies, green enterprises' strategies, and innovation in digital technologies[1].

What is worthwhile for our purposes is that the VI wave of the RIL survey includes a specific set of questions designed to collect information on the characteristics and the amount of expenditure for green investments over the period 2019-2021. In particular, we collect data on the following typologies of green technologies: i) *energy efficiency* (including those activities 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).

Further, the RIL survey adds detailed information on management and corporate governance, workforce composition, industrial relations, firms' performance, productive specialization, and many

[1] For further details, see: https://www.inapp.gov.it/rilevazioni/rilevazioni-periodiche/rilevazione-imprese-e-lavoro-ril.

other characteristics that may shape the relationship between green investments and competitiveness.

As for sample selection, we excluded from our analysis micro-firms with less than five employees to keep productive units with a minimum level of internal organization. In addition, once we keep observations with no missing values on the key variables, our cross-sectional sample is about 18,000 firms operating in 2021. Finally, we use the longitudinal sample of RIL surveys, which amounts to around 13,000 companies operating in both 2021 and 2018 and to 5,000 companies once we focus on those companies found in 2015, 2018, and 2021.

3.2. Descriptive statistics

Tables 1 and 2 show descriptive statistics for small and no-small firms, respectively.

We distinguish these statistics by cross-sectional (T=1) and longitudinal samples (T=2 and T=3) to provide a descriptive picture coherent with our econometric strategy.

For the main variables of interest in our study, dimensional aspects explain a high degree of heterogeneity among Italian firms.

42% of large firms adopt investments in green technologies, while the corresponding share of small firms implementing these technologies is only half, around 20%.

A significant disparity is also recorded for the expenditure on these investments. Cross-sectional data (T=1) show an amount of around 600 euros per capita for large firms, and higher values (about 730 euros) are recorded by the longitudinal data (T=3) because of sample selection. Small firms' corresponding per capita expenses are only about 320 euros (T=1) and 420 euros (T=3).

Tables 1 and 2 also provide some descriptive evidence for our outcome variables, the adoption of second level bargaining (SLB), performance-related payments (PRP), and workplace training.

As expected, the diffusion of SLB in small companies is only one-fifth of that present among larger companies. Even more marked is the different diffusion of PRP schemes. These payments are present in 25% of larger companies and instead are adopted in only 3% of small businesses.

It must be recalled that the Italian regulation of collective bargaining features a two-tier bargaining framework based on national sector-wide agreements (the first level) and agreements at either the company or territorial levels (the second bargaining level SBL). Through the SLB, each firm may adopt a discretional pay policy but cannot negotiate ‘in menus’, allowing only higher wages than those established at the first level. In this setting, SLB permits the adoption of PRP as an incentive policy to attract and retain more highly skilled workers (Lazear and Oyer 2007). However, designing reward systems requires professional practices and for small firms, high-level technical competencies for implementing these incentive schemes are often not affordable.

On the other hand, small businesses that can offer lower compensations and fewer career opportunities deal with more difficulties in recruiting the needed skills from the external market (Berton *et al.* 2023). These firms cannot adopt a wage bonus policy as an incentive to select and retain the most qualified workers and must make the recourse to skill formation within the workplace. Also notice a divide between firms in terms of formal education as, on average, small firms have a lower share of tertiary-educated workers, 26,2% vs the corresponding share of 46,8% featuring the larger ones. All these concerns may help to explain why small businesses spend relatively more on training their workers. As shown by table 1, the share of small businesses that adopt training programs is about

60% (78,6% in larger firms), while their expenses for each worker are about 96% of the payments of larger companies.
The overall weakness of small Italian firms is confirmed by their lower share of innovative and exporting units. Enterprises that originated new products were only 26% in 2021, well below the share of larger ones (49%), and the proportion of small companies that carry out product innovation does not reach 20%, a figure lower than that recorded for larger ones (33%).
Dimensional aspects are also associated with the distribution of firms owned and managed by families, which, as expected, decreases with firm size.

Table 1. Descriptive statistics on small firms

	T=1		T=2		T=3	
	Mean	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
			Key variables			
SLB	0.068	0.252	0.071	0.257	0.071	0.257
PRP	0.037	0.188	0.043	0.204	0.046	0.209
Training investment (0/1)	0.599	0.490	0.627	0.484	0.563	0.496
Training costs pc*	186.2	449.4	170.9	374.9	154.1	354.9
Green technologies (0/1)	0.208	0.406	0.231	0.421	0.228	0.419
Green expenses pc*	318.5	1719.7	355.5	1814.6	420.4	2021.9
			Management characteristics			
Tertiary education	0.262	0.440	0.258	0.438	0.262	0.440
Upper secondary education	0.547	0.498	0.568	0.495	0.540	0.498
Female	0.178	0.382	0.133	0.339	0.139	0.346
Family ownership	0.850	0.357	0.872	0.334	0.887	0.317
			Workforce characteristics			
Share of executives	0.033	0.080	0.041	0.087	0.039	0.088
Share of white collars	0.328	0.296	0.361	0.300	0.372	0.300
Share of ble collars	0.639	0.318	0.598	0.321	0.589	0.321
Share of FT contracts	0.101	0.189	0.127	0.184	0.109	0.179
Share of female	0.302	0.251	0.347	0.258	0.332	0.261
Share of hirings	0.208	0.242	0.166	0.197	0.132	0.193
Share of separations	0.164	0.232	0.113	0.173	0.109	0.180
			Firms characteristics			
Foreign markets	0.261	0.439	0.317	0.465	0.332	0.471
Public procurement	0.318	0.466	0.284	0.451	0.311	0.463
Product innovation	0.180	0.384	0.338	0.473	0.309	0.462
Process innovation	0.202	0.402	0.331	0.471	0.287	0.453
Ln(firms age in years)	3.021	0.775	3.128	0.787	3.337	0.533
Ln(sales per employee)	11.687	1.235	11.749	1.300	11.860	1.225
Ln(n of employee)	2.811	0.462	2.945	0.439	2.906	0.460
N of obs	7181		4591		4421	

Note: sampling weights applied. * in euros.
Source: Authors' elaborations on RIL data

Table 2. descriptive statistics on no-small firms

	T=1		T=2		T=3	
	Mean	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
	Key variables					
SLB	0.333	0.471	0.356	0.479	0.366	0.482
PRP	0.254	0.435	0.282	0.450	0.297	0.457
Training investment (0/1)	0.786	0.410	0.794	0.405	0.772	0.420
Training costs pc*	194.8	349.3	185.9	321.2	187.7	346.7
Green technologies (0/1)	0.420	0.494	0.408	0.492	0.440	0.496
Green expenses pc*	598.7	2083.9	600.5	2081.4	734.3	2356.1
	Management characteristics					
Tertiary education	0.478	0.500	0.450	0.498	0.455	0.498
Upper secondary education	0.413	0.492	0.429	0.495	0.421	0.494
Female	0.126	0.332	0.110	0.313	0.115	0.319
Family ownership	0.559	0.497	0.585	0.493	0.613	0.487
	Workforce characteristics					
Share of executives	0.051	0.094	0.054	0.091	0.050	0.082
Share of white collars	0.374	0.293	0.375	0.281	0.364	0.274
Share of blue collars	0.575	0.325	0.571	0.315	0.586	0.305
Share of FT contracts	0.091	0.142	0.108	0.154	0.101	0.150
Share of female	0.305	0.241	0.315	0.241	0.314	0.245
Share of hirings	0.193	0.212	0.164	0.192	0.145	0.188
Share of separations	0.143	0.194	0.124	0.180	0.111	0.173
	Firm characteristics					
Foreign markets	0.493	0.500	0.543	0.498	0.544	0.498
Public procurement	0.341	0.474	0.313	0.464	0.323	0.468
Product innovation	0.336	0.472	0.434	0.496	0.455	0.498
Process innovation	0.300	0.458	0.409	0.492	0.417	0.493
Ln(firms age in years)	3.302	0.675	3.377	0.621	3.446	0.559
Ln(sales per employee)	11.934	1.412	12.001	1.413	11.925	1.365
Ln(n of employee)	4.739	0.810	4.724	0.755	4.747	0.787
N of obs	4263		4454		4004	

