



Green jobs and eco-innovations in European SMEs



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ABSTRACT

Green jobs are a key objective of societal efforts to concretely support the long-term endeavour to reconcile sustainability and development. The present article analyses the extent to which the future growth of green jobs is influenced by microeconomic and sector/macro level factors. We conduct econometric analyses of European Small Medium Enterprise firms to assess the factors affecting the creation of green jobs in small and medium firms. We find that green product and service innovation is primarily relevant to the creation of green jobs. The interaction term between an environmental management system and product and service innovations has a positive and significant effect on the decision to hire for green jobs. We also conduct a deep analysis of the subset of firms that produce green products and services, which reveals some idiosyncratic features. This study lays the foundations for future research on the development of green skills, competences and jobs in firms as a reaction to market and policy levers.

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1. Introduction

European unemployment rates are currently still high and also vary from country to country. Both unemployment and the challenges posed by new climate change and resource efficiency targets (EEA, 2013) raise serious questions about how to effectively transition towards a sound and high-performing green economy. The 2008–2009 recession has fiercely reignited the question of how to turn ‘normal’ growth into green growth, which should bring together increasing labor productivity and wages, on the one hand, and increasing energy and environmental production efficiency on the other. Given this reasoning, innovation is a pivotal force to sustain growth and development and to decouple these from environmental impacts (for macroeconomically oriented discussions of green jobs-related issues, see Antal, 2014; Fankhauser et al., 2008; UNEP, 2011). The factor that may compensate for scale effects is technology: technological development can boost both labor and resource efficiency (EEA, 2014), as has already been shown in previous empirical literature (Horbach and Rennings, 2013). Through (policy induced) innovation, sustainable development policies may support employment creation (McNeil and Williams, 2007).

Eco Innovations (EI)¹ are at the core of this reasoning (Cainelli et al., 2015a, 2015b; Horbach and Rennings, 2012): Eco innovation might contribute to reducing environmental impacts and increasing competitiveness, which may include the

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¹ See Rennings (2000); Mazzanti and Zoboli (2010), Kemp (2010) and Kemp and Pontoglio (2011) for in depth conceptual discussions around the theme. Wide recent surveys of the literature are presented by Barbieri et al. (2016) and Mazzanti et al. (2016).

development of green jobs. Creating jobs and developing skills are linked to the important complementarity that exists between technology and human capital (Antoninoli et al., 2013; Consoli et al., 2016a,b).

Against this background, a specific critical aspect of the EU's future economic development is how SMEs, which are a large part of the EU economy, may bring together competitiveness and sustainability strategies, namely economic and environmental productivity/efficiency² strategies (Grolleau et al., 2012; Cainelli et al., 2013). Small and Medium Enterprises (SMEs) account for a large share of the EU economy and are expanding their eco-innovation activities (Marin et al., 2015) to increase labor demand in relation to green jobs. One of the most concrete outcomes of an integrated green economy strategy is the 'creation' of green jobs and green skills³ that entail a greening/reskilling of the current workforce and creation of jobs/skills. The term 'green job' is a loose one (Kouri and Clarke, 2014): so far it has been used both in relation to employment in pollution control, energy efficiency and waste management as well as in a broader sense, that is, referring to occupations in agriculture, industry, and services that contribute to preserving or restoring the quality of the environment.

The present article exploits a large dataset of European SMEs to analyse the extent to which the future growth of green jobs is influenced by micro-economic (innovation strategy), sectoral and macro-economic level factors. As far as we know, analyses of (green) jobs are rare and complement studies of the economic effects of eco-innovation (Marin, 2014; Mazzanti et al., 2016). The key research question revolves around the job creation role of (i) green product⁴ and service innovations and (ii) organisational innovations.⁵ The former are targeted at increasing the value of marketed outputs, with a direct impact on job creation by demand effects (Hamermesh, 1993; Horbach and Janser, 2016). The latter are aimed at creating value and employment through the re-organisations of firms' processes and structures, including skills and jobs. To deeply investigate the creation of green jobs among green innovators we run a subset of analyses to study how the increased turnover generated from green innovations and the motivations that lead to green products and services affect the creation of green jobs. The focus on product innovation adds more specific knowledge to the bulk of studies that exploit Community Innovation data at the EU level, which do not disentangle product and process innovations (e.g., Horbach and Rennings, 2012; Borghesi et al., 2015; Horbach and Janser, 2016).

The article is structured as follows. Section 1 presents a review of relevant literature. Section 2 describes the hypothesis and method. Section 3 presents the overall sample and the empirical strategy used to analyse all SME firms. Section 4 presents the results of estimations using the sample of firms producing green products and services. Section 5 concludes.

2. The relevant literature: theory and recent advancements

Academic research has interacted closely with international organisations' attention to the green economy and job creation. As a key example, the OECD (2012) stressed that (1) supporting green skills is integral to the transition to a low carbon economy; (2) developing green skills is part of a broader challenge of increasing the strategic management capabilities of SMEs; and (3) investing in R&D is essential in order to anticipate the gaps in knowledge that the green economy challenge reveals. Job growth in low carbon/circular economy oriented activities might offset losses in brown sectors, although the skills involved in greener (new) activities are possibly different from those now required in contracting sectors.

Green jobs are an important aspect of the relationships that might exist between (green) innovation and the creation of jobs (Deschenes, 2013); this recalls the key issue in the 'jobs versus the environment' debate (Baer et al., 2015). The economic literature has analysed whether the costs introduced by environmental strategies and policies might turn into technological developments, organisational changes and value creation that lead to a net effect on employment.⁶

There is still a lack of specific evidence on the effects of (eco) innovation on employment and on green jobs in particular. Fankhauser et al. (2008) suggest that jobs could be stimulated by shifts to higher labor intensity sectors in the short term and that the higher intensity of labor might be a feature of the first period of the green economic path. Young and green technologies may in fact be (temporarily) more labor intensive due to short-term capital fixity (Gagliardi et al., 2016). In the medium and long term, economic adjustments are difficult to gauge, given the strong structural adjustments required by climate policy targets. Wide job creation effects could be generated in the medium-long term by lower energy prices induced by lower energy demands (Baer et al., 2015). Looking at structural change dynamics, employment gains may follow from environmental policies and green strategies, given the reallocation of value and production from highly capital-intensive industries to labor-intensive sectors. This 'transition' could witness an increasing role for SMEs in the creation of green jobs.

