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HETEROGENEITY OF GREEN EXPENDITURE, FIRMS' PERFORMANCES AND WAGES: ITALIAN EVIDENCE ON CIRCULAR ECONOMY, RESOURCE-SAVING AND ENERGY EFFICIENCY INVESTMENTS

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Heterogeneity of green expenditure, firms' performances and wages: Italian evidence on circular economy, resource-saving and energy efficiency investments

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Abstract

This paper analyses the relationship between firms' investment in green technologies and competitive performance. At this aim, we take advantage of new data on the adoption of different green technologies (circular economy, technical advancements, energy savings, efficiency gains) from a large representative sample of Italian firms. We find the following results. First, overall green investment increases the sales per employee and average wages. Second, we show a significant heterogeneity in the estimated effect across different green technologies. These results are robust to an econometric strategy that controls for a large set of observed characteristics, time-invariant unobserved heterogeneity and endogeneity issues. In sum, our results support the hypothesis that the ongoing ecological transformation of productive processes may favor firms' competitiveness but substantial heterogeneity still matters. The policy implications are then discussed.

Keywords: green investments, circular economy, energy efficiency, resource-saving, sales, wages

JEL Classification Codes:

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1 Introduction

The dramatic consequences of climate change are nowadays rather evident and call for urgent action. The 2022 report issued by the United Nations Environment Programme (UNEP) stressed how the scope of these impacts goes well beyond environmental degradation, including also increasing inequalities, conflicts and rising food and energy prices (UNEP, 2022).

In this context, greening the economy is advocated as a no longer postponable objective by the most influential international government and non-government organizations, stimulating the debate in policy and academic circles. The European Commission launched 2019 the European Green Deal, aiming to promote climate neutrality by 2050 through technology-based reduction of polluting emissions and exploitation of natural resources (EC, 2019). The Next Generation EU launched in December 2020 has provided additional funding to stimulate recovery from the COVID-19 pandemic based on green expenditure and investments in advanced technologies allowing for the improvement of a wide array of human actions' environmental performances. The reduction of the carbon footprint, the achievement of sustainable transport and clean energy systems, and the circular economy transition are key pillars of this funding scheme, which has been implemented in EU countries within the National Recovery and Resilience Plans (EC, 2020).

The economic academic debate has long focused on the interplay between the green transition, firms' innovation dynamics and performances. The seminal contribution by Porter and van der Linde (1995) has paved the way to a fruitful stream of research on the economic impact of the regulation-induced adoption of eco-innovations on firms' performances (Kemp and Pearson, 2007; Barbieri et al., 2016) as well as on its effects in terms of new markets creation and the associated incentive for green technology suppliers to invest in their production (Nemet, 2009; Ghisetti and Quatraro; Colombelli et al., 2020; Colombelli et al., 2021).

Almost all of the existing firm-level studies have focused on overall innovative efforts, neglecting the possible heterogeneous effects that different typologies of green investments can yield on economic performance. Some exceptions can be found in studies using information contained in the Community Innovation Survey, mainly exploiting the difference between product and process innovation (Horbach and Rennings, 2013; Ghisetti and Rennings, 2014). Moreover, extant studies have investigated the economic impact of firms' new green investments by focusing on firms' growth, and finding evidence of a positive impact on sales, employment and market value. Yet, the important issue of the impact on income distribution has been substantially overlooked.

This paper aims at filling these gaps, by investigating the impact of firms' new green investments on productivity and average wages. In doing so, we dig into the heterogeneity of green innovation, stressing the differences between new investments related to the circular economy, resource-saving and energy efficiency. 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 have a positive impact on both sales and wages per employee. Yet the magnitude of the effect appear to be larger for sales than for wages. Moreover, the different typologies of investments show differential effects on both measures. Circular economy investments seem to drive the impact on firms' sales, while technological developments appear to drive the impact on wages. We also detect geographical heterogeneity of effects, whereby the overall results seem to be driven by the dynamics at stake in Central and Northern Italy.

The contribution of this paper to the literature is twofold. First, by investigating the impact of new green investments, it sheds new light on the differential effects that can be observed when disentangling different types of innovations. Second, it tackles the issue of the distributional effects of new green investments. While extant literature investigates their impact on employment dynamics, we bring the focus on wages dynamics, to ascertain whether and to what extent also employees share the benefits accruing to firms from the adoption of green innovations.

The rest of the paper is organized as follows. Section 2 presents the theoretical framework. In Section 3 we describe the data and discuss the methodology. Section 4 discusses the results of the econometric estimations, while we provide conclusions and policy recommendations in Section 5.

2 Theory development

2.1 Green investments, eco-innovation and firms' growth

The academic debate has paid much attention to the issue of firms' economic incentives to allocate resources to investmens aiming at improving their environmental performances. A major problem concerning the alignment to the targets of the green transition relates to the role of path-dependency for economic agents' decisions. It has been stressed that the economic systems of advanced industries have long been locked into the exploitation of fossil fuel-based production technologies (Unruh, 2000). The carbon lock-in argument points in fact to a larger problem pertaining the substantial neglect of environmental issues in firms' decisions concerning not only production technologies, but also organizational design and the relationship with suppliers and retailers. For these reasons, escaping from such lock-in inherently would require that firms engage in some kind of innovation activity. The concept of eco-innovation has therefore been introduced to identify new green investments aiming at improving firms environmental perforances in terms of polluting emissions or resources exploitation (Kemp, 2010).

In this framework, the resources allocated by firms to new green investments risk to be suboptimal due to the well-known "double externality problem". Accordingly, environmental and innovation policies are deemed to be essential to cope with the associated market failures and restore the socially optimum levels of investments (Rennings, 2000; Unruh, 2002). Yet, it is worth stressing that firms' private benefits can be nonnegligible, as in many cases the introduction eco-innovation stimulated by policy intervention may yield an additional positive effect on firms' economic performances in terms of productivity or sales (Porter and van der Linde, 1995).

Based on these arguments, a large body of literature has flourished in the past decade, aiming at providing evidence about the relevance of eco-innovation (Barbieri et al., 2016). In particular, much emphasis has been devoted to the determinants of firms' adoption choices as well as the allocation of resources to green R&D and new technologies production, focusing on the inducement mechanisms activated by environmental policy measures (Johnstone and Laborne; 2007; Johnstone et al., 2012; Ghisetti and Quatraro, 2013; Marin et al., 2015; Triguero et al., 2013).