Note: sampling weights applied. * in euros.
Source: Authors' elaborations on RIL data

3.3. Econometric strategy

We estimate the following linear relationship:

$$Y_{i,t} = \beta_0 + \beta_1 \cdot GI_i + \beta_2 \cdot (GI_i \cdot year_{2021}) + \beta_3 \cdot (GI_i \cdot year_{2018}) + \gamma \cdot M_{i,t} + \delta \cdot W_{i,t} + \vartheta \cdot F_{i,t} + \lambda_t + \alpha_i + \varepsilon_{i,t} \quad [1]$$

where outcome $Y_{i,t}$ is the (log of) training costs per employee and the probability of performance-related pay agreements for each i firm at year t. Our key explanatory variable GI_i represents ‘extensive’ and ‘intensive’ measures of green investment, that is the probability of adopting green technologies over the period 2019-2021 and the amount of financial resources invested in green technologies per employee in 2021. Further, we exploit the effect of the heterogeneity of green technologies, namely investing in productive and efficiency gains, resource savings, technological developments, and circular productive processes.

As for other controls, the vector $M_{i,t}$ stands for managerial and corporate governance characteristics, $W_{i,t}$ formalizes the workforce composition and $F_{i,t}$ includes a wide set of firms' productive characteristics, geographical location and sectorial specialization (all these covariates will be discussed in the descriptive section; for further details see table B.1 in appendix). Furthermore, the parameters λ_t are year-fixed effects, α_i is firms' time-invariant unobserved heterogeneity and $\varepsilon_{i,t}$ is the idiosyncratic error term with zero mean and finite variance.

As the first step, we perform cross-sectional OLS regressions of the equation [1] by imposing t=2021 and the parameter β_2=β_3=0. The resulting estimate of the coefficient β_1 is unbiased if time-invariant unobserved heterogeneity and endogeneity issues do not affect the choice of green investing and the firm outcomes. Or, put it differently, if the inclusion of a wide set of firm-level controls works well in netting out omitted variables and reverse causality concerns.

However, this might not be the case for different reasons. For instance, implicit cultural norms and unobservable managerial characteristics that shape firm strategies in human resource organization, training and cooperative industrial relations may also affect the adoption of green technologies (Bloom and Van Reenen 2010; Bloom *et al.* 2019). Moreover, expenditures on green transition may reflect firm performance and innovation capabilities, which, in turn, mirror the past accumulation of human capital and productivity at the workplace. Then, firms that experienced higher training and second-level bargaining agreements to bargain over productivity gains may be favored in embracing the ecological transition, inducing a source of potential endogeneity.

Based on these arguments, we exploit the longitudinal component of the RIL surveys to control for a rich set of firm-level observational data on both treatment and control groups in the pre- and post-investment periods.

We run difference-in-difference fixed effect models of the equation [1] over the two-period panel sample by allowing β_1=β_3=0 and t=2021,2018. In this case, the diff-in-diff Fes estimates of the coefficient β_2 deal with firms' time-invariant unobserved heterogeneity and short-run variation of observed controls, a feature of great importance considering that the outbreak of the Covid-19 health crisis affected the pattern and the nature of the human resource organization and other feature of the internal labor market (Bratti *et al.* 2024).

Finally, we run the difference-in-difference Fes models imposing no parameter restrictions and relying on the three-period longitudinal sample, t =2015,2018, 2021. Analogously, the time indicator year 2021 represents the post-treatment period, and the year 2018 remarks the pre-treatment period while the omitted year 2015 is the reference period.

Therefore, the diff-in-diff FEs estimates of the parameter β_2 associated with the interaction term $GI_i \cdot year_{2021}$ identify the effect of green technologies on the log of training costs and probability of implementing PRP. Here, the crucial assumption to obtain unbiased estimates of β_2 is to verify the Common Trend Assumption (CTA) which implies that parallel trends in the outcome of treated and control firms should be observed in the absence of treatment. If CTA holds, the diff-in-diff estimator has the advantage of removing any common period effects influencing the treatment and control groups in identical ways[2].

Note that by including a broad set of controls for managerial, organizational, and corporate features, as well as firm internationalization and innovation, we claim to reduce omitted variable biases. Of course, this strategy faces some limitations: for instance, we cannot track companies before 2019-2017 on green decisions.

4. Empirical results

In discussing results, we emphasize the split sample analysis where estimates are separately conducted for small and medium-large firms. Firm size heterogeneity plays an important role in studying the impact of green technologies on PRP and training. This is evident starting from the results obtained on the whole sample, as shown in tables A.1, A.2, and A.3 in the appendix.

4.1 Main results

Table 3 reports cross-sectional and longitudinal estimates for performance-related pay in small firms (columns 1, 2, and 3) and no small firms (columns 4, 5, and 6)[3]. According to the OLS specification (columns 1 and 4), the intensity of green investments positively influences the probability of introducing performance-related pay schemes (PRP) only in non-small firms. One log point increase in the per capita green investment boosts the likelihood of adopting PRP by 1.4 percentage points (p.p.), whereas no effect is detected across small firms. However, these results may be biased by unobserved heterogeneity across companies. For this reason, we use 2-year (columns 2 and 5) and 3-year panel data (columns 3 and 6). The coefficient of interest here, ln(green exp pc)*2021, tells us that after introducing green technologies in 2021, companies experienced differential changes in the probability of adopting incentive pay schemes compared to their status in 2018 (0.4 and 0.6 p.p. in columns 2 and 5 respectively). We tested for the CTA assumption, as discussed in the previous section to ensure that these differential trends were not present before the period of interest. In other words, we use the interaction ln(green exp pc)*2018 to perform a *common trend test* and verify that there were no changes in the probability of adopting PRP between 2015 and 2018. We observe positive and significant coefficients for PRP probability changes in all firms that have introduced green technologies

[2] To put it differently, in equation [1], the year 2021 – the year of the survey wave collecting information about the green investments – is a time indicator for the post-treatment period, and 2018 remarks the pre-treatment period. The interaction term $GI_i \cdot 2021$ identifies the Diff-in-Diffs effect of GIs adoption. Our objective is to estimate the parameter B_2. Instead, $GI_i \cdot 2018$ allows us to verify the Common Trends Assumption (CTA) with respect to the initial period 2014. The CTA implies that we should observe parallel trends in the outcome variable for treated and control groups without treatment. If CTA holds, the Diff-in-Diffs estimator removes any time-varying effect influencing the treatment and control groups.