The literature shows that innovation creates both short-term and long-term effects, which are different across various types of innovation. Innovation can have a positive or negative effect on the creation of employment (we refer to Pianta, 2005 for an extensive survey of the classic question 'does technology destroy or create jobs?'). One seminal piece of work

² See the OECD's activities in the field of green jobs and skills (<http://www.oecd.org/employment/greeningjobsandskills.htm>).

³ It is worth referring to the 'Skills for Green Jobs' Technical Validation Workshop International Labour Organization/CEDEFOP May 17, 2010, Geneva, Switzerland.

⁴ We refer to Dangelico and Pontrandolfo (2010) for green product classifications and definitions.

⁵ It should be noticed that also process innovations can impact the creation of green job, unfortunately the dataset used do not have information related to process innovation.

⁶ Recalling that social welfare is composed of environmental and economic values that might be characterized by trade-offs or synergies. Employment is then an additional complementary social goal. The role of technology is crucial for linking environmental, economic and employment dynamics (Costantini and Mazzanti, 2013; Fankhauser et al., 2008).

is [Van Reenen \(1997\)](#), who shows that technological progress creates jobs (in British firms) with effects that are persistent over time and is more important than industry spillover effects and wages, among other factors.

There is a major strand of literature in innovation studies that analyses the effects of innovation in the creation of employment. This literature mainly uses and exploits different types of data based on EU firm-based surveys. [Antonucci and Pianta \(2002\)](#) analyse the EU CIS waves with the aim of assessing the relevance of differentiating employment effects generated by process and product technological innovations. A relatively more structural change-oriented perspective on the role of product and process innovation during the economic cycle (growth and downturn) is offered by [Lucchese and Pianta \(2012\)](#). [Mastrostefano and Pianta \(2009\)](#), using CIS data, assess the effects of innovations on employment. They stress the role of both short-term labor market effects and long-term structural change dynamics, the importance of considering various innovation types, and the relevance of analysing diversified effects across high- and low-innovation industries. An important research question they analyse is the role of different sectors' technological effects in the creation of employment ([Bogliacino and Pianta 2010](#)⁷), with particular emphasis on macro-effects ([Lucchese and Pianta, 2012](#)).

Studies of the role of (eco) innovation's effects on the creation of green jobs are still in their infancy. Notable contributions are in particular the article of [Horbach and Rennings \(2013\)](#) who show that innovative firms are characterized by the creation of employment, particularly once they adopt green process technologies. They suggest that cost savings induced by this type of process innovation improve the competitiveness of firms, which in turn increases employment. [Gagliardi et al. \(2016\)](#) focus on employment and patents, namely invention rather than innovation adoption. In their Italian case study, they do find positive and significant effects of green patents and total patents on employment.

[Albrizio et al. \(2014\)](#) have recently re-emphasised the need to focus on the economic effects of environmental policy and innovation strategies ([Cainelli et al., 2011](#); [Mazzanti and Montini, 2010](#); [Ghisetti and Rennings, 2014](#)), a line of research that has been relatively overlooked with respect to the more consolidated literature that addresses the drivers of eco-innovations and patents ([Popp, 2002](#); [Horbach, 2008](#)). Interestingly, and limited to the case of France, recent works have also analysed the correlation between Environmental Standards and a firm's recruitment on the one hand and workers' attitudes on the other as indicators of a firm's performance ([Lanfranchi and Pekovic, 2014](#); [Grolleau et al., 2012](#)). This is important because job creation is going to produce qualified occupations if both skills upgrading and workers' attitudes are enhanced. Profitability and productivity also depend on these intangible human resource factors, which eventually complement the adoption of eco-innovation ([Antonoli et al., 2013](#)).

It follows that jobs and skills are integrated pillars. [Vona et al. \(2015\)](#) discuss the various definitions of green jobs in various institutions and try to provide a more solid grounding for the definition of green skills using a task and competence-based approach. One critical issue they raise is whether green jobs are defined by the greenness of the industry (also including brown jobs) or by the bottom-up classification of jobs through the analysis of tasks and competences in a given firm. For a comprehensive set of definitions see [OECD \(2013, p. 50\)](#). The definition used in this article follows the ILO green job approach more than the Eurostat perspective of 'employment in environmental goods and services sectors' ([Bezdek et al., 2008](#) find that green jobs are created in manufacturing and in specialised and professional services; the net job effect of environmental protection investments is a net positive for the US).⁸

The present article contributes to the literature that studies the role of (eco) innovation's effects on the creation of green jobs. The article focuses on the short run demand for new additional jobs as one of the main ways SMEs can integrate new skills and enhance firms' capabilities to cope with the challenges of green strategies and environmental policies⁹ in a cycle phase where the EU economy is not at full employment and environmental targets are up-levelled.

The specific analysis of green jobs is embedded within a broader picture that describes firms' 'capabilities development', that are enhanced by increasing workers' skills and/or recruiting new workers. We focus on the latter, under a set of contingent motivations of the study.

3. Research hypotheses, data and model

We define our empirical specification on the basis of a consolidated literature that studies the link between innovation and employment by using firms' data ([Van Reenen, 1997](#)). In the econometric analysis we specifically refer to the specification used by [Antonucci and Pianta \(2002\)](#).¹⁰

We conceptually exploit a standard labor demand model in which environmental considerations are introduced. In the broad picture, the 'greening' of labor demand may take different forms and is embedded within the even more general

⁷ The effect of value-creating product innovations, cost competitiveness process innovations, demand and industry dynamics are analysed for 8 countries using the usual CIS framework as the empirical setting.