Less attention has been instead dedicated to the economic impact of eco-innovation generation and adoption. On the one hand, few existing studies have investigated the extent to which suppliers of green technologies experience higher sales, productivity or market value as compared to suppliers of non-green technologies, finding evidence of a sort of "green premium". These analyses hypothesize a transmission of the inducement mechanisms upwards in the value chain, due the market creation effects of policy-induced firms' decision to invest in green innovation (Nemet, 2009; Marin, 2014; Colombelli et al., 2021; Colombelli et al., 2022). On the other hand, an even lower number of studies have attempted to provide evidence of positive economic impacts of firms' investments to adopt new green technological and non-technological innovations.

The extant literature has stressed the existence of several channels by which firms' new green investments can positively affect their economic performances (Ghisetti and Rennings, 2014; Rexhäuser & Rammer, 2014; Ghisetti, 2018; Horbach and Rammer, 2019). First of all, green investments may concern the the adoption of new organizational modes or the implementation of new activities and technologies that, by improving the efficiency in the use of resources or avoiding waste of valuable resources, may lead to cost savings and increased productivity. Second, first-mover advantages may accrue to firms in which green investments drive the commercialization of products that can obtain some eco-label. Third, changes in consumer preferences can drive higher willingness to pay for green products, engendering further positive impacts on firms' economic performances, especially on sales, as also discusse in the literature on the impact of corporate social responsibility practices (Ambec and Lanoie, 2008; Hart, 1997; Margolis and Walsh, 2003; Orlitzky, Siegel, and Waldman, 2011. In view of the arguments elaborated so far, we can spell out our first hypothesis:

H1: New green investments are positively linked to firms' productivity.

2.2 Innovation and wages

The literature on the interplay between innovation and labor market dynamics has venerable origins, and it is rooted in the well-known debate on the displacement effects of innovation that was originated by the work by Marx (1961 and 1969) and Ricardo (1951). The latter stressed the job-destruction effect of innovation, while the former, and subsequent literature, has instead posited the existence of possible compensation mechanisms for fired workers. Consistently, the initial labor-saving effect of technological change was expected to be partially or totally counterbalanced by a variety of dynamics including the creation of new jobs in the capital sectors, increasing demand associated to decreasing prices, reallocation of profits to new investments (and new job opportunities), increasing labor demand following reduction in wages (in competitive markets) and increases in income (as opposed to reduction in wages) that arise in contexts in which workers are able to share the economic benefits of technological progress. Increasing income is then the driver of final demand growth, leading to market expansion and hence increasing labor demand (see Piva and Vivarelli (2018) for an extensive review of these arguments).

The analysis of the relationship between eco-innovation and labor market dynamics so far has focused on the assessment of possible displacement effects of green technological change. Previous studies in this stream of literature have looked at the employment effects of both the adoption and the generation of eco-innovations. On the one hand, extant studies find evidence of a positive impact of innovation adoption on employment, due to increased competitiveness based on production costs reduction (Horbach and Rennings, 2013; Cecere and Mazzanti, 2017; Kunapatarawong and Martinez-Ros, 2016). On the other, the generation of green technologies has also been found to be positively associated to employment growth. This dynamics is driven by market-led expansion induced by regulation changes that icreases firms' profits and scale of production (Gagliardi et al., 2016; Marin and Vona, 2023).

A major and yet overlooked issue concerns the distributional effects of green investments. This issue is connected to the debate on the impact of innovation on wages paid by firms and more in general on the nexus between innovation and wage inequality (Aghion et al., 2017). The impact of firms' innovation activities on wages has been investigated by a several studies. On the one hand, indirect contribution to the debate is provided by studies showing that when labor markets are imperfect, workers employed by more productive firms may yield significant benefits in terms of wages as compared to workers with similar characteristics, but employed in less productive firms (Mortensen, 2003; Dickens and Katz, 1986; Card et al., 2018). On the other hand, analyses of the direct impact of innovation on the wage premium are carried out by the rent-sharing literature stressing that the positive effect of innovation on wages stems from the appropriation of the rents it generates (van Reenen, 1996; Martinez-Ros, 2001; Aghion et al., 2019, 2018; Akcigit et al., 2017; Kline et al., 2019).

The studies focusing on direct and indirect impacts of innovation on wages do not dig into the heterogeneity of technologies. Related literature in the skills-biased technological change framework of analysis proposes instead that the wage premium is associated to specific technologies, and in particular those associated to the ICT revolution, as they are complemento to skilled wokers. The diffusion of new technologies therefore engenders an increase in the demand for skilled relative to unskilled labor, and hence pushes the skilled workers' wages upwards (Acemoglu, 2002; Acemoglu and Autor, 2011). Based on similar arguments, Wang et al. (2022) develop and test a theoretical model in which green technological progresses is assumed to have strong complementarities with specific skills sets and hence associated with biased skill premia and income inequality. This evidence is coherent with the recent efforts to analyze the implications of the greening of the economy on the skills configuration of occupations, showing that excaping the carbon lock-in would require important changes in the composition of skills within occupation and industrial activities (Vona et al., 2015).

This discussion leads us to articulate the following hypothesis:

H2: *New green investments have a positive impact on firms' averages wages.*

2.3 Heterogeneous effects of green investments

The literature on eco-innovation has stressed the need to focus on the idiosyncratic characteristics of different kinds of innovative solutions, pointing to possible heterogeneous effects (Carrillo-Hermosilla et al., 2010; Kiefer et al. 2017; Horbach and Rammer, 2019; Castellacci and Lie, 2019; Caravella and Crespi, 2020; Montresor and Quatraro, 2020).

Accordingly, green investments are not all alike, and an increasing number of empirical studies has focused the attention on specific typologies of innovation. The first study digging in to the speficities of eco-innovation is the one by Carillo Hermosilla et al. (2010). Relying on a case studiy approach, they provide a four-dimensional taxonomy based on eco-innovations dimensions like design, user, product service and governance. Within this strand of analysis, Kiefer et al. (2017) provide a quantitative assessment of the differences entailed by eco-innovations, based on a survey submitted to a sample of Spanish firms. They find that important heterogeneities pertain not only to the environmental effects of different kinds of eco-innovations, but also to company-level dynamics, like internal management and organizational practices. Kiefer et al. (2018) have instead proposed a taxonomy of eco-innovations, identifying five main types, i.e. systemic, externally driven, continuous improvement, radical and technology push, and eco-efficient. These groups differ in terms of novelty degree, main drivers as well as economic impacts.

On similar grounds, Castellacci and Lie (2019) stress that eco-innovation differ also with respect to the main drivers triggering their generation and adoption. They find that R&D and environmental policies are especially important for technologies relate o waste and pollution reduction, while demand-pull levers affect innovation for recycling and waste reduction. Large firms are more likely to be associated with innovation concerning CO2 and waste reduction, while small firms are associated to innovato for pollution reduction and recycling. Finally, also the balance between internal and external sources of innovation changes across the different typologies of eco-innovation. Similarly, Crespi and Caravella (2020) use the Italian section of the Community Innovation Survey (CIS) to cluster the different kinds of eco-innovation and identify the heterogeneity of effects of policies and market drivers.