[3] Since PRP is a binary variable, all coefficients reported in table 3 are from a linear probability model. According to Wooldridge (2010) and many other econometricians, the linear probability model could produce biased coefficients if the predicted value for the probability of adopting PRP is out of the [0-1] range. This is not our case, as the large majority of predictions for our dependent variable falls in this range. Results from this test are available upon request.

only during the period between 2018 and 2021 and not before 2018. Indeed, the coefficient for ln(green exp pc)*2018 is not statistically significant, as shown in columns 3 and 6.

Table 3. Linear estimates. Dep var: performance-related pay

	Small firms			**Medium-large firms**		
	OLS	**Diff fe**	**Diff fe**	**OLS**	**Diff fe**	**Diff fe**
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**
Ln(green exp pc)	0.000 [0.001]			0.014*** [0.002]		
Ln(green exp pc)*2021		0.004* [0.003]	0.006** [0.003]		0.006** [0.002]	0.008* [0.004]
Ln(green exp pc)*2018			0.003 [0.003]			0.005 [0.004]
Year 2021		-0.006 [0.005]	-0.030*** [0.009]		-0.021** [0.009]	0.006 [0.016]
Year 2018			-0.020*** [0.008]			0.011 [0.014]
Share of hirings	-0.005 [0.013]	0.026 [0.021]	-0.011 [0.027]	-0.162*** [0.043]	-0.008 [0.039]	-0.019 [0.055]
Ln(sales per empl)	-0.002 [0.002]	0.004 [0.003]	0.003 [0.004]	0.008* [0.005]	0.002 [0.005]	0.001 [0.006]
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.002 [0.050]	-0.013 [0.109]	0.03 [0.188]	-0.034 [0.109]	-0.404 [0.249]	-0.027 [0.451]
Obs	7181	2163	1675	4263	5884	1498
R2	0.036	0.542	[0.450]	0.282	[0.680]	[0.650]

Note: management controls include education, gender, and ownership of who runs the firms; employment composition by professional status, gender, fixed term contracts, and hirings; firm productive characteristics by product innovation, process innovation, public procurement, and firm age (in years). All regressions include firms' size in classes, NACE sectors, and NUTS 2 regions fixed effects. Robust standard errors (clustered at firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2021-2018-2015 data

Therefore, our H1 is not confirmed, as no significant difference is detected between small and non-small firms when using a more robust econometric strategy based on diff-in-diff Fes estimates. This means that introducing green technologies in organizations often leads to changes in production and labour organization, regardless of the organization's complexity or size. To increase worker commitment and productivity, companies are willing to implement PRP schemes despite the cost and need for union involvement.

Interestingly, things change when we study the effects of the same green investments on per capita training expenditures incurred by companies (table 4). Although we still observe a similar pattern in the OLS specifications, where green investments induce more training activities in both small and non-small firms (columns 1 and 4), results become much clearer with the diff-in-diff Fes estimates (columns 2, 3, 5, and 6). Thus, after considering unobserved heterogeneity and other potential confounding factors, we find that adopting green technologies only stimulates additional investments in training in small firms, as conjectured in H2. This is because the coefficients of ln(green exp pc)*2021 are no longer statistically significant among the non-small firms (columns 5 and 6). In the case of small firms, instead, if we consider the one with a common trend test as our preferred model, we can observe that a 1 per cent increase in green investments stimulates an additional 0.083 per cent increase in training costs (column 3). It's possible that the transition towards a more environmentally friendly business model could have a greater impact on companies with less than 50 employees. For these businesses, implementing PRP to make those changes in the labour organization induced by green technologies more efficient and acceptable for workers may also require expensive training programs. As discussed in H2, training represents a strategic lever to integrate and upgrade workers' knowledge and align skills with new requirements induced by organizational and technological changes (Ahadi and Jacobs 2017; Jacobs 2014; Campbell and Kuncel 2002; Fan and Wei 2010). The well-known propensity to labour hoarding and to establish labour relations based on socio-emotional wealth in small and most frequently family-owned units could explain that it is likely in these small firms often operating in traditional industries that training activities are functional to the conversion from brown to green skills (Pompei *et al.*2018).

Table 4. Linear estimates. Dep var: (log of) training expenditures per employee

	Small firms			**Medium-large firms**		
	OLS	**Diff fe**	**Diff fe**	**OLS**	**Diff fe**	**Diff fe**
	[1]	**[2]**	**[3]**	**[1]**	**[2]**	**[3]**
Ln(green exp pc)	0.105***			0.048***		
	[0.015]			[0.010]		
Ln(green exp pc)*2021		0.077***	0.083**		-0.010	-0.012
		[0.028]	[0.042]		[0.016]	[0.022]
Ln(green exp pc)*2018			0.029			0.014
			[0.036]			[0.021]
Year 2021		-0.045	0.137		0.060	0.251**
		[0.081]	[0.114]		[0.074]	[0.100]
Year 2018			0.201**			0.167*
			[0.095]			[0.091]
Share of hirings	0.151	0.831**	0.928**	0.115	0.235	0.629
	[0.189]	[0.403]	[0.391]	[0.281]	[0.416]	[0.421]
Ln(sales per empl)	0.069**	0.018	0.061	0.023	0.057	0.015
	[0.027]	[0.048]	[0.043]	[0.028]	[0.039]	[0.036]
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	2.944***	3.379	0.04	3.531***	-2.927	2.201
	[0.620]	[2.287]	[2.386]	[0.593	[1.836]	[2.207]
Obs	7181	2163	1675	4263	2092	1498
R2	0.119	0.313	0.341	0.158	0.362	0.375

Note: management controls include education, gender and ownership of who run the firms; employment composition by professional status, gender, fixed term contracts, and hirings; firm productive characteristics by product innovation, process innovation, public procurement, and firms age (in years). All regressions include firms' size in classes, NACE sectors and NUTS 2 regions fixed effects. Robust standard errors (clustered at firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2021-2018-2015 data

4.2 Further results: heterogeneity of green technologies

In this section, we investigate whether different characteristics of green technologies exert a role in affecting the accumulation of human capital and performance-related pay in small firms as compared to medium and large ones. Actually, extant literature has stressed the need to focus on the idiosyncratic characteristics of different kinds of eco-innovative solutions, pointing to possible heterogeneous effects (Carrillo-Hermosilla *et al.* 2010; Kiefer *et al.* 2017; Horbach and Rammer 2020; Castellacci and Lie 2017; Caravella and Crespi 2020; Montresor and Quatraro 2020).

For instance, Ghisetti and Rennings (2014) decompose EIs into two typologies: energy and resource efficiency and externality-reducing innovations. They argue that the former are more likely to positively impact economic performance as they require a change in the resource bases and capabilities following the redesign of the production process. Horbach and Rammer (2020) focus on the impact of innovation for the Circular Economy transition on firms' turnover and employment, finding evidence of positive and significant effects, but only for firms below the median values of both dependent variables.