⁸ [Bowen and Kuralbayeva \(2015\)](#) interestingly define and integrate categories of: employment in production of environmental outputs, employment in environmental processes, employment in non environmental sectors created thanks to greening, and finally decent jobs (related to wage, workers' satisfaction, and training issues).

⁹ The enhancement of workforce quantitative and qualitative green capabilities is a factor that may dynamically impact innovation and is linked to the need to incorporate knowledge from outside the firm's boundaries. The relative 'complexity' of green management depends, among other things, on a riskier, long term business environment ([Berrone et al., 2013](#)), where external sources of knowledge are required ([Ghisetti et al., 2015](#)). Changing the work force structure and cooperating with other firms and institutions are all ways to enhance economic performance while targeting sustainability.

¹⁰ [Horbach and Janser \(2016\)](#) also estimate a labor demand in a panel setting.

greening of economic performance functions, e.g., production/jobs (Mazzanti et al., 2016; Costantini and Mazzanti, 2012). Green job demand is enhanced by the adoption of techno-organisational innovations because extended/new skills are needed and – regarding both process and product innovation – the market share and/or market value of products might expand by direct and indirect mechanisms (Harrison et al., 2014).¹¹ We define two distinct hypotheses:

3.1. Product and service innovation ‘value’ effect

Product and service innovations may support green jobs through the enhancement of value creation: net positive effects are expected at least in the short-medium run from the time of adoption.¹² Green products are driven by policy and market drivers. They are a strong component of green structural change in the economy, where additional units of output and value are greener (more efficient in using resources). The demand (and policy) effect is also important when we consider the Jevons/rebound effect. As a more efficient use of the environment partially incentivizes the use of a more efficient tool (e.g., cars), it is relevant that the generated income effect is allocated to greener consumption.

3.2. ‘Re-organisation’ innovation effect

Adopting organisational innovation strategies – such as EMS and ISO – increases expected green job demand due to the need to re-organize the entire firm’s ‘innovation structure’, wherein specific green recruitment and green training are key complementary elements to this organisational type of innovation (Antonioni et al., 2013; Wagner, 2013)¹³; or, they might increase the firms’ competitiveness, leading to increased job creation (Horbach and Rennings, 2013).¹⁴ Consoli et al. (2016a,b) show that green jobs use higher-level skills compared to non-green jobs, as green jobs are characterized by high intensity of formal education and training. Green jobs are also more exposed to technology. This higher exposure to technology (e.g. environmental patents) affects the demand for some types of (higher) skills. The strong interconnections among organisational change, human capital and job creation are clearly at the core of the narrative about the green economy and jobs.

To estimate the extent to which the joint production of green innovations and organisational innovations can impact the decision to hire workers for green jobs in the future, we introduce an interaction effect of these two measures.

4. Empirical analysis of green jobs demand

The empirical section includes two parts. The first section presents the estimations related to the entire sample of the firms. The second part focuses only on the firms that produce green products and services to enhance our understanding of the particular effects of innovative firms. In the empirical model, the dependent variable Nb Green Job is a count variable that measures ‘the (expected) creation of new jobs in the next 2 years’. A Poisson regression is a baseline model for count data (Hausman et al., 1984). However, the results of the Poisson specification compared to the negative binomial model show that the standard errors gain in efficiency with the negative binomial (Cameron and Trivedi, 2009) and the test of over-dispersion confirms the application of the negative binomial specification. The main purpose here is to analyse the extent to which future growth of green jobs¹⁵ is influenced by micro-economic factors, such as technological and organisational (e.g., EMS) innovation adoption in firms, and macro/sector features. The data were collected at the beginning of 2012.¹⁶

Eq. (1) presents the econometric specification:

$$l_{i,t+2} = \alpha + \beta_1 \text{GreenProductService}_i + \beta_2 \text{EMS}_i + \beta_3 \text{GreenProductService}_i * \text{EMS}_i + \beta_4 \text{Greenpresent} + \beta_5 Y_i + \beta_6 \frac{W_j}{P_j} + \beta_7 Y_j + \beta_8 C_k + \varepsilon_i \quad (1)$$

where $l_{i,t+2}$ is labor demand (for green jobs)¹⁷ of firm i in time $t+2$; Y_i includes two characteristics of the firms: the economic component (turnover) that can drive the labor demand of firm i in time t and the age of firm i at time t . To measure the production of green innovations and services we include the dummy variable $\text{GreenProductService}_i$, and to consider the introduction of organisational innovation we include the variable EMS_i . The interaction term between these two dummy

¹¹ They model and analyse the employment growth of process and product innovations in the UK, Spain, Germany, and France.

¹² In the medium-term, product innovations may nevertheless reduce market competitiveness, thus changing market structures. Output reduction could reduce labor demand at the industry level due to more monopolistic behaviour.

¹³ Borghesi et al. (2015) suggest the key role of both organisational and technological innovations to enhance the overall advancement of EU sectors towards the low carbon economy.

¹⁴ Lam and Marsden (2016, p. 5) state: “Organisational knowledge evolves over time as the organisation’s environment and needs change”. This means that the organisational structure will strongly influence the demand for labor (in the short-term) and labor supply (adapting more slowly through education and training in the medium-term) with the necessary skills and knowledge.

¹⁵ The survey allows for lags between correlated factors, with the question on green jobs posed at time $T+1$ (2012) with respect to other examined factors (2011 and earlier).

¹⁶ 2012 was a recession year, with GDP decreasing in the EU by 0.4% and in the Eurozone by 0.7%. Unemployment increased to 10.3 in 2012 in the EU from the 2011 level of 9.5.

¹⁷ Following Baer et al.’s (2015) definition of ‘impacts’ on jobs, we focus on ‘first order impacts’, where partial equilibrium with price and technology coefficients are constant. We introduce a dynamic in the way innovation evidence and data precedes job creation evidence by firms.

variables measures the joint decision to become involved in green innovations and green organisational practices. y_i is a set of variables that measures the organisational characteristics of the firms. The ratio $\frac{w_j}{p_j}$ is the measure of sectoral productivity growth, which capture wage effects,¹⁸ and γ_j includes the sectoral dummies to consider sector-specific effects (Cainelli et al., 2013). We assume, on the basis of consolidated evidence, that eco-innovations are driven by market (demand) and policy factors, as well as by structural change and composition effects. In this article we do not specifically consider environmental policy effects. These are more manageably investigated at the meso and macro levels, which allow the use of indicators of policy stringency. At the firm level this is likely to be feasible in the case the analysis is devoted to specific policies, such as the EU emission trading policy (Calel and Dechezleprêtre, 2016).