The literature on the economic impact of eco-innovation has devoted less attention to such idiosyncratic features and possible heterogeneity of effects. Klassen and Whybark (1999) develop a theoretical framework based on the resource-based approach to explain the differential impacts of different kinds of EIs on firms' performances. In particular, they distinguish between pollution prevention and pollution control technologies, stressing that positive economic impacts are expected to be associated to the first ones. Ghisetti and Rennings (2019) propose to decompose EIs in two typologies, i.e. energy and resource efficiency, and externality reducing innovations. They propose that the former are more likely to engender a positive impact on economic performances as they require a change in the resource bases and capabilities following the redesign of the production process. Horbach and Rammer (2019) 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 in below the median values of both of the dependent variables.

The theoretical considerations and the empirical results of these studies lead us to spell out the following hypothesis on the heterogeneity of impacts of green investments on firms' economic performances:

H3: Different typologies of green investments are associated to differential economic impacts, both in terms of firms' performances and of labor market outcomes.

3 Data and methodology

Our analysis is based on the RIL survey conducted by INAPP on a representative sample of partnerships and limited liability firms[1]. 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[2].

What is worth for our purposes, The VI wave of the RIL survey includes a specific set of questions designed to collect information on the characteristics and on the amount of green investments over the period 2019-2021. In particular, we collect data on the firm investment in 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 and productive specialization and a large set of other characteristics that may have a role in shaping the relationship between green investments and competitiveness.

As for sample selection, once we keep observations with no missing values on the key variables, our cross-sectional sample is about of 18,000 firms operating in 2021. Finally, we use the longitudinal

[2] https://www.inapp.gov.it/rilevazioni/rilevazioni-periodiche/rilevazione-imprese-e-lavoro-ril

sample of RIL surveys amounting to around 13,000 companies operating in both 2021 and 2018 and to 5,000 once we focus on those companies found in 2015, 2018 and 2021.

3.1 Descriptive statistics

Table 1 reports the summary statistics for the main variables, distinguishing between cross sectional and longitudinal samples.

As for cross-sectional data, we observe that on average 14% of the Italian firms invested in at least one green technology over the period 2019-2021. Note that green investments are relatively concentrated in efficiency gains (10%) and technological advancements (7%) rather than in energy savings (4%) and circular economy (2.5%)[3]. The amount of expenditures in green technologies was approximately 214 euros per employee.

Further, we observe that the relative incidence and typologies of green investments (ie) found in the cross-sectional sample are also confirmed in the longitudinal samples – even though the average values increase in magnitude because of selection. Concerning the two-period panel sample, the average incidence of "green" firms rises to 17,2% while the green investment is relatively concentrated in efficiency gains (12%) and technological advancements (9%) as compared with energy savings and circular economy. The average amount of green expenditures per employee is 293 euros. Descriptive statistics on three-period sample stay in between previous ones. Namely on average green firms amount to 16% and they allocate their investment mainly to obtain efficiency gains (11%) and technical improvements (7%) than in energy saving and circular economy options.

>>> INSERT TABLE 1 ABOUT HERE <<<

Of course we expect that figures in Table 1 varies significantly across firms size, territories and sectors of activities. Then Table 1A and 2A allows us to evaluate sizeble differences across Centre-North and southern regions as well as by firm size

>>> INSERT TABLES 1A AND 1B ABOUT HERE <<<

Table 2 shows the summary statistics for the controls variables, namely management, workforce composition and productive characteristics.

>>> INSERT TABLE 2 ABOUT HERE <<<

[3] Note that if we consider the subsample of firms that invested in at least one green, the average amount of expenditures in green investment (per employee) rises to 1337 euros per employee. Note that these expenses are concentrated in technological advancements (1913 euros per employee) and in the circular economy (1838 euros per employee). This is interesting: circular economy seems to involve a relatively low incidence of Italian firms but at the same time absorb a relatively high proportion of green finance.

3.2 Empirical strategy

We estimate the following linear relationship:

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

where outcome $Y_{i,t}$ is the (log of) sales per employee or, alternatively, the (log of) average wages per employee in i firm at year t. Our key explanatory variable GI_i stands for both "intensive" and "extensive" measures of green investment, namely: i) the (log of) total amount of financing in green technologies per employee in 2021 and ii) the probability of having invested in at least one green technology over the period 2019-2021. In this latter case, we disentangle the nature of the green technologies by distinguishing the probability of investing in iii) energy efficiency, iv) technological advancements, v) saving costs the energy use vi) circular economy.

As for other controls, the vector $M_{i,t}$ includes managerial and corporate governance characteristics, $W_{i,t}$ formalizes the workforce composition and $F_{i,t}$ is for a rich set of firms' productive characteristics (all these covariates will be discussed in the descriptive section; for further details see Table B1 in Appendix). Furthermore, the parameter α_i is firms' time-invariant unobserved heterogeneity, λ_t are year fixed effects, the interaction terms $(s_{i,t} \cdot r_{i,t})$ are sector-by-regions fixed effects that capture the competitive patterns across 2-digit sector-specific technologies that vary between nuts2 geographical regions. Finally, $\varepsilon_{i,t}$ is the idiosyncratic error term with zero mean and finite variance.

As the first step, we run cross-sectional regressions of the equation [1] by imposing the parameter restriction $\alpha_i = \beta_2 = \beta_3$ and t=2021. The resulting OLS estimate of the coefficient β_1 is unbiased if time-invariant unobserved heterogeneity and endogeneity play no role in affecting both the choice of green technologies and the competitive performance. In other words, if the inclusion of a wide set of firm-level controls works well in netting out omitted variables and reverse causality concerns.

However, one may argue that the amount of green expenditures and/or use of green technologies are affected by financial constraints that, in turn, reflect past competitive performance. As a consequence, firms that experienced higher productivity (and wages) may be favored in embracing the ecological transition at the workplace. Moreover, implicit social and cultural norms that shape managerial strategies and firms' performance may also influence the propensity to introduce green technologies inducing another source of potential endogeneity

In a second step, we then exploit the longitudinal component of the RIL surveys to address unobserved factors and reverse causality issues. In particular we within fixed effect models of eq (1) on the two-period longitudinal sample by allowing $\beta_1 = \beta_3 = 0$ and t=2021,2018. In this case, the FE 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 of the performance, the human resorce management and investment in new technologies. On the other hand, within FE framework is not enough to address endogeneity related to time-varying unobserved factors and other latent processes that are at the roots of firms' strategies.