However, existing studies have not yet illustrated the role of different eco-technologies on the grounds of human capital accumulation and industrial relations at the workplace. Though this evidence makes it difficult to formulate an ex-ante hypothesis on how the heterogeneity of green investment induces a differentiated effect on training and performance-related pay, it suggests that it is worth digging into these dynamics.

To clarify, we first aim to determine if only certain categories of green technologies are responsible for implementing PRP and training activities or if there is no variation in the impact among these technologies, and they all contribute equally to the results mentioned earlier. Next, our goal is to examine if there are any differences in the patterns between small and non-small firms when heterogeneity across green technologies is considered. As already discussed, the bundle of green technologies includes the following four categories: i) energy efficiency, ii) green technological development, iii) resource-saving technologies, and iv) circular economy.

Table 5 presents the estimates of equation [1] for each green technology examined in relation to performance-related pay.

Columns [1] and [6] report estimates associated with the circumstance of having invested in at least one green technology over the period 2019-2021 in small and non-small firms, respectively. We observe findings that are coherent with those found for green expenditures in the previous section. In particular, in medium and large firms, the cross-sectional estimate equals +7.3 percent, while the diff-in-diff ones range between +3.7 percent (Panel B) and +5.6 percent (Panel C).

About the heterogeneity of green technologies, we find (T=2) that the circular economy is the only type of green investment that increases the PRP in small businesses. In contrast, the choice of technological developments in green transition and resource-saving technologies are the stronger factors behind the adoption of PRP in medium and large firms. In small firms, diff-in-diff estimates for CE are +4.0 percent in Panel B and +7.9 percent in Panel C (see column 5), while in the subsample of larger firms, the diff-in-diff results for green technological development (TD) amount to + 4.3 percent in Panel B and +5.8% percent in Panel C (see column 8).

In sum, Table 5 supports the hypothesis emerging from the literature discussed above (Ghisetti and Rennings 2014) that new ecologically friendly equipment and plants play a key role in large firms. Likely, in these large units, implementing eco-friendly new plants requires essential organisational changes and incentive pay schemes to make the adaptation of incumbent workers more accessible or even sorting new employees with the right skills. In small firms, investments to implement circularity strategies drive PRP schemes instead. This could be explained by product-related circular economy strategies, such as extending the lifespan of products (Horbach and Rammer 2020), which may encourage companies to retain employees and prioritise specific functions, such as maintenance activities. Again, this human resource management practice could be based on incentive pay schemes (PRP). The fact that these incentives are designed to support product innovations makes them more widespread among small firms (Vaona and Pianta 2008).

Table 5. Linear estimates by heterogeneity of green technologies. Dep var: performance-related pay

	Small firms					**No small firms**				
	Total	**EE**	**TD**	**RS**	**CE**	**Total**	**EE**	**TD**	**RS**	**CE**
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**	**[8]**	**[9]**	**[10]**
	Panel A: T=1 OLS estimates									
B1	0.016**	0.014*	0.015	0.028**	0.009	0.073***	0.060***	0.074***	0.060***	0.040*
	[0.007]	[0.008]	[0.010]	[0.012]	[0.014]	[0.013]	[0.014]	[0.016]	[0.017]	[0.021]
R2	0.037	0.037	0.037	0.037	0.036	0.280	0.278	0.279	0.277	0.276
	Panel B: T=2 diff in diff fe									
B2	0.012	0.008	0.022	0.020	0.040*	0.037**	0.031*	0.043**	0.042**	0.017
	[0.012]	[0.013]	[0.016]	[0.019]	[0.024]	[0.016]	[0.017]	[0.019]	[0.019]	[0.025]
Year 2021	-0.006	-0.005	-0.006	-0.005	-0.005	-0.035***	-0.029**	-0.031***	-0.028**	-0.020*
	[0.006]	[0.005]	[0.005]	[0.005]	[0.005]	[0.012]	[0.012]	[0.011]	[0.011]	[0.010]
R2	0.541	0.541	0.541	0.542	0.542	0.690	0.690	0.690	0.690	0.689
	Panel C: T=3 diff in diff fe									
B2	0.051***	0.038**	0.073***	0.067***	0.079**	0.056**	0.041	0.058*	0.033	0.052
	[0.016]	[0.019]	[0.019]	[0.026]	[0.038]	[0.026]	[0.027]	[0.030]	[0.033]	[0.038]
B3	0.028*	0.033*	0.037**	0.045*	0.047	0.026	0.006	0.022	-0.017	0.028
	[0.015]	[0.019]	[0.016]	[0.024]	[0.034]	[0.024]	[0.026]	[0.028]	[0.029	[0.037]
Year 2021	-0.038***	-0.032***	-0.034***	-0.030***	-0.029***	-0.007	0.004	0.003	0.012	0.012
	[0.010]	[0.010]	[0.010]	[0.009]	[0.009]	[0.019]	[0.018	[0.017]	[0.017]	[0.016]
Year 2018	-0.024***	-0.023***	-0.022***	-0.021***	-0.020***	0.008	0.018	0.014	0.024*	0.016
	[0.009]	[0.008]	[0.008]	[0.008]	[0.007]	[0.017]	[0.016]	[0.014]	[0.014]	[0.014]
R2	0.450	0.450	0.450	0.449	0.449	0.650	0.650	0.650	0.650	0.650
Other controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Note: EE= energy saving technologies; TD = technology development; RE= resource-saving technologies; CE=circular economy technologies. Other controls include education and gender of who runs the firms and family ownership; employment composition by professional status, gender, fixed term contracts, and hirings; firm productive characteristics by product innovation, process innovation, public procurement, and firm age (in years), number of employees (in classes), NACE sectors and NUTS 2 regions fixed effects. Robust standard errors (clustered at firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2022 data

Table 6 presents the estimates for various green investments when the result is the training cost per employee. The findings suggest that the diversity of green technologies has a greater impact on training expenses in small companies than in larger ones.

In this case, the empirical picture changes depending on the regression methods and the reference period. However, focusing on the difference-in-difference framework, we find that small firms investing in the circular economy (around +0.99) and resource-input savings (+0.96) induce higher training investments than in technological developments (+0.79) and energy efficiency (0.47). Further, we notice that all green technologies contribute to increasing the disbursement for training activities in small firms, while no inference is possible in the subsample of firms with more than 50 employees.

This result complements our PRP findings and the results discussed in the previous section. Product-related circular economy strategies result in the category of green investments, which are the most important for organizational changes among small firms. Pecuniary incentives (PRP) and efforts for worker reskilling (training expenditures) are likely the levers to implement the organizational changes in these units.