To test to what extent the firms that are already employing green jobs will continue in this pattern we include in the regression the dummy variable *GreenPresent_i*, which measures whether there are already green jobs in the company. C_k measures the set of country dummies to consider any particular national patterns.

The Eq. (2) presents the model specification of the second empirical estimation in which we concentrate on the subsample of innovative firms.

$$l_{i,t+2} = \alpha + \beta_1 \alpha_i + \beta_2 EMS_i + \beta_3 \text{Greenpresent} + \beta_4 Y_i + \beta_5 \frac{w_j}{p_j} + \beta_6 y_j + \beta_7 C_k + \varepsilon_i \quad (2)$$

where $l_{i,t+2}$ is labor demand (for green jobs)¹⁹ of firm i (that has already producing green products and services) in time $t+2$. In the model (3) and (4) in Table 5, α_i includes the set of variables indicating the main reason why firm has producing any green products and services. In the model (1) and (2) in Table 5, α_i measures the turnover generated from the commercialization of green products and services. The other variables are specified as in Eq. (1).

4.1. Description of the whole sample

To test the main research hypothesis and estimate the labor demand, we exploit original European firms' data, which permits an assessment of the factors affecting the creation of green jobs in small and medium firms (Eurobarometer survey, EU Commission).²⁰ The sample was collected between January and February 2012 and concerns 7457 firms. We concentrate our analysis on the sample of SMEs. The dataset contains a large number of variables that permits the measurement of firms' innovative activities, and in particular measurement of the relative importance of green products and services in terms of turnover and the past experience of green innovation. There are different sets of data, namely (1) information related to the improvement of resource efficiency, (2) the motivation that leads firms to improve the environmental footprint of their activities, (3) the use of environmental management systems and (4) the set of firms' organisational characteristics.

Concerning the number of green jobs that firms intend to create in the next two years, on average firms aim to create about six new jobs. About 42.5% of firms have at least one green job employee. With regards to the size of firms, approximately 45.9% of the sample includes firms with fewer than 9 employees, 34.8% of the firms have between 10 and 49 employees, and 19.2% of the firms have between 50 and 249 employees. Table 1 presents the descriptive statistics of the variables. The correlation matrix that regards explanatory variables is presented in Tables 3 and A1 in Appendix A (sub set of firms).

To test the main research hypothesis, we consider the following information offered by the questionnaire. The survey asks individuals if they have introduced a green product or service – defined in the sample as *GreenProductService_i*, which represents approximately 30.2% of firms in our sample. To measure organisational innovative practices, the dummy variable *EMS* indicates if the firm has used any environmental management system, such as EMAS or ISO14000, in the period preceding green job creation. Approximately 28% of the firms use one of these practices.

To estimate the effect of wages, which is important in assessing the demand for labor, we use the variable *GrowthValueaddedEmp*, which measures the growth of the ratio between the sector value added and the sector employment. We also include the sectoral dummies, as they measure the idiosyncratic condition of each sector. In particular, firms in the Manufacturing sector represent approximately 25.4% of the sample, the Trade and Wholesale sector represents approximately 24.4% and Construction approximately 20% of the sample.

4.2. Econometric evidence: all firms

The specification of the model follows Eq. (1). The results of the negative binomial estimations are presented in Tables 2A and 2B. To test the robustness of our results, we investigate different sets of specifications. The estimation of the labor demand for green jobs shows that the introduction of green products and services *GreenProductService_i* positively correlates to the creation of new green jobs. This result corroborates a specific green realm and – at the EU level – some

¹⁸ We know that in this partial equilibrium framework we cannot provide evidence of the net effect on jobs (creation of green jobs and eventual destruction of other jobs).

¹⁹ Following Baer et al.'s (2015) definition of 'impacts' on jobs, we focus on 'first order impacts', where partial equilibrium with price and technology coefficients are constant. We introduce a dynamic in the way innovation evidence and data precedes job creation evidence by firms.

²⁰ De Wit and Kok (2014) exploit a European Commission survey to analyse the seminal hypothesis 'do SMEs create more jobs?'.

Table 1
Descriptive statistics.