Then we rely on the Difference-in-Difference Fes approach using the three-period longitudinal sample and imposing no parameter restrictions. In this framework, the treatment group is composed of those firms declaring to have invested in green technologies and the control group consists of those that did not invest. Analogously the time indicator $year_{2021}$ represents the post-treatment period and the $year_{2018}$ remarks the pre-treatment period while the omitted $year_{2014}$ is the reference period. 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 while the parameter β_3 for the interaction $GI_i \cdot year_{2018}$ allows to test the Common Trends Assumption (CTA) concerning the initial omitted year, 2014. The CTA requires that we should observe parallel trends in the outcomes - productivity and wages - for treated and control groups in the absence of the treatment, i.e. past adoption of green technologies. If CTA holds, the Diff-in-Diffs estimator removes any time-varying effect influencing the treatment and control groups.

Finally, we combine the Diff-in-Diffs FEs regression model with Propensity Score Matching (PSM) methods to further mitigate potential self-selection biases. Here the idea is to run regressions on a restricted sample of "treated" and control firms with similar probabilities (propensity scores) of investing in green technologies.

4 Econometric analysis

4.1 Main results: the effect of green investments on productivity and wages

Table 3 reports the estimates of the effects of green expenditures on firms' productivity. As explained in the previous section, we carried out three different tests. Accordingly, the OLS estimates based on cross-sectional data are reported in column (1) while the difference in difference fixed effect estimates based on the two-period and three-period RIL longitudinal sample are displayed in columns (2) and (3) respectively.

>>> INSERT TABLE 3 ABOUT HERE <<<

In line with previous literature originating from the well-known Porter's hypothesis (Porter and van der Linde, 1995), in all three cases, the estimated coefficients indicate that the amount of green expenditures leads to higher firm performance.

In particular, the cross-sectional results in column (1) reveal that the green investment implies an increase of 1.4% in sales per employee while the estimated effect is equal to +1.8% in within FE models (column 2) and +3.3% in Diff in diff FE regressions (column 3). In this case, the not-statistically significant coefficient associated with the interaction terms $GI_i \cdot year_{2018}$ supports the validity of the CTA. In other words, we find parallel trends in sales performance between firms in the treated and control groups up until the adoption of green technologies.

All of the models include a wide set of controls accounting for management, workforce and firms' characteristics. It is interesting to note that the value of the coefficient increases when we move from the simplest to the most reliable estimation strategy. That is once we account for firm unobserved heterogeneity and endogeneity. These results provide quite robust evidence in support of our hypothesis 1, according to which green investments are expected to boost firms' economic performances, likely due to improvements of cost-conditions and of market penetration.

Table 4 provides the regression results of equation (1) when the outcome is the (log of) average wages per employee. Note that in column (1) the OLS coefficient estimates related to green investments is not significant, though positive. However, running estimates based on longitudinal data we find that the green transition may also favor the labor income. More specifically within FE and Diff in Diff regression models show that increasing the green expenditures leads to higher average wages by 1.2% (column 2) and 0.9% (column 3). Again, the coefficient estimate associated with $GI_i \cdot year_{2018}$ indicates that the CTA holds and confirms parallel trends in average wages between firms in the treated and control groups up until the adoption of green technologies,

>>> INSERT TABLE 4 ABOUT HERE <<<

This analysis provides the first systematic assessment of green investments on average wages in a sound empirical setting, providing support to Hypothesis 2 spelt out in Section 2. The evidence suggests that there is a wage premium associated to firms going green. There can be different channels behind this evidence. On the hand, this result can stem out of rent-sharing mechanisms in which employees are able to appropriate a share of the rents accruing to firms deciding to allocate resources to green investments. On the other hand, this can be the signal of a skill bias associated with green innovative investments.

4.2 Main results: heterogeneity of green investments

The results discussed in the previous section provide robust support to the hypothesis according to which firms' productivity and average wages are positively affected by the decision to allocate resources to green investments. Yet, as discussed in Section 2.3, several studies have stressed the heterogeneity of green new investments, in terms of drivers and effects. In this section, we provide the results of estimations aiming at assessing if and to what extent different kinds of green investments may have differential effects on firms' productivity and average wages paid to employees.

>>> INSERT TABLES 5 AND 6 ABOUT HERE <<

We follow the same empirical strategy used for the previous analysis. As for sales per employee, Table 5 reports the coefficient estimates of equation (1) in correspondence with different green technologies - adopted in the period 2019-2021 – and regression models.

Cross-sectional results in Panel A indicate the relationship between the nature of green technology and firms' performance is fairly poor heterogeneous: we find positive OLS estimates related to efficiency gains (+4%) and circular economy (+6.4%) while no effect is detected for technological advancements and energy savings.

Within FE results in Panel B show that the coefficient estimates associated with different technologies are heterogeneous in magnitude and statistical significance: it is evident for the circular economy (+13.6%) and, to a lesser extent, for efficiency gains (+7%) and technological advancements (+6.6%).

The Diff in Diff FE estimates are displayed in Panel C. Here we observe an increased role of heterogeneity in measuring the effect of green investments on productivity: estimates related to the term $GI_i \cdot year_{2021}$ is + 16.8% for the circular economy, +13.5% for efficiency gains and +11.7% for technical advancements while no effect is found energy-saving actions. Note that the estimates related to $GI_i \cdot year_{2018}$ are not statistically significant and support that CTA holds in all regression models – except for the case of having invested in at least one green technology. In sum expenditures in circular economy and in ecological efficiency appear to be more effective than energy savings in favoring the firm performance.

As for the (log of) wages per employee, we report the regression results in Table 6. Here we observe results coherent with those on productivity once taking into account firm unobserved heterogeneity (Panel B) and endogeneity issues (Panel C).

The cross-sectional estimates data are negligible in magnitude and statistically insignificant while Within FE and Diff-in-Diff results indicate that each typology of green investment increases the average wages, with the notable exception of energy savings. The coefficient estimates in Panels B and C show positive and significant coefficients, even though weak in magnitude (around +5%) across alternative actions. Note also that the highest coefficient is the one involving the introduction of technological advancement within firms' boundaries. This suggests the existence of a sort of skill-biased green technological change effect. Needless to say, the diff in diff estimates of $GI_i \cdot year_{2018}$ in Panel C is not statistically significant and supports that CTA holds also for wage regression models.

4.3 Further results by macro-area and firm size

In the previous section, we investigated the impact of green investments on fims' sales per employee and average wages, delving into the heterogeneity of green investments. In this section, we focus on two additional sources of heterogeneity related to geographical specificities and firms' size respectively.