Table 6. Linear estimates by heterogeneity of green technologies. Dep var: (log of) training costs per employee

	Small firms					No small firms				
	Total	**EE**	**TD**	**RS**	**CE**	**Total**	**EE**	**TD**	**RS**	**CE**
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**	**[8]**	**[9]**	**[10]**
	Panel A: T=1 OLS estimates									
B1	0.805***	0.638***	0.806***	0.816***	0.630***	0.457***	0.489***	0.400***	0.360***	0.337***
	[0.077]	[0.092]	[0.102]	[0.121]	[0.154]	[0.069]	[0.069]	[0.073]	[0.074]	[0.088]
R2	0.126	0.119	0.121	0.119	0.115	0.163	0.164	0.16	0.158	0.157
	Panel B: T=2 diff in diff fe									
B2	0.521***	0.462**	0.749***	1.049***	0.997***	0.081	0.151	-0.100	-0.002	-0.058
	[0.154]	[0.187]	[0.207]	[0.255]	[0.315]	[0.106]	[0.107]	[0.108]	[0.116]	[0.143]
Year 2021	-0.121	-0.066	-0.092	-0.08	-0.046	0.004	-0.013	0.07	0.042	0.049
	[0.087]	[0.083]	[0.082]	[0.079]	[0.079]	[0.086]	[0.079]	[0.076	[0.073	[0.068
R2	0.313	0.311	0.314	0.316	0.313	0.361	0.362	0.361	0.361	0.361
	Panel C: T=3 diff in diff fe									
B2	0.771***	0.471*	0.796***	0.964***	0.990**	0.072	0.216	-0.283*	-0.108	-0.147
	[0.218]	[0.266]	[0.288]	[0.368]	[0.410]	[0.151]	[0.151]	[0.149]	[0.153]	[0.195]
B3	0.166	0.006	0.013	-0.134	-0.030	0.033	0.134	-0.096	-0.034	-0.011
	[0.197]	[0.239]	[0.262]	[0.325]	[0.383]	[0.145]	[0.146]	[0.146]	[0.161]	[0.187]
Year 2021	0.011	0.117	0.093	0.121	0.141	0.194	0.146	0.311***	0.253**	0.251***
	[0.122]	[0.118]	[0.115]	[0.112]	[0.112]	[0.120]	[0.109]	[0.105]	[0.099]	[0.094]
Year 2018	0.183*	0.217**	0.220**	0.234**	0.221**	0.175	0.14	0.220**	0.199**	0.193**
	[0.100]	[0.095]	[0.093]	[0.091]	[0.090]	[0.109]	[0.099]	[0.094]	[0.088]	[0.083]
R2	0.342	0.339	0.341	0.342	0.34	0.375	0.375	0.376	0.375	0.375
Other controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Note: EE= energy saving technologies; TD=technology development; RE= resource-saving technologies; CE=circular economy technologies. Other controls include education and gender of who runs the firms and family ownership; employment composition by professional status, gender, fixed term contracts, and hirings; firm productive characteristics by product innovation, process innovation, public procurement, and firm age (in years), number of employees (in classes), NACE sectors and NUTS 2 regions fixed effects. Robust standard errors (clustered at firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2022 data

5. Discussion and conclusion

How do firms involved in ecological transition align their human resources strategies with the new requirements of green investments? This paper has tried to answer this question by looking at how green investments influence the wage-setting strategies of enterprises and the training programs offered to their workforce. We also investigated if the wide heterogeneity across firms' size distribution may explain the ambiguous results emerging for the whole Italian economy and significantly contribute to explaining the different roles of ecological transition processes on industrial relations.

We advanced the hypothesis that providing employees with performance-related pay (PRP) can be a strategic move, especially for large firms. This wage policy may enhance the firm's ability to attract and retain highly qualified workers in new green occupations, thereby influencing the hiring strategies and reducing job turnover. In line with existing literature (Idson and Oi 1999; Oi and Idson 1999), it is conceivable that large firms that set higher targets in terms of labour productivity may require the support of wage bonuses and compensating wage differentials. PRP can serve as an incentive to improve workers 'environmental performance and a rent-sharing scheme to reward employees involved in environmental transition. However, our results, obtained under controls for unobserved heterogeneity and endogeneity concerns, do not confirm the dimensional heterogeneity hypothesis, as no significant differentials in the adoption of PRP schemes have been found between large and small green firms.

Interestingly, however, we found clear differences in firm size for training policies. Our results show that green expenditure stimulates training investments in small firms, while this impact has been found not statistically significant in large companies. As widely recognized, training is one of the most effective interventions in HRD, not only to improve firm performance but also to increase job and organizational commitment (Campbell and Kuncel 2002; Ahadi and Jacobs 2017). For small enterprises, often featuring strong identification of (family) owners with the firm and its image, it is conceivable a greater reluctance to worker turnover and low churning rates. Hence, for small enterprises that 'pay less but offer more secure jobs' (Bassanini *et al.* 2013), training reveals a key strategy to reemploying brown workers into new green jobs. This conjecture, supported by our estimates, is coherent with previous research underlining that the skill gap between green and brown jobs is modest, although green jobs require significantly more training (Popp *et al.* 2022). Furthermore, structured on-the-job training may improve workers' ability at comparatively low costs and, therefore, be affordable for small enterprises (Ahadi and Jacobs 2017). In other terms, for small firms that cannot afford the payments of high compensations to recruit highly skilled employees, training to upskill and reskill programs are feasible strategies for the green energy transition.

Finally, there is growing literature on the relevance of various typologies of environmental investments, but empirical studies are limited because of the scarce availability of firm statistical information. Thanks to the richness of our database, we advance in this direction and provide estimates for four different types of green expenditures. Our results confirm that for all four types, the impact of training is more meaningful for small firms. One additional finding, obtained with difference and difference estimates, is the significant role of the circular economy as the main driver of training programs in small firms. These results align with an emerging literature that signals the lack of required skills as one of the most important obstacles to the transition to a circular economy.

Our results suggest that small businesses' high propensity to offer training programs to their workers is a favourable condition for promoting CE. This innovative green technology means expanding product lifetimes and a regenerative system in which waste and resource input are minimized.

Future research could shed light on other main differences in green technologies and their implications for employment and industrial relations.

Appendix

Evidence for the whole sample

Table A.1 Linear estimates on the whole sample

	Performance-related pay			Log of training costs pc		
	OLS	**Diff fe**	**Diff fe**	**OLS**	**Diff fe**	**Diff fe**
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**
Ln(green exp pc)	0.009*** [0.001]			0.072*** [0.009]		
Ln(green exp pc)*2021		0.005*** [0.002]	0.009*** [0.003]		0.026** [0.013]	0.014 [0.019]
Ln(green exp pc)*2018			0.006** [0.003]			0.008 [0.018]
Year 2021		-0.014*** [0.005]	-0.017* [0.009]		0.003 [0.053]	0.222*** [0.073]
Year 2018			-0.006 [0.008]			0.205*** [0.064]
Share of hirings	-0.081*** [0.016]	0.006 [0.021]	-0.025 [0.027]	0.145 [0.154]	0.546** [0.266]	0.641** [0.270]
Ln(sales per empl)	0.005** [0.002]	0.004 [0.003]	0.004 [0.003]	0.056*** [0.020]	0.033 [0.029]	0.046* [0.027]
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Firms fixed effects	No	Yes	Yes	No	Yes	Yes
Constant	-0.013 [0.056]	-0.187 [0.137]	0.043 [0.217]	3.003*** [0.432]	0.681 [1.493]	1.061 [1.559]
N of firms	11422	6188	3270	11422	4510	3270
R2	0.275	0.68	0.653	0.153	0.35	0.372