Variable	Description	Obs	Mean	St. Dev	Min	Max
Nb green job	Number of green job created in the next 2 years	7457	5.658	18.386	0	240
GreenProductService	Takes value 1 if firm has introduced a green product or services, 0 otherwise	7457	.302	.459	0	1
EMS	Takes value 1 if firm uses environmental management system (such as EMAS, ISO14000), 0 otherwise	7457	.281	.449	0	1
GreenPS* EMS	Interaction effect between the variable <i>GreenProductService</i> and <i>EMS</i>	7457	.095	.293	0	1
Greenpresent	Takes value 1 if firm has already hired at least one employee qualified as green jobs, 0 otherwise	7457	.426	.494	0	1
Turnover1	Takes value 1 if firm's Turnover is less than 100 000 euro, 0 otherwise	7457	.184	.388	0	1
Turnover2	Takes value 1 if firm's Turnover is More than 100 000–500 000 euro, 0 otherwise	7457	.264	.441	0	1
Turnover3	Takes value 1 if firm's Turnover is More than 500 000–2 million euro, 0 otherwise	7457	.254	.435	0	1
Turnover4	Takes value 1 if firm's Turnover is More than 2–10 million euro, 0 otherwise	7457	.190	.392	0	1
Turnover5	Takes value 1 if firm's Turnover is More than 10–50 million euro, 0 otherwise	7457	.089	.284	0	1
Turnover6	Takes value 1 if firm's Turnover is More than 50 million euro, 0 otherwise	7457	.019	.136	0	1
Age	Categorical variable ^a	7457	9.658	3.163	1	14
<i>Employee1</i>	<i>Takes value 1 if firm has between 1 to 49 employees, 0 otherwise</i>	7457	.459	.498	0	1
<i>Employee2</i>	<i>Takes value 1 if firm has between 10–49 employees, 0 otherwise</i>	7457	.348	.476	0	1
<i>Employee3</i>	<i>Takes value 1 if firm has between 50–249 employees, 0 otherwise</i>	7457	.193	.394	0	1
Manufacturing	Takes value 1 if firm belongs to Manufacturing sector, 0 otherwise	7457	.255	.436	0	1
Electricity, gas, steam	Takes value 1 if firm belongs to Electricity, gas, steam sector, 0 otherwise	7457	.013	.113	0	1
Water supply, sewerage, waste management	Takes value 1 if firm belongs to Water supply, sewerage, waste management sector, 0 otherwise	7457	.019	.138	0	1
Construction	Takes value 1 if firm belongs to construction sector, 0 otherwise	7457	.201	.401	0	1
Wholesale and retail trade repair	Takes value 1 if firm belongs to Wholesale and retail trade, repair sector, 0 otherwise	7457	.244	.430	0	1
Transportation and storage	Takes value 1 if firm belongs to Transportation and storage sector, 0 otherwise	7457	.051	.219	0	1
Accommodation and food service activities	Takes value 1 if firm belongs to Accommodation and food service activities, 0 otherwise	7457	.042	.201	0	1
Information and communication	Takes value 1 if firm belongs to Information and communication sector, 0 otherwise	7457	.032	.176	0	1
Financial and insurance activities	Takes value 1 if firm belongs to Financial and insurance activities, 0 otherwise	7457	.016	.124	0	1
Real estate activities	Takes value 1 if firm belongs to Real estate activities, 0 otherwise	7457	.028	.166	0	1
Professional, scientific activities	Takes value 1 if firm belongs to Professional, scientific activities, 0 otherwise	7457	.090	.286	0	1

Source: Elaborated by the authors. The variables in italics can further detail on the nature of the sample but they are not used in the regression.

^a Takes value 1 if the firm stays in the business one year or less, 2 if the firm stays in the business for 2 years, 3 if the firm stays in the business for 3 years, 4 if the firm stays in the business for 4 years, 5 if the firm stays in the business for 5 years, 6 if the firm stays in the business for 6 years, 7 if the firm stays in the business for 7 years, 8 if the firm stays in the business for 8 years, 9 if the firm stays in the business for 9 years, 10 if the firm stays in the business 10–19 years, 11 if the firm stays in the business for 20–29 years, 12 if the firm stays in the business for 30–39 years, 13 if the firm stays in the business for 40–49 years, 14 if the firm stays in the business more than 50 years.

Table 2A

Results of the Negative binomial estimations (First part of the table): Number of green job that firms want to create in the future.

	(1)	(2)	(3)	(4)
GreenProductService	0.516*** (6.75)	0.512*** (6.71)	0.351*** (3.58)	0.546*** (6.58)
Greenpresent	2.708*** (27.59)	2.696*** (27.73)	2.705*** (27.99)	2.683*** (25.57)
EMS		0.0933 (1.27)	−0.0921 (−0.91)	
GreenPS ^a EMS			0.464*** (3.33)	
GrowthValueaddedEmp ^a				−0.00107** (−2.03)
Turnover2	0.377*** (2.74)	0.381*** (2.78)	0.397*** (2.92)	0.371** (2.50)
Turnover3	0.806*** (6.09)	0.808*** (6.11)	0.832*** (6.41)	0.862*** (6.12)
Turnover4	1.220*** (8.95)	1.217*** (8.91)	1.224*** (9.12)	1.247*** (8.51)
Turnover5	1.467*** (9.79)	1.441*** (9.55)	1.433*** (9.61)	1.494*** (9.30)
Turnover6	2.250*** (9.01)	2.217*** (8.75)	2.174*** (8.64)	2.430*** (9.04)
age	0.0340** (2.19)	0.0335** (2.16)	0.0325** (2.12)	0.0343* (1.95)

To be continued in Table 2B R² and number of observations are reported in Table 2B.

t statistics in parentheses.

* p < 0.10.

** p < 0.05.

*** p < 0.01.

^a This variable measures the Growth of 'value added of employment' and is a proxy for real wages: the mean is 2.88 and the standard deviation is 30.146.**Table 2B**

Results of the Negative binomial estimations (Second part of the table): Number of green job that firms want to create in the future.

	(1)	(2)	(3)	(4)
Manufacturing	0.243 (0.53)	0.254 (0.55)	0.272 (0.60)	0.212 (0.42)
Electricity	0.712 (1.51)	0.717 (1.51)	0.751 (1.61)	0.565 (1.08)
Water supply sewerage	0.702 (1.54)	0.704 (1.53)	0.718 (1.59)	0.529 (1.04)
Construction	0.231 (0.50)	0.236 (0.51)	0.253 (0.56)	0.0824 (0.16)
Wholesale_ retail trade	−0.208 (−0.46)	−0.199 (−0.43)	−0.168 (−0.37)	−0.399 (−0.79)
Transportation	0.0769 (0.16)	0.0891 (0.19)	0.140 (0.30)	−0.0423 (−0.08)
Accommodation_food service	0.483 (0.92)	0.505 (0.95)	0.537 (1.02)	0.397 (0.68)
ICT ^a	0.371 (0.71)	0.395 (0.74)	0.396 (0.76)	0.392 (0.66)
Financial and insurance	0.162 (0.30)	0.192 (0.35)	0.204 (0.38)	0.154 (0.26)
Real estate	0.271 (0.55)	0.280 (0.56)	0.282 (0.57)	0.267 (0.49)
Scientific and research	0.513 (1.08)	0.522 (1.09)	0.523 (1.12)	0.506 (0.96)
Country dummies	Yes	Yes	Yes	Yes
_cons	−2.587*** (−5.02)	−2.597*** (−4.99)	−2.567*** (−5.02)	−2.534*** (−4.46)
Inalpha _cons	0.748*** (12.59)	0.746*** (12.40)	0.740*** (12.46)	0.735*** (11.13)
N	7457	7457	7457	6405
pseudo R ²	0.137	0.138	0.138	0.142

t statistics in parentheses.