In Tables 7 and 8 we present the results of estimations discussed in the previous section, run on the sub-sample of firms located in Northern and Central Italy.

>>> INSERT TABLE 7 AND 8 ABOUT HERE <<<

Table 7 shows the results concerning the impact of green investments on sales per employee (columns (1) to (3)) and on average wages (columns (4) to (6)). In both cases, we first show the results from cross-sectional OLS, followed by difference-in-differences exploiting two and three waves of the RIL survey. We find that the coefficients of green expenditure is positive and significant in all of the estimates of the impact on sales per employee, while in those concerning the impact on average wages, the coefficients are positive only in the difference-in-differences models.

Table 8 presents the results of the estimates digging into the heterogeneity of green investments. For the sake of clarity, we only show coefficients obtained with the difference-in-difference setting exploiting three waves of the RIL survey. Results are confirmed in terms of sign and statistical significance of the coefficients, as well as in terms of relative magnitude, being green investments for technological advancements the type of expenditure yielding the largest impact.

Another key source of heterogeneity in the Italian productive system is the firm size – and its correlated characteristics such as corporate governance and internal labour market organization.

In this regard, we run the regression models by distinguishing small and medium enterprises from the large ones with more than 250 employees.

>>> INSERT TABLE 9 AND 10 ABOUT HERE <<<

Table 9 shows in columns (1) to (3) the estimation results concerning the impact of GI on sales per employee in small and medium-sized firms. The results are in line with the evidence discussed so far, according to which GI has a positive and significant coefficient, which becomes larger in magnitude as we move from the simple OLS to the Diff-in-diff estimator. Columns (4) to (6) show the results of the estimation of the impact of GI on average wages. In this case the coefficient is positive and significant in the FE and Diff-in-diff estimations. We could therefore infer that the overall evidence is driven by dynamics in small and medium-sized companies., which account for nearly the 90% of the sampled firms.

In table 10, panel A. we report the results of the estimates concerning the different types of green investments on sales per employee. When we focus on SMEs, the largest coefficient is the one related to circular economy investments, while the lowest one concerns efficiency gains investments. Interestingly enough, investments for energy saving do not yield any significant impact. Panel B presents the results of the estimation of the impact on average wages. Also in this case we do not find any significant coefficient for what concerns energy savings investments, while the largest positive and significant coefficient is the one associated to green technological investments, suggesting that the skill bias is especially important when the adoption of new green technologies is at stake.

4.4 Robustness: propensity score matching

We are aware that our empirical setting could be not sufficient to infer a causal impact of GI on firm performance and average wages. This happens when some time-varying characteristics are systematically different between the "green" firms (treated) and no green firms (control group). To restore randomness in the selection process into the treatment, we run the regression models on the common support condition. In this regard, treated and control firms are singled out through a PSM approach according to their likelihood of investment in green technologies.

To assess the quality of the matching, we calculate the differences between the mean values of a large subset of the variables we used to match the treatment and control groups for each firm outcome, namely the sales per employee and average wages. Overall, the figures confirm that the two groups, although initially different, appear to be rather similar after matching. That is, the matching is successful both for productivity and average wages, and the trimming mechanism leads us to notably restrict the sample to comply with the common support condition.

As for the sales per employee, Table 11 reports the regression results after imposing the common support condition, i.e., restricting the sample and applying the weights obtained by the PSM matching procedure. The estimates found in the matched sample are consistent with those presented in Table 4 regarding the direction and statistical significance of the impact of green expenditures on firms' performance. In particular, the estimated coefficients related to green investment range from + 1.2% in columns (1) to +1.8% and +2.3% in columns (2) and (3), respectively. As before, in diff in diff models, the test for the CTA is not significantly different from zero, confirming that green expenditures boost competitive performance.

>>> INSERT TABLE 11 AND 12 ABOUT HERE <<<

Turning to the average wages, Table 12 illustrates that coefficient estimates derived from using PSM are quite different than those in Table 6. Imposing a common support condition weakens the estimated relationship between green expenditures and wages in cross-sectional and diff in diff regression models (see columns 1 and 3) while the Within FE estimates is + 0.8% (column 2).

However, the PSM-related models reinforce the main finding discussed until now. The green transition at the workplace is expected to boost productive competitiveness even though inequality concerns remain.

5 Conclusions

In this paper we have investigated the impact of firms' green investments on productivity and average wages, digging into the idiosyncratic characteristics of investment typologies. A wide body of literature, originating from the seminal contribution by Porter and van der Linde (1995), has stressed the double impact of firms' new green investments on both economic and environmental performances. Economic improvements may stem from both supply and demand side dynamics, i.e. improvements in cost conditions and in market penetration. Our results are in line with the findings of previous literature, showing that new green investments have positive effects on sales per employee.

Previous literature on the impact of green investments on firms' average wages is instead scant. Following the stream of literature stressing the positive impact of innovation on wages channeled by skill-bias and rent-sharing dynamics, we have hypothesized that new green investments yield a positive impact on firms' average wages. Our results are quite robust and provide support to this hypothesis.

In addition, we have delved into the heterogeneous characteristics of green investments, hypothesizing the existence of differential impacts on sales per employee and average wages according to the specific typology of investment considered in the analysis. We have distinguished between four typologies of investments, i.e. those associated with efficiency gains, technical advancements, cost savings, circular economy transition.

We found evidence of differential impacts on both sales per employee and average wages. In particular, energy-saving investments performed poorly in terms of effects on sales, while it shows a significant effect on wages only in the difference-in-difference estimation. Green investments involving technological advancement have the largest effect on average wages, while investments for the circular economy transition have the largest impact on sales per employee.

This paper provides a novel contribution to the literature at least in two respects. First of all, it tackles the issue of the impact of new green investments on wages, investigating in a reliable empirical framework the existence of possible wage premia. Second, we contribute to the literature by stressing the need to ascertain the differential impacts of specific types of green investments. This paper provides a systematic account of the impact of different kinds of investments, by looking at their outcome in terms of environmental performance.

Yet, this paper is not free from limitations. The most important concern is the identification of the channels behind the results we have found in our estimates. Further research efforts should be devoted for example to understand the impact on sales per employee are driven by improvement in cost conditions or by better performances in final markets with preferences for green products. Similarly, additional research should clarify whether the effects on average wages are driven by skill-bias dynamics or by the appropriation of rents accruing to the firm following the implementation of the investments.