Note: management controls include education, gender and ownership of who runs the firms; employment composition by professional status, gender, fixed term contracts, and hirings; firm productive characteristics by product innovation, process innovation, public procurement, and firm age (in years). All regressions include firms' size in classes, NACE sectors and NUTS 2 regions fixed effects. Robust standard errors (clustered at firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2021-2018-2015 data

Table A.2 Heterogeneity of green technologies on the whole sample. Dep var: PRP

	GI	EE	TD	RS	CE
	[1]	[2]	[3]	[4]	[5]
			T=1 OLS estimates		
b1	0.046***	0.048***	0.057***	0.060***	0.051***
	[0.007]	[0.009]	[0.010]	[0.011]	[0.014]
R2	0.274	0.274	0.274	0.274	0.273
			T=2 diff in diff fe		
B2	0.020**	0.017	0.033***	0.030**	0.020
	[0.010]	[0.011]	[0.013]	[0.014]	[0.018]
year 2021	-0.018***	-0.015**	-0.017***	-0.015***	-0.012**
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]
R2	0.698	0.698	0.699	0.699	0.698
			T=3 diff in diff fe		
B2	0.058***	0.050***	0.067***	0.053**	0.062**
	[0.016]	[0.018]	[0.020]	[0.023]	[0.028]
B3	0.034**	0.025	0.031*	0.014	0.037
	[0.014]	[0.017]	[0.018]	[0.020]	[0.027]
Year 2021	-0.026**	-0.019*	-0.019**	-0.013	-0.012
	[0.010]	[0.010]	[0.009]	[0.009]	[0.009]
Year 2018	-0.011	-0.006	-0.005	-0.001	-0.003
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]
R2	0.653	0.652	0.653	0.652	0.652
Other controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Note: other controls include education and gender of who runs the firms and family ownership; employment composition by professional status, gender, fixed term contracts, and hirings; firm productive characteristics by product innovation, process innovation, public procurement, and firm age (in years), number of employees (in classes), NACE sectors and NUTS 2 regions fixed effects. Robust standard errors (clustered at firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2022 data

Table A.3 Heterogeneity of green technologies on the whole sample. Dep var: (log of) training costs per employee

	GI	**EE**	**TD**	**RS**	**CE**
	[1]	**[2]**	**[3]**	**[4]**	**[5]**
			T=1 OLS estimates		
b1	0.648***	0.545***	0.578***	0.551***	0.433***
	[0.053]	[0.057]	[0.062]	[0.067]	[0.082]
R2	0.160	0.155	0.155	0.153	0.15
			T=2 diff in diff fe		
B2	0.291***	0.300***	0.226**	0.321***	0.302**
	[0.083]	[0.090]	[0.095]	[0.109]	[0.133]
Year 2021	-0.066	-0.041	-0.012	-0.013	0.008
	[0.060]	[0.056	[0.054	[0.052	[0.051]
R2	0.351	0.351	0.35	0.351	0.35
			T=3 diff in diff fe		
B2	0.333***	0.245**	0.105	0.187	0.195
	[0.116]	[0.124]	[0.129]	[0.143]	[0.172]
B3	0.023	-0.008	-0.086	-0.073	-0.046
	[0.111]	[0.120]	[0.127]	[0.144]	[0.170]
Year 2021	0.123	0.174**	0.217***	0.211***	0.219***
	[0.082]	[0.077]	[0.074]	[0.072]	[0.070]
Year 2018	0.205***	0.214***	0.230***	0.224***	0.217***
	[0.071]	[0.067]	[0.064]	[0.062]	[0.060]
R2	0.373	0.372	0.372	0.372	0.372
Other controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Note: other controls include education and gender of who runs the firms and family ownership; employment composition by professional status, gender, fixed term contracts, and hirings; firm productive characteristics by product innovation, process innovation, public procurement, and firm age (in years), number of employees (in classes), NACE sectors and NUTS 2 regions fixed effects. Robust standard errors (clustered at firm level) are in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%.
Source: Authors' elaborations on RIL 2022 data

Table B.1 Definition of variables

	Main variables
Training costs	(Log of) training costs (in Euros) per employee.
Performance related pay	The dummy variable equals 1 if firms adopted at least one green technology (energy efficiency, technological development, resource-saving, circular economy) over the period 2019-2021, 0 otherwise.
Green investment per employee	(Log of) total expenditures in green technologies in 2021 per employee.
Typologies of green Technologies	Four dummy variables indicating firms' investment over the period 2019-2021 in: i) energy efficiency, ii) technological development in eco-friendly equipment and cleaner production processes, iii) resource-saving technologies (investments to save inputs and promoting eco-friendly practices among employees, iv) circular economy - for the re-using of products and the reduction of any wastes, 0 otherwise.
	Management and corporate governance
Managers' education	Three dummy variables that equal to 1 whether the educational level of the entrepreneurs /managers who run the firm is: i) tertiary; ii) upper secondary iii) lower secondary or elementary, 0 otherwise.
Managers' gender	Dummy variable that equals 1 whether the entrepreneurs/managers who run the firm are female, 0 otherwise.
Family ownership	The dummy variable equals 1 if the ownership of the firm is held by a single family, 0 otherwise.
	Workforce composition
Education	Three variables indicating the share of employees (on the firm's total number of employees) with i) tertiary education, ii) upper secondary education, iii) lower secondary or elementary.
Professional status	Three variables indicate the share (on the firm's total employment) of: i) executives, ii) white collars, and iii) blue collars.
Contractual arrangements	Share of workers with a fixed-term contract on the firms' total employment.
Female	Share of female workers in the firms' total employment.
Hirings	Share of newly hired workers on the firms' total employment.
Separations	Share of separated workers - excluded for retirements and other no economic reasons - on the firms' total employment.
	Firms characteristics
Product innovation	The dummy variable equals to 1 if the firms invested in new products and services in a three-year period before the survey, 0 otherwise.
Process innovation	The dummy variable equals to 1 if the firms innovated productive processes in a three-year period before the survey, 0 otherwise.
Public procurement	Dummy variable that equals 1 if the firms sell/provide services and/or products to the public administrations, = otherwise.
Exports	The dummy variable equals 1 if the firms sell their products/services in foreign markets, 0 otherwise.
Sales per capita	(Log of) the total sales (in Euros) per employee. The amount of sales is deflated.
Firm's size	Four classes are classified according to the total number of employees: [0-9], [10-49], [50-249], and more than 250 employees.
Firms' age	(Log of) number of years since the firm has been funded.
Geographical localization	20 dummies variables indicating the Italian NUTS 2 regions.
Sector of activities	13 dummies variables indicating- according to OECD classification: 1 High-Tech, 2 Med-High-Tech, 3 Med-Low-Tech, 4 Low-Tech, 5 KIS-Market, 6 KIS-High-Tech, 7 KIS-Finance, 8 KIS-Other, 9 LKIS-Market, 10 LKIS-Other, 11 Mining & Quarring, 12 Construction, 13 Utilities.