* p < 0.10, ** p < 0.05, *** p < 0.01.

^a Information communication technologies.

Table 3
Correlation Matrix all sample.

	1	2	3	4	5	6	7	8	9	10	11	
Nb GreenJob	1	1										
GreenProductService	2	0.2080*	1									
EMS	3	0.1233*	0.0490*	1								
GreenPS* EMS	4	0.2313*	0.4922*	0.5183*	1							
Greenpresent	5	0.3181*	0.3920*	0.1330*	0.2475*	1						
Turnover2	6	−0.0943*	−0.0247	−0.0734*	−0.0413*	−0.2847*	1					
Turnover3	7	−0.0231	0.0189	−0.0359*	−0.0326*	−0.2778*	−0.3495*	1				
Turnover4	8	0.0732*	0.0336*	0.0406*	0.0485*	−0.2303*	−0.2898*	−0.2827*	1			
Turnover5	9	0.1576*	0.0667*	0.1302*	0.1160*	−0.1485*	−0.1868*	−0.1823*	−0.1511*	1		
Turnover6	10	0.0956*	0.0252	0.0631*	0.0732*	−0.0658*	−0.0828*	−0.0808*	−0.0670*	−0.0432*	1	
Age	11	0.0808*	0.0399*	0.0513*	0.0602*	−0.2275*	−0.1357*	0.0502*	0.1631*	0.1847*	0.0712*	1

Significance level * $p < 0.01$.

previous findings on the link between employment and green (product) innovation in Germany (Rennings et al., 2004²¹; Horbach, 2010). It suggests that the introduction of services and product innovations stimulates the expected creation of new jobs. The increased demand is associated with the new skills required and especially with the increased economic value that product innovations generate in niche markets where the willingness to pay for new green products is higher (Gagliardi et al., 2016).

The introduction of an environmental management system EMS has no particular effect on the creation of green jobs. To enhance our analysis, we estimate the effect of the joint decision to implement an environmental management system and product and service innovations, including the interaction effect between the decision to produce green products and services and the EMS dummy variables. The interaction term has a positive and significant effect on the decision to hire for green jobs, which suggests that the introduction of green products and services, coupled with environmental management practices, can boost the creation of these types of jobs corroborating the previous results of Horbach and Rennings (2013).

As far as the other factors of labor demand are concerned, we first note that turnover (Turnover2–Turnover6) is relevant for the creation of jobs, thus corroborating the previous findings of Horbach and Janser (2016), where more profitable firms have more dynamic employment growth. Second, sector labor productivity is not significant in our estimates. This result is consistent with the limited empirical relevance of real wages, which are theoretically correlated with productivity, as a determinant of jobs in market *equilibria* that are distant from full employment.

Overall, path dependency – the stock of green jobs – and value-enhancing techno-organisational innovations largely explain the probability of creating green jobs compared to sector relevance. Structural factors do not matter compared with the role of internal innovative solutions (Table 3).

4.3. Subsample: firms producing green products and services²²

To improve our understanding of the impact of green products and services in the creation of green jobs, we conduct an empirical analysis focusing on the firms producing green products and services, which represents a subsample of 2263 firms. The same dependent variable Nb Green Job, that is the number of green jobs that a firm aims to create in the next 2 years, is used as indicated in the Eq. (1). Table 4 details the descriptive statistics of this subsample of firms. On average, firms producing green products and services are willing to create an average of approximately 11.3 green jobs and 71% of these firms already have at least one employee in a role that qualifies as a green job.

This empirical strategy analyses which specific motivations, related to the production of green products and services, are correlated with the creation of green jobs. In addition, the effect of green turnover (generated by green products and services) is considered with respect to the creation of green jobs. For this purpose, we include a set of eight dummy variables measuring the motivation to create new products or services (not mutually exclusive): *DemandConsumers*, *CompanyImage*, *PublSubsidies*, *TaxIncentives*, *CompanyValue*, *CompetitiveAdvantage*, *CatchUp* and *Compliance* (See Table 4 for the descriptions of these variables). It is interesting to note that 52.4% of the companies produce green products or services to meet the demand of the customers and 32% of the sample does so because they want to have a competitive advantage over competitors. To measure the effect of the turnover we include the ordered variable *GreenTurnover*, which takes value 1 if the intensity of annual turnover generated by green products is between 1 and 5%, 2 if it is between 6 and 10% of annual turnover, 3 if it is between 11 and 30% of annual turnover, 4 if it is between 31 and 50% of annual turnover, 5 if it is between 51 and 75% of annual turnover, and 6 if it is more than 75% of annual turnover.

²¹ They find on the basis of a German firm's dataset that 'the most important environmental innovation is a product or service innovation which has a significantly positive effect on the probability of an increase in employment'.

²² We thank one referee for suggestions regarding this investigation.

Table 4
Descriptive statistics on the subsample of firms that produce green products and services.