TABLES

table 1: descriptive statistics on main variables

	T=1		T=2		T=3	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
			firms outcomes			
ln (sales per empl)*	11.757	1.206	11.888	1.215	11.902	1.130
ln (average wages per empl)*	9.646	0.724	9.871	0.670	9.926	0.615
			green investments			
at least one green tech	0.144	0.351	0.172	0.377	0.162	0.369
efficiency gains	0.096	0.294	0.119	0.324	0.106	0.307
technical advancements	0.069	0.253	0.085	0.279	0.076	0.265
cost savings	0.047	0.213	0.060	0.237	0.048	0.214
circularity	0.025	0.155	0.029	0.167	0.025	0.156
green expenditures pc*	217.2	1.448	274.8	1.649	214.1	1420
ln (green expenditures pc)*	0.365	1.645	0.473	1.849	0.413	1.716
N of obs	21,999		15,426		12,647	

Source: authors' calculations on RIL data. Sampling weights applied. * deflated values in euros

Table 1A. Average values by Macro-area

	Centre North			South		
	T=1	T=2	T=3	T=1	T=2	T=3
	firms outcomes					
ln(sales pc)*	11.811	11.897	11.919	11.569	11.838	11.796
ln(average wages pc)*	9.725	9.905	9.956	9.375	9.691	9.750
	green investments					
green technology (0/1)	0.149	0.179	0.168	0.125	0.138	0.127
efficiency gains	0.098	0.122	0.107	0.087	0.105	0.095
technical advancements	0.071	0.090	0.082	0.059	0.059	0.041
cost savings	0.051	0.060	0.051	0.036	0.056	0.033
circularity	0.027	0.029	0.027	0.017	0.030	0.015
green expenditures pc*	230,05	294,89	222,81	173,02	175,81	160,68
ln (green expenditures pc)*	0.368	0.477	0.398	0.351	0.462	0.507

Source: authors' calculations on RIL data. Sampling weights applied. * deflated values in euros

Table 1B. Average values by firm size

	n of employees<250			n of employees>249		
	T=1	T=2	T=3	T=1	T=2	T=3
	firms outcomes					
ln(sales pc)*	11.756	11.888	11.901	11.911	11.885	11.951
ln(average wages pc)*	9.644	9.869	9.924	10.159	10.176	10.221
	green investments					
green technology (0/1)	0.141	0.169	0.158	0.568	0.592	0.649
efficiency gains	0.094	0.116	0.102	0.463	0.480	0.552
technical advancements	0.067	0.082	0.073	0.384	0.416	0.460
cost savings	0.046	0.057	0.046	0.322	0.352	0.340
circularity	0.024	0.028	0.023	0.204	0.204	0.229
green expenditures pc	213.78	271.78	207.86	846.98	768.44	947.37
ln (green expenditures pc)*	0.355	0.457	0.394	2.166	2.384	2.683

Source: authors' calculations on RIL data. Sampling weights applied. * deflated values in euros

table 2: descriptive statistics on control variables

	T=1		T=2		T=3	
	mean	Std dev	mean	Std dev	mean	Std dev
	management characteristics					
tertiary education	0.237	0.425	0.242	0.428	0.242	0.428
upper secondary education	0.564	0.496	0.577	0.494	0.566	0.496
lower secondary/no education	0.199	0.399	0.181	0.385	0.192	0.394
female	0.211	0.408	0.192	0.394	0.197	0.397
family ownership	0.899	0.301	0.892	0.311	0.907	0.290
	workforce compositions					
share of executive	0.040	0.133	0.039	0.119	0.035	0.107
share of white collars	0.417	0.382	0.444	0.377	0.463	0.382
share of female	0.409	0.351	0.418	0.342	0.434	0.351
share of fixed term contracts	0.072	0.177	0.104	0.205	0.088	0.194
	firms characteristics					
exports	0.176	0.381	0.232	0.422	0.229	0.420
process innovation	0.131	0.337	0.229	0.420	0.203	0.402
product innovation	0.144	0.351	0.253	0.435	0.249	0.432
public financial aids Covid	0.600	0.490	0.273	0.446	0.200	0.400
firms age (in years)	23.277	15.013	26.711	14.995	28.945	20.859
Ln(tangible asset per employee)	9.887	2.062	10.078	2.027	10.082	2.206
employers' association	0.443	0.497	0.462	0.499	0.479	0.500
n of employee<10	0.713	0.453	0.627	0.484	0.653	0.476
9< n of employee<50	0.247	0.431	0.305	0.460	0.286	0.452
49< n of employee<250	0.035	0.183	0.059	0.236	0.052	0.223
n of employee>249	0.005	0.074	0.009	0.093	0.008	0.090
North West	0.313	0.464	0.379	0.485	0.363	0.481
North East	0.239	0.427	0.241	0.428	0.275	0.447
Centre	0.223	0.416	0.221	0.415	0.218	0.413
South	0.225	0.418	0.158	0.365	0.143	0.350
N of obs	21,999		15,426		12,647	

Source: authors' calculations on RIL data. Sampling weights applied. * deflated values in euros

Table 3: cross-sectional and panel estimates. Dep var: ln(sales per employee)

	OLS	FE	Diff-in Diff
	[1]	[2]	[3]
ln(green invest pc)	0.014***		
	[0.004]		
ln(green invest pc)*2021		0.019***	0.033***
		[0.006]	[0.010]
ln(green invest pc)*2018			0.014
			[0.010]
year 2021		-0.009	0.04
		[0.028]	[0.035]
year 2018			0.016
			[0.025]
ln (tangible asset pc)	0.128***	0.082***	0.045***
	[0.005]	[0.011]	[0.009]
other controls	Yes	Yes	Yes
firms FE	No	Yes	Yes
constant	10.571***	12.266***	12.643***
	[0.059]	[0.291]	[0.238]
N of firms	21999	7728	4802
R2	0.18	0.418	0.398

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees, public financed aids related to Covid shock. All regressions include fixed effects for the full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Table 4: cross-sectional and panel estimates. Depvar: ln (average wage per employee)

	OLS	FE	Diff-in Diff
	[1]	[2]	[3]
ln(green invest pc)	0.002		
	[0.002]		
ln(green invest pc)*2021		0.011***	0.009***
		[0.003]	[0.004]
ln(green invest pc)*2018			0.001
			[0.004]
year 2021		-0.049***	0.000
		[0.012]	[0.017]
year 2018			0.046***
			[0.011]
lkpcp	0.055***	0.048***	0.036***
	[0.003]	[0.006]	[0.004]
other controls	Yes	Yes	Yes
firms FE	No	Yes	Yes
constant	9.000***	10.708***	10.605***
	[0.032]	[0.159]	[0.152]
N of firms	21999	7617	4802
R2	0.316	0.536	0.508

