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Resource Efficiency and Circular Economy in European SMEs: Investigating the Role of Green Jobs and Skills

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Abstract: This study explored the size and potential of green employment for circular economy (CE) in small and medium enterprises (SMEs) in the European Union, and investigated the role of green jobs and skills for the implementation of CE practices. The data were collected in a Eurobarometer survey, and refer to resource efficiency, green markets, and CE procedures. Lack of environmental expertise is one of the factors that might be perceived as an obstacle when trying to implement resource-efficiency actions. Previous research has shown that, although resource-efficiency practices are adopted by firms in all European countries, there are differences both within and between countries. The analysis of the determinants of green behavior by European SMEs was completed by a study of heterogeneity across firms and within countries with a multilevel latent class model, a hierarchical clustering method. A general important observation is that having no workers dedicated to green jobs is strongly correlated to the probability of adopting resource-efficiency practices, while perceiving the need of extra environmental skills has a positive effect on the intention to implement actions in the future. Other characteristics of the firms play a significant impact on resource efficiency: in general, older and bigger firms, with larger yearly turnover, are more prone to implement actions.

Keywords: resource efficiency; environmental skills; green economy; multilevel modeling; circular economy

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1. Introduction

The idea of sustainability was born only a few decades ago, due to the evidence of diminishing natural resources, climate change, and increasing environmental degradation. These facts induced industries to pay attention to appropriate management of environmental impacts of their actions. The idea of sustainability builds on the fact that there are limits to the availability of natural resources and the ability of the biosphere to absorb human activities (WCED [1]).

There is clear evidence that the traditional system of production and consumption needs to be changed in order to guarantee a future for the next generations. As Bayeh and Workie [2] showed, average world temperature is at least one degree Celsius higher than in the preindustrial era and this is due, according to 97% of climate experts, to emission of gasses resulting from human activities. This evidence has become even clearer during the recent COVID-19 pandemic: many papers have already been published on the possible link between the diffusion of the virus and environmental pollution (Gupta et al. [3]). Moreover, economic growth will be a high priority for European countries in the months following the COVID-19 pandemic.

Circular economy and resource-efficiency practices will significantly contribute to this recovery in all economic activity sectors, both in industries and SMEs. SMEs represent 99% of all businesses in Europe. Therefore, assessing factors that influence adoption of CE practices appears a crucial research question in this period.

Circular economy (CE) was introduced at the end of the last century as a promising idea for sustainable development, and the first literature discussing it appeared in the

1980s. Since then, scholars and practitioners dedicated their attention to it, in order to identify principles and practices for its concrete implementation into the economic system (Lieder and Rashid [4]; Suarez-Eiroa et al. [5]). This growing body of literature suggests many definitions of CE and, despite some criticism arising on the disorganized nature of the research concerning it (Korhonen et al. [6]), the main idea of CE refers to harmonizing economic growth and environmental protection. Specifically, for enterprises, circular economy fosters better use of resources, gaining profit without depleting the environment.

In this study, we focused attention on SMEs, their implementation of CE practices, and its relationship with green employment. The European Commission [7] defines SMEs as those that have fewer than 250 employees, total yearly turnover does not exceed EUR 50 million, and the total yearly balance sheet is under EUR 43 million. As the 2019 CE European action plan indicates, SMEs are the main vehicle for the transition to CE of the entire production system. As many papers in the reference literature report (see, among others, Yadav et al. [8]), SMEs are responsible for between 60 and 70% of total pollution, at least in Europe, where they represent almost 99% of the companies (European Commission [9]). Therefore, assessing factors that influence the adoption of CE practices appears a crucial research question in this period. Ideas and practices of circular economy developed in big industries and have not yet spread sufficiently to SMEs.

This study aimed at analyzing within- and between-country variability with respect to implementation of resource-efficiency actions and the intention to adopt CE practices. Moreover, green employment and attitude towards green skills in European SMEs were accounted for, in order to evaluate the relationship of these factors with resource-efficiency accomplishment.

The study extends the work by Bassi and Dias [10] in various directions. First of all, the data are more recent, collected in September 2017 vs. April 2016, on an equivalent sample of European SMEs. The data refer to a Eurobarometer survey explicitly focused on resource-efficiency practices; moreover, attention was dedicated to green employment and green skills and their association with resource efficiency in European firms, a quite new topic within the reference literature. This analysis of the determinants of green behavior by European SMEs was completed by a study of heterogeneity in applying resource-efficiency practices across firms and within countries with a multilevel latent class model, a hierarchical clustering method.

Specifically, we evaluated which characteristics of SMEs are correlated to resource-efficiency-practice implementation, accounting for within- and between-country heterogeneity. In doing so, we paid special attention to the variables describing the number of green workers and the perception of lack of environmental skills in the employees as possible drivers of the implementation of resource-efficiency actions in the immediate future.

In order to account for the nested nature of our data (SMEs within European MSs), we employed a multilevel modeling approach by considering a multilevel latent class analysis and