Variable		Obs	Mean	Dev.	Min	Max
Nb green job	Number of green job created in the next 2 years	2263	11.434	26.451	0	240
GreenTurnover	Intensity of turnover generated from green products and services ^a	2073	2.996	1.928	1	6
DemandConsumers	Takes value 1 if firm produces green products or services to meet the demand of consumers	2263	0.524	0.499	0	1
CompanyImage	Takes value 1 if firm produces green products or services for the company image	2263	0.313	0.464	0	1
PublicSubsidies	Takes value 1 if firm produces green products or services to receive Subsidies/public support	2263	0.042	0.202	0	1
TaxIncentives	Takes value 1 if firm produces green products or services to have tax incentives	2263	0.031	0.173	0	1
CompanyValue	Takes value 1 if firm produces green products or services because it is a company core value	2263	0.315	0.465	0	1
Competitive Advantage	Takes value 1 if firm produces green products or services to create a competitive advantage	2263	0.320	0.467	0	1
CatchUp	Takes value 1 if firm produces green products or services to catch up competitors	2263	0.110	0.313	0	1
Compliance	Takes value 1 if firm produces green products or services to comply with national, regional or European legislation	2263	0.182	0.386	0	1
EMS	Takes value 1 if firm uses environmental management system (such as EMAS, ISO14000), 0 otherwise	2263	0.314	0.464	0	1
Greenpresent	Takes value 1 if firm has already hired at least one employee qualified as green jobs, 0 otherwise	2263	0.719	0.449	0	1
Turnover1	Takes value 1 if firm's Turnover is less than 100 000 euro, 0 otherwise	2263	0.134	0.341	0	1
Turnover2	Takes value 1 if firm's Turnover is More than 100 000–500 000 euro, 0 otherwise	2263	0.247	0.431	0	1
Turnover3	Takes value 1 if firm's Turnover is More than 500 000–2 million euro, 0 otherwise	2263	0.267	0.442	0	1
Turnover4	Takes value 1 if firm's Turnover is More than 2–10 million euro, 0 otherwise	2263	0.211	0.408	0	1
Turnover5	Takes value 1 if firm's Turnover is More than 10–50 million euro, 0 otherwise	2263	0.117	0.322	0	1
Turnover6	Takes value 1 if firm's Turnover is More than 50 million euro, 0 otherwise	2263	0.024	0.153	0	1
Age	Categorical variable ^b	2253	9.850	3.170	1	14
Manufacturing	Takes value 1 if firm belongs to Manufacturing sector, 0 otherwise	2263	0.245	0.430	0	1
Electricity, gas, steam	Takes value 1 if firm belongs to Electricity, gas, steam sector, 0 otherwise	2263	0.029	0.167	0	1
Water supply, sewerage, waste management	Takes value 1 if firm belongs to Water supply, sewerage, waste management sector, 0 otherwise	2263	0.029	0.168	0	1
Construction	Takes value 1 if firm belongs to construction sector, 0 otherwise	2263	0.195	0.396	0	1
Wholesale and retail trade, repair	Takes value 1 if firm belongs to Wholesale and retail trade, repair sector, 0 otherwise	2263	0.290	0.454	0	1
Transportation and storage	Takes value 1 if firm belongs to Transportation and storage sector, 0 otherwise	2263	0.032	0.178	0	1
Accommodation and food service activities	Takes value 1 if firm belongs to Accommodation and food service activities, 0 otherwise	2263	0.049	0.215	0	1
Information and communication	Takes value 1 if firm belongs to Information and communication sector, 0 otherwise	2263	0.023	0.150	0	1
Financial and insurance activities	Takes value 1 if firm belongs to Financial and insurance activities, 0 otherwise	2263	0.005	0.070	0	1
Real estate activities	Takes value 1 if firm belongs to Real estate activities, 0 otherwise	2263	0.021	0.143	0	1
Professional, scientific activities	Takes value 1 if firm belongs to Professional, scientific activities, 0 otherwise	2263	0.075	0.263	0	1

^a Takes value 1 if the intensity of annual turnover generated by green products is between 1 and 5%, 2 if it is between 6 and 10% of annual turnover, 3 if it is between 11 and 30% of annual turnover, 4 if it is between 31 and 50% of annual turnover, 5 if it is between 51 and 75% of annual turnover, 6 if it is more than 75% of annual turnover.

^b Takes value 1 if the firm stays in the business one year or less, 2 if the firm stays in the business for 2 years, 3 if the firm stays in the business for 3 years, 4 if the firm stays in the business for 4 years, 5 if the firm stays in the business for 5 years, 6 if the firm stays in the business for 6 years, 7 if the firm stays in the business for 7 years, 8 if the firm stays in the business for 8 years, 9 if the firm stays in the business for 9 years, 10 if the firm stays in the business 10–19 years, 11 if the firm stays in the business for 20–29 years, 12 if the firm stays in the business for 30–39 years, 13 if the firm stays in the business for 40–49 years, 14 if the firm stays in the business more than 50 years.

Table 5

Results of the negative binomial based on the sample of firms producing Green Products and Services considering the Turnover generated and the motivation to implement green products and services.

	(1)	(2)	(3)	(4)
GreenTurnover	0.186*** (9.62)	0.185*** (9.80)		
EMS		0.412*** (5.41)		0.422*** (5.34)
Age	0.0486*** (4.30)	0.0467*** (4.25)	0.0487*** (4.27)	0.0451*** (4.07)
DemandConsumers			−0.0321 (−0.41)	−0.0365 (−0.47)
CompanyImage			0.135 (1.71)	0.147* (1.89)
PublicSubsidies			0.410** (1.98)	0.368* (1.84)
TaxIncentive			0.0165 (0.10)	−0.0167 (−0.10)
CompanyValue			0.270*** (3.49)	0.242*** (3.17)
CompetitiveAdvantage			0.161** (2.02)	0.102 (1.29)
CatchUp			0.133 (1.24)	0.105 (0.97)
Compliance			0.120 (1.33)	0.0800 (0.88)
Turnover2	0.283** (2.28)	0.306*** (2.58)	0.219 (1.71)	0.263** (2.18)
Turnover3	0.951*** (7.37)	0.956*** (7.74)	0.943*** (6.81)	0.986*** (7.50)
Turnover4	1.601*** (12.18)	1.585*** (12.38)	1.508*** (10.72)	1.506*** (11.21)
Turnover5	2.119*** (13.77)	2.026*** (13.15)	2.176*** (12.81)	2.091*** (12.55)
Turnover6	2.883*** (8.93)	2.607*** (8.62)	2.740*** (9.09)	2.544*** (8.80)
Manufacturing	−0.0696 (−0.27)	0.0444 (0.19)	−0.0296 (−0.11)	0.0930 (0.36)
Electricity	0.201 (0.66)	0.282 (1.00)	0.405 (1.25)	0.494 (1.59)
Water supply sewerage	0.483* (1.71)	0.600** (2.27)	0.698** (2.38)	0.801*** (2.82)
Construction	−0.202 (−0.80)	−0.124 (−0.55)	−0.323 (−1.20)	−0.222 (−0.87)
Wholesale_ retail trade	−0.703*** (−2.76)	−0.547** (−2.37)	−0.765*** (−2.86)	−0.613** (−2.40)
Transportation	0.163 (0.45)	0.334 (0.96)	−0.0574 (−0.17)	0.172 (0.50)
Accommodation_food service	0.122 (0.42)	0.266 (0.98)	−0.235 (−0.77)	−0.0792 (−0.27)
ICT ^a	−0.0920 (−0.29)	0.0736 (0.24)	−0.210 (−0.66)	−0.0280 (−0.09)
Financial and insurance	−1.306*** (−2.77)	−1.122** (−2.39)	−1.403*** (−3.12)	−1.179*** (−2.65)
Real estate	−0.0214 (−0.06)	0.0455 (0.14)	−0.389 (−1.19)	−0.257 (−0.83)
Scientific and research	0.306 (1.09)	0.393 (1.54)	0.305 (1.04)	0.411 (1.47)
_cons	−0.0540 (−0.16)	−0.205 (−0.63)	0.359 (1.02)	0.212 (0.63)
lnalpha _cons	0.541*** (13.49)	0.522*** (13.12)	0.660*** (17.21)	0.642*** (16.95)
N	2090	2090	2284	2284
pseudo R ²	0.068	0.071	0.058	0.061