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees, public financed aids related to Covid shock. All regressions include fixed effects for the full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Tab 5: cross section and panel estimates. Dep var: log of sales per employee

	at least one green	efficiency gains	technical advancem	energy savings	circular economy
	[1]	[2]	[3]	[4]	[5]
			Panel A: OLS		
b1	0.009	0.035	0.02	-0.008	0.068*
	[0.020]	[0.023]	[0.025]	[0.029]	[0.038]
other controls	Yes	Yes	Yes	Yes	Yes
R2			0.179		
			Panel B: Within FE		
b2	0.054	0.076*	0.070	0.028	0.152**
	[0.035]	[0.041]	[0.045]	[0.053]	[0.062]
other controls	Yes	Yes	Yes	Yes	Yes
R2			0.418		
			Panel C: Diff in Diff FE		
b2	0.149***	0.145**	0.137**	0.030	0.229**
	[0.051]	[0.060]	[0.067]	[0.074]	[0.095]
b3	0.090*	0.071	0.044	-0.029	0.026
	[0.051]	[0.060]	[0.068]	[0.071]	[0.093]
other controls	Yes	Yes	Yes	Yes	Yes
R2			0.398		

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed year fixed effects and the fixed effects for full set of interactions between nuts 2 regions and 13 nace sectors (Ocse classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Tab 6: cross section and panel estimates. Dep var: (log of) average wages per employee

	at least one green	efficiency gains	technical advancem	energy savings	circular economy
	[1]	[2]	[3]	[4]	[5]
	Panel A: OLS				
b1	0.004	-0.002	0.007	-0.016	-0.010
	[0.009]	[0.010]	[0.012]	[0.013]	[0.016]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.316				
	Panel B: Within FE				
b2	0.052***	0.059***	0.066***	0.018	0.039**
	[0.015]	[0.017]	[0.016]	[0.020]	[0.020]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.535				
	Panel C: Diff in Diff FE				
b2	0.051**	0.056**	0.079***	0.030	0.068**
	[0.020]	[0.023]	[0.023]	[0.026]	[0.032]
b3	0.003	-0.009	0.030	-0.025	0.023
	[0.021]	[0.024]	[0.023]	[0.027]	[0.031]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.508				

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed year fixed effects and the fixed effects for full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Table 7: cross sectional and panel estimates. Centre-Northern regions

	ln (sales per empl)			ln (average wages per empl)		
	OLS	FE	Dif-in-Dif	OLS	FE	Dif-in-Dif
	[1]	[2]	[3]	[4]	[5]	[6]
Ln (green exp pc)	0.012***			0.002		
	[0.004]			[0.002]		
Ln (green exp pc)*2021		0.018***	0.037***		0.011***	0.009**
		[0.007]	[0.011]		[0.003]	[0.004]
Ln (green exp pc)*2018			0.016			0.000
			[0.011]			[0.004]
year2021		-0.033	0.028		-0.053***	0.001
		[0.031]	[0.039]		[0.013	[0.018]
year2018			0.017			0.039***
			[0.027]			[0.012]
Ln (tangible asset pc)	0.122***	0.088***	0.046***	0.053***	0.056***	0.036***
	[0.006]	[0.012]	[0.010]	[0.003]	[0.007]	[0.005]
other controls	Yes	Yes	Yes	Yes	Yes	Yes
constant	10.702***	12.091***	12.804***	9.199***	10.593***	10.657***
	[0.071]	[0.305]	[0.266]	[0.037]	[0.179]	[0.165]
Obs	15682	12434	10467	15682	12790	10467
R2	0.172	0.41	0.392	0.327	0.515	0.503

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, contractual arrangements, hirings, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, union presence, employers' membership, firms age (in years). All regressions include fixed effects for nuts 2 regions, 13 nace sectors and firms' size (log of number of employees. Robust standard errors - clustered at firm level- in parentheses. Statistical significance *** at 1%, ** at 5% and * at 10%

Tab 8: Diff in diff FE estimates. North-Centre regions.

	at least one green	efficiency gains	technical advancem	energy savings	circular economy
	[1]	[2]	[3]	[4]	[5]
	Panel A: sales per employee				
b2	0.135***	0.151***	0.139**	0.053	0.169*
	[0.052]	[0.058]	[0.066]	[0.073]	[0.091]
b3	0.071	0.070	0.034	-0.027	0.029
	[0.052]	[0.059]	[0.068]	[0.074]	[0.092]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.388				
	Panel B: average wages per employee				
b2	0.058***	0.060***	0.067***	0.050*	0.055*
	[0.02	[0.023]	[0.023]	[0.028]	[0.028]
b3	0.010	-0.002	0.025	-0.001	-0.001
	[0.021]	[0.023]	[0.023]	[0.029]	[0.029]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.499				

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed year fixed effects and the fixed effects for full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Table 9: cross sectional and panel estimates. Firms with less than 250 employees

	ln (sales per employees)			ln (average wages per employee)		
	ols	fe	diff	ols	fe	diff
	[1]	[2]	[3]	[4]	[5]	[6]
ln(green invest pc)	0.012***			0.002		
	[0.004]			[0.002]		
ln(green invest pc)*2021		0.019***	0.028***		0.013***	0.008**
		[0.007]	[0.010]		[0.003]	[0.004]
ln(green invest pc)*2018			0.009			0.000
			[0.010]			[0.004
ln (tangible asset pc)	0.122***	0.081***	0.042***	0.053***	0.047***	0.037***
	[0.005]	[0.011]	[0.008]	[0.003]	[0.006]	[0.004]
year 2021		0.000	0.067*		-0.042***	0.002
		[0.029]	[0.036]		[0.012]	[0.018]
year 2018			0.013			0.041***
			[0.026]			[0.012]
other controls	Yes	Yes	Yes	Yes	Yes	Yes
constant	10.649***	12.030***	12.418***	8.990***	10.633***	10.402***
	[0.061]	[0.299]	[0.237]	[0.033]	[0.165]	[0.163]
N of firms	20616	6896	4397	20616	6896	4397
R2	0.167	0.412	0.394	0.303	0.530	0.503

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed effects for the full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Tab 10: Diff in diff FE estimates. Firm with less than 250 employees.

	at least one green	efficiency gains	technical advancem	energy savings	circular economy
	[1]	[2]	[3]	[4]	[5]
	Panel A: sales per employee				
b2	0.162***	0.136**	0.164**	0.027	0.277**
	[0.054]	[0.063]	[0.069]	[0.079]	[0.112]
b3	0.074	0.05	0.023	-0.043	0.009
	[0.053]	[0.063]	[0.071]	[0.076]	[0.112]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.393				
	Panel B: average wages per employee				
b2	0.047**	0.039	0.071***	0.043	0.070*
	[0.021]	[0.025]	[0.026]	[0.033]	[0.039]
b3	-0.003	-0.019	0.030	-0.027	0.033
	[0.022]	[0.026]	[0.026]	[0.034]	[0.040]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.503				