Source: RIL data

References

Acemoglu D., Autor D. (2011), Skills, Tasks and Technologies: Implications for Employment and Earnings, *Handbook of Labor Economics*, 4, part B, pp.1043-1171

Ahadi S., Jacobs R.L. (2017), A Review of the Literature on Structured On-the-Job Training and Directions for Future Research, *Human Resource Development Review*, 16, n.4 pp.323-349

Barbieri N., Ghisetti C., Gilli M., Marin G., Nicolli F. (2016), A survey of the literature on environmental innovation based on main path analysis, *Journal of Economic Surveys*, 30, n.3, pp.596-623

Bassanini A., Breda T., Caroli E., Rebérioux A. (2013), Working in Family Firms: Paid Less but More Secure? Evidence from French Matched Employer-Employee Data, *ILR Review*, 66, n.2, pp.433-466

Bauer T.K., Bender S. (2004), Technological Change, Organizational Change, and Job Turnover, *Labour Economics*, 11, n.3, pp.265-291

Berton F., Carreri A., Devicienti F., Ricci A. (2023), The Collective Voice of Unions and Workplace Training in Italy: New Insights from Mixed Methods, *British Journal of Industrial Relations*, 61, n.3, pp.595-622

Black S.E., Lynch L.M. (2001), How to Compete: The Impact of Workplace Practices and Information Technology on Productivity, *Review of Economics and Statistics*, 83, n.3, pp.434-445

Bloom N., Brynjolfsson E., Foster L., Jarmin R., Patnaik M., Saporta-Eksten I., Van Reenen J. (2019), What Drives Differences in Management Practices?, *American Economic Review*, 109, n.5, pp.1648-1683

Bloom N., Van Reenen J. (2010), Why Do Management Practices Differ across Firms and Countries?, *Journal of Economic Perspectives*, 24, n.1, pp.203-224

Bluedorn J., Hansen N.-J., Noureldin D., Shibata I., Tavares M.M. (2023), Transitioning to a Greener Labor Market: Cross-Country Evidence from Microdata, *Energy Economics*, 126, article 106836

Bosworth D. (1993), Skill Shortages in Britain, *Scottish Journal of Political Economy*, 40, n.3, pp.241-271

Bratti M., Brunetti I., Corvasce A., Maida A., Ricci A. (2024), *Did Covid-19 (Permanently) Raise the Demand for 'Teleworkable' Jobs?*, GLO Discussion Paper n.1415, Essen, Global Labor Organization

Buyukyazici D., Quatraro F. (2024), *The Skill Requirements of the Circular Economy*, Utrecht, Utrecht University, Department of Human Geography and Spatial Planning

Cadsby C.B., Song F., Tapon F. (2007), Sorting and Incentive Effects of Pay for Performance: An Experimental Investigation, *Academy of Management Journal*, 50, n.2, 387-405

Campbell J.P., Kuncel N.R. (2002), Individual and Team Training, in Anderson N., Ones D.S., Sinangil H.K., Viswesvaran C. (eds.), *Handbook of industrial, work and organizational psychology, Vol. 1: Personnel psychology*, Thousand Oaks CA, SAGE Publications, pp.278-312

Cappelli P.H. (2015), Skill Gaps, Skill Shortages, and Skill Mismatches, *ILR Review*, 68, n.2, pp.251-290

Caravella S., Crespi F. (2020), Unfolding Heterogeneity: The Different Policy Drivers of Different Eco-Innovation Modes, *Environmental Science & Policy*, 114, pp.182-193

Cardon M.S., Valentin S.D. (2017), Training and Development in Small and Medium Enterprises, in Brown K.G. (ed.), *The Cambridge Handbook of Workplace Training and Employee Development*, Cambridge, Cambridge University Press, pp.363-382

Carrillo-Hermosilla J., Del Río P., Könnölä T. (2010), Diversity of Eco-Innovations: Reflections from Selected Case Studies, *Journal of Cleaner Production*, 18, n.10-11, pp.1073-1083

Castellacci F., Lie C.M. (2017), A Taxonomy of Green Innovators: Empirical Evidence from South Korea, *Journal of Cleaner Production*, 143, pp.1036-1047

Coetzer A., Inma C., Poisat P. (2017), The job embeddedness-turnover relationship: Effects of organisation size and work group cohesion, *Personnel Review*, 46, n.6, pp.1070-1088

Coetzer A., Inma C., Poisat P., Redmond J., Standing C. (2019), Does Job Embeddedness Predict Turnover Intentions in SMEs?, *International Journal of Productivity and Performance Management*, 68, n.2, pp.340-361

Coetzer A., Perry M. (2008), Factors Influencing Employee Learning in Small Businesses, *Education + Training*, 50, n.8/9, pp.648-660

Coetzer A., Redmond J., Sharafizad J., Lundy J. (2023), Enhancing Learning in Small Businesses, *Human Resource Management Journal*, 33, n.2, pp.470-490

Consoli D., Marin G., Marzucchi A., Vona F. (2016), Do Green Jobs Differ from Non-Green Jobs in Terms of Skills and Human Capital?, *Research Policy*, 45, n.5, pp.1046-1060

Deshpande S.P., Golhar D.Y. (1994), HRM practices in large and small manufacturing firms: A comparative study, *Journal of Small Business Management*, 32, n.2, pp.49-56

Fan C.S., Wei X. (2010), Training and Worker Effort: A Signalling Perspective, *Canadian Journal of Economics/Revue Canadienne d'économique*, 43, n.2, pp.604-621

Fox J.T. (2009), Firm-Size Wage Gaps, Job Responsibility, and Hierarchical Matching, *Journal of Labor Economics*, 27, n.1, pp.83-126

Gabaix X., Landier A. (2008), Why Has CEO Pay Increased So Much?, *Quarterly Journal of Economics*, 123, n.1, pp.49-100

Gagliardi L., Marin G., Miriello C. (2016), The Greener the Better? Job Creation Effects of Environmentally-Friendly Technological Change, *Industrial and Corporate Change*, 25, n.5, pp.779-807

Ghisetti C., Quatraro F. (2013), Beyond Inducement in Climate Change: Does Environmental Performance Spur Environmental Technologies? A Regional Analysis of Cross-Sectoral Differences, *Ecological Economics*, 96, pp.99-113

Ghisetti C., Klaus Rennings K. (2014), Environmental Innovations and Profitability: How Does It Pay to Be Green? An Empirical Analysis on the German Innovation Survey, *Journal of Cleaner Production*, 75, pp.106-117

González X., Loveira R., Pazó C. (2022), Performance Pay, Firm Size and Export Market Participation: Evidence from Matched Employer–Employee Data, *Labour*, 36, n.3, pp.342-366

Haltiwanger J.C., Hyatt H.R., Kahn L.B., McEntarfer E. (2018), Cyclical Job Ladders by Firm Size and Firm Wage, *American Economic Journal: Macroeconomics*, 10, n.2, pp.52-85

Healy J., Mavromaras K., Sloane P.J. (2015), Adjusting to Skill Shortages in Australian SMEs, *Applied Economics*, 47, n.24, pp.2470-2087

Helpman E., Itskhoki O., Redding S. (2010), Inequality and Unemployment in a Global Economy, *Econometrica*, 78, n.4, pp.1239-1283

Holmström B. (2017), Pay for Performance and Beyond, *American Economic Review*, 107, n.7, pp.1753-1777

Horbach J. (2010), The Impact of Innovation Activities on Employment in the Environmental Sector - Empirical Results for Germany at the Firm Level, *Jahrbücher Für Nationalökonomie Und Statistik*, 230, n.4, pp.403-419

Horbach J., Janser M. (2016), The Role of Innovation and Agglomeration for Employment Growth in the Environmental Sector, *Industry and Innovation*, 23, n.6, pp.488-511

Horbach J., Rammer C. (2020), Circular Economy Innovations, Growth and Employment at the Firm Level: Empirical Evidence from Germany, *Journal of Industrial Ecology*, 24, n.3, pp.615-625

Idson T.L., Oi W.Y. (1999), Workers Are More Productive in Large Firms, *American Economic Review* 89, n.2, pp.104-108

Jacobs R.L. (2014), Structured On-the-Job Training, in Poell R.F., Rocco T.S., Roth G.L. (eds.), *The Routledge Companion to Human Resource Development*, London, Routledge, pp.272-284

Johnstone N., Haščič I., Popp D. (2010), Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts, *Environmental and Resource Economics*, 45, n.1,

Josefy M., Kuban S., Ireland R.D., Hitt M.A. (2015), All Things Great and Small: Organizational Size, Boundaries of the Firm, and a Changing Environment, *Academy of Management Annals*, 9, n.1, pp.715-802

Kiefer C.P., Carrillo-Hermosilla J., Del Río P., Barroso F.J.C. (2017), Diversity of Eco-Innovations: A Quantitative Approach, *Journal of Cleaner Production*, 166, pp.1494-1506

Kotey B., Folker C. (2007), Employee Training in SMEs: Effect of Size and Firm Type-Family and Nonfamily, *Journal of Small Business Management*, 45, n.2, pp.214-238

Kotey B., Slade P. (2005), Formal Human Resource Management Practices in Small Growing Firms*, *Journal of Small Business Management*, 43, n.1, pp.16-40

Lähdesmäki M., Siltaoja M., Spence L.J. (2019), Stakeholder Salience for Small Businesses: A Social Proximity Perspective, *Journal of Business Ethics*, 158, n.2, pp.373-385

Lazear E.P. (2000), Performance Pay and Productivity, *American Economic Review*, 90, n.5, pp.1346-1361

Lazear E.P. (2018), Compensation and Incentives in the Workplace, *Journal of Economic Perspectives*, 32, n.3, pp.195-214

Lazear E.P., Oyer P. (2007), *Personnel Economics*, NBER Working Paper n.13480, Cambridge MA, National Bureau of Economic Research

López Novella M., Sissoko S. (2013), Understanding Wage Determination in a Multi-Level Bargaining System: A Panel Data Analysis, *Empirical Economics*, 44, n.2, pp.879-897

Marin G., Vona F. (2019), Climate Policies and Skill-Biased Employment Dynamics: Evidence from EU Countries, *Journal of Environmental Economics and Management*, 98, article 102253

Marlow S., Taylor S., Thompson A. (2010), Informality and Formality in Medium-sized Companies: Contestation and Synchronization, *British Journal of Management*, 21, n.4, pp.954-966

Mitchell T.R., Holtom B.C., Lee T.W., Sablynski C.J., Erez M. (2001), Why People Stay: Using Job Embeddedness to Predict Voluntary Turnover, *Academy of Management Journal*, 44, n.6, pp.1102-1121

Montresor S., Quatraro F. (2020), Green Technologies and Smart Specialisation Strategies: A European Patent-Based Analysis of the Intertwining of Technological Relatedness and Key Enabling Technologies, *Regional Studies*, 54, n.10, pp.1354-1365

Oi W.Y., Idson T.L. (1999), Firm Size and Wages, in Ashenfelter O.C., Card D. (eds.), *Handbook of Labor Economics. Vol. 3B*, Elsevier, pp.2165-2214

Pompei F., Damiani M., Ricci A. (2018), Family firms, performance-related pay, and the great crisis: Evidence from the Italian case, *Industrial and Corporate Change*, 28, n.5, pp.1193-1225

Popp D., Vona F., Marin G., Chen Z., Chodorow-Reich G., Ramey V.A., Buckman S.B., Choi L.Y., Daly M.C., Seitelman L.M. (2022), Brookings Papers on Economic Activity. Fall 2021, *Brookings Papers on Economic Activity*, pp.1-139

Prendergast C. (1999), The Provision of Incentives in Firms, *Journal of Economic Literature*, 37, n.1, pp.7-63

Rennings K. (2000), Redefining Innovation – Eco-Innovation Research and the Contribution from Ecological Economics, *Ecological Economics*, 32, n.2, pp.319-332

Saussay A., Sato M., Vona F., O'Kane L. (2022), *Who's Fit for the Low-Carbon Transition? Emerging Skills and Wage Gaps in Job and Data*, FEEM Working Paper n.31, Milano, Fondazione Eni Enrico Mattei

Schmidt C.M., Zimmermann K.F. (1991), Work Characteristics, Firm Size and Wages, *The Review of Economics and Statistics*, 73, n.4, pp.705-710

Schumpeter J.A. (1947), The Creative Response in Economic History, *The Journal of Economic History*, 7, n.2, pp.149-159

Storey D.J., Saridakis G., Sen-Gupta S., Edwards P.K., Blackburn R.A. (2010), Linking HR Formality with Employee Job Quality: The Role of Firm and Workplace Size, *Human Resource Management*, 49, n.2, pp.305-329

Unruh G.C. (2000), Understanding Carbon Lock-In, *Energy Policy*, 28, n.12, pp.817-830

van der Velden R., Bijlsma I. (2016), College Wage Premiums and Skills: A Cross-Country Analysis, *Oxford Review of Economic Policy*, 32, n.4, pp.497-513

Vaona A., Pianta M. (2008), Firm size and innovation in European manufacturing, *Small Business Economics*, 30, n.3, pp.283-299

Vona F. (2023), Managing the Distributional Effects of Climate Policies: A Narrow Path to a Just Transition, *Ecological Economics*, 205, article 107689

Vona F., Marin G., Consoli D., Popp D. (2018), Environmental Regulation and Green Skills: An Empirical Exploration, *Journal of the Association of Environmental and Resource Economists*, 5, n.4, pp.713-753

Vona F., Marin G., Consoli D., Popp D. (2015), Green Skills, NBER Working Paper n.21116, Cambridge MA, National Bureau of Economic Research

Walker I., Zhu Y. (2008), The College Wage Premium and the Expansion of Higher Education in the UK, *The Scandinavian Journal of Economics*, 110, n.4, pp.695-709

Winter-Ebmer R., Zweimüller J. (1999), Firm-Size Wage Differentials in Switzerland: Evidence from Job-Changers, *American Economic Review*, 89, n.2, pp.89-93

Yi H. (2014), Green Businesses in a Clean Energy Economy: Analyzing Drivers of Green Business Growth in U.S. States, *Energy*, 68, pp.922-929

INAPP
ISTITUTO NAZIONALE PER L'ANALISI
DELLE POLITICHE PUBBLICHE