t statistics in parentheses.

* p < 0.10.

** p < 0.05.

*** p < 0.01.

^a Information communication technologies.

4.4. Results: firms producing green products and services²³

Table 5 presents the results of the negative binomial on the probability of creating green jobs (see Table A1 in Appendix A for the correlation matrix). The estimations (1) and (2) include the variable *GreenTurnover*, while the estimations (3) and (4) consider the set of variables measuring the motivation to produce green products and services. To test the robustness of the estimations we test the regression without the variable EMS in the estimations (1) and (3).

The results show that the increase in turnover generated from the production of green products and services is significantly associated with the demand for green jobs. In other words, successful green products and services increase the demand for green jobs. Looking at estimations (3) and (4) in Table 5, public subsidies (*PublicSubsidies*) are statistically and positively associated with the creation of green jobs, which suggests an increase in the attention of policy makers to the support of green innovations. This is coherent with national and regional strategies which support SMEs' innovation and investments to compensate possible low scale driven deficiencies. Nevertheless, this also poses the question about the potential transition from subsidies, which are often used in the first phases of green economy transition to support strategies and technologies (Borghesi et al., 2015). Similarly, those firms that associated great importance with environmental issues *CompanyValue* are more willing to demand green jobs. Firms internal policies are behind the motivation to create green jobs for firms that adopt green products and services.

5. Conclusions

This article analyses the extent to which the future growth of green jobs in SMEs in the EU is influenced by factors that are internal to the firm and sector related. Among the former, we focus on the adoption of eco-innovation: product technological innovations and organisational innovations (EMS). The focus is on the short term, where SMEs adopt strategies to cope with a post-recession phase and the challenges posed by green economy targets. The empirical evidence is based on a wide and rich cross section EU27 dataset that covers EU SMEs, collected in 2012.

An econometric analysis of labor demand highlights the fact that the adoption of green product innovations, as well as organisational innovations, is quite relevant to supporting the creation of green jobs. Overall, path dependency (the stock of green jobs) and techno-organisational innovations (product and organisational innovations) drive the green job dynamics of the EU. The changes in SMEs' green jobs during the post-recession phase in the EU seem linked more to the green strategic components of firms rather than to sector and structural factors.

Innovation, and especially eco-innovations, may emerge as the key factor that is capable of sustainably reconciling green growth, development and job creation. As the EEA (2014:49) stressed: "Given the relatively low share of firms that adopt EI in many countries there is room for higher eco-innovation adoption and diffusion in the EU, especially in laggard countries". Such an increase is potentially an engine of future green job creation.

Further empirical research should be oriented towards the construction of panel datasets based on surveys and on the definition of firm-based and sector-based environmental policy indicators to investigate the policy-innovation-economic performance relationship in more detail. It would be interesting in future works to analyse the impact of process innovation in the probability of creating? green jobs. In addition, the 'quality' of green jobs should be assessed, in terms of wages and workers' conditions. Again, specific surveys and data mergers are necessary for such purposes.

Appendix A.

Table A1
Correlation Matrix subsample of firms that produce green products or services.

	1	2	3	4	5	6	7	8	9	10	11	12
Nb Green Job	2	1.0000										
DemandConsumers	2	−0.0577*	1.0000									
CompanyImage	3	0.0284	−0.0987*	1.0000								
PublicSubsidies	4	0.0232	−0.0393	−0.0224	1.0000							
TaxIncentives	5	0.0256	−0.0822*	−0.0005	0.1733*	1.0000						
CompanyValue	6	0.0501	−0.1572*	0.0892*	−0.0633*	−0.0623*	1.0000					
Competitive Advantage	7	0.0546*	−0.0537*	0.0182	−0.0358	−0.0192	−0.0231	1.0000				
CatchUp	8	0.0321	−0.0106	−0.0096	−0.0263	0.0124	−0.1013*	0.0044	1.0000			
Compliance	9	0.0409	−0.1202*	−0.0480*	0.0184	0.0149	−0.1037*	−0.1083*	0.0023	1.0000		
Green Turnover	10	0.2138*	−0.1044*	−0.0387	0.0429	0.0313	0.1664*	−0.0222	−0.0800*	−0.0087	1.0000	
Green Present	11	0.3168*	−0.0371	−0.0096	0.0386	0.0495*	0.0896*	0.0789*	0.0215	0.0488*	0.2166*	1.0000

Significance level *p < 0.01.

²³ We thank one referee for suggestions regarding this investigation.

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