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed year fixed effects and the fixed effects for full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Table 11: cross-sectional and panel estimates with PSM. Dep var: ln(sales per employee)

	OLS	FE	Diff-in Diff
	[1]	[2]	[3]
ln(green invest pc)	0.012***		
	[0.004]		
ln(green invest pc)*2021		0.018**	0.023**
		[0.007]	[0.011]
ln(green invest pc)*2018			0.007
			[0.011]
year 2021		0.023	0.089
		[0.052]	[0.057]
year 2018			0.071
			[0.048]
ln (tangible asset pc)	0.140***	0.090***	0.057***
	[0.006]	[0.022]	[0.015]
other controls	Yes	Yes	Yes
firms FE	No	Yes	Yes
constant	10.318***	12.967***	13.423***
	[0.092]	[0.492]	[0.435]
N of firms	10036	3132	2080
R2	0.205	0.586	0.536

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed effects for the full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Table 12: cross-sectional and panel estimates with PSM. Dep var: ln(wages per employee)

	OLS	FE	Diff-in Diff
	[1]	[2]	[3]
ln(green invest pc)	0.001		
	[0.002]		
ln(green invest pc)*2021		0.008***	0.002
		[0.003]	[0.004]
ln(green invest pc)*2018			-0.002
			[0.005]
year 2021		-0.023	0.052*
		[0.016]	[0.027]
year 2018			0.079***
			[0.026]
ln (tangible asset pc)	0.067***	0.062***	0.036***
	[0.003]	[0.010]	[0.007]
other controls	Yes	Yes	Yes
firms FE	No	Yes	Yes
constant	8.902***	11.028***	11.550***
	[0.043]	[0.263]	[0.244]
N of firms	10036	7421	6179
R2	0.379	0.682	0.595

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed effects for the full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

APPENDIX

Table 5A: cross sectional and panel estimates. Southern regions

	ln (sales per employees)			ln (average wages per employee)		
	ols	fe	diff	ols	fe	diff
	[1]	[2]	[3]	[4]	[5]	[6]
ln(green expenditures pc)	0.020***			0.004		
	[0.007]			[0.003		
ln(green expenditures pc)*2021		0.017	0.013		0.014**	0.013
		[0.016]	[0.027]		[0.006]	[0.010]
ln(green invest pc)*2018			0.005			0.004
			[0.022]			[0.009]
year2021		0.065	-0.016		-0.080***	-0.031
		[0.073]	[0.088]		[0.029]	[0.052]
year2018			-0.031			0.056*
			[0.066]			[0.033]
ln (tangible asset pc)	0.146***	0.050*	0.033*	0.061***	0.040***	0.035***
	[0.008]	[0.026]	[0.020]	[0.005]	[0.011]	[0.008]
other controls	Yes	Yes	Yes	Yes	Yes	Yes
constant	10.287***	13.021***	11.758***	8.768***	10.564***	10.009***
	[0.109]	[0.873]	[0.587]	[0.063]	[0.327]	[0.419]
Obs	6317	2882	2138	6317	3000	2138
R2	0.18	0.44	0.426	0.22	0.508	0.478

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, contractual arrangements, hirings, firms characteristics such as selling services and products on foreign markets, product innovation, process innovations, union presence, employers' membership, firms age (in years). All regressions include fixed effects for nuts 2 regions, 13 nace sectors and firms' size (log of number of employees. Robust standard errors - clustered at firm level- in parentheses. Statistical significance *** at 1%, ** at 5% and * at 10%

Tab 6A: Diff in diff FE estimates. Southern regions.

	at least one green	efficiency gains	technical advancem	energy savings	circular economy
	[1]	[2]	[3]	[4]	[5]
	Panel A: sales per employee				
b2	0.075	0.026	-0.038	-0.322	0.055
	[0.132]	[0.167]	[0.183	[0.209	[0.258]
b3	0.164	0.177	0.115	-0.12	-0.189
	[0.121]	[0.145]	[0.160]	[0.162	[0.218]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.431				
	Panel B: average wages per employee				
b2	0.051	0.074	0.118*	0.057	0.092
	[0.060]	[0.069]	[0.072]	[0.086]	[0.124]
b3	0.032	0.012	0.063	0.015	0.032
	[0.057]	[0.066]	[0.068]	[0.084]	[0.114]
other controls	Yes	Yes	Yes	Yes	Yes
R2	0.467				

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms' characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed year fixed effects and the fixed effects for full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

Table 7A: cross sectional and panel estimates. Firms with more than 249 employees

	ln (sales per employees)			ln (average wages per employee)		
	ols	fe	diff	ols	fe	diff
	[1]	[2]	[3]	[4]	[5]	[6]
ln(green invest pc)	0.011			0.006		
	[0.012]			[0.005		
ln(green invest pc)*2021		0.016	0.051		-0.003	-0.006
		[0.023]	[0.031]		[0.008]	[0.012]
ln(green invest pc)*2018			0.021			-0.008
			[0.029]			[0.011]
ln (tangible asset pc)	0.171***	0.091*	0.080*	0.063***	0.054**	0.036**
	[0.022	[0.051	[0.044	[0.011	[0.023	[0.017]
year 2021		0.002	-0.070		-0.062	0.021
		[0.130]	[0.162]		[0.039]	[0.059]
year 2018			0.052			0.099**
			[0.106]			[0.047]
other controls	Yes	Yes	Yes	Yes	Yes	Yes
constant	9.153***	15.345***	14.615***	9.281***	12.032***	11.772***
	[0.374]	[2.218]	[1.829]	[0.167	[0.912]	[0.759]
N of firms	1343	569	373	1343	569	373
R2	0.370	0.405	0.466	0.474	0.548	0.560

Source: authors' elaborations on RIL 2021-2018-2015 data. Note: other controls include management characteristics by entrepreneurs' education, gender and family ownership; workforce composition by professional status, gender, and contractual arrangements, firms’ characteristics such as selling services and products on foreign markets, product innovation, process innovations, employers' membership, firms age (in years), (log of) number of employees. All regressions include fixed effects for the full set of interactions between nuts 2 regions and 13 nace sectors (Oce classification). Robust standard errors - clustered at the firm level- in parentheses. Statistical significance: *** at 1%, ** at 5% and * at 10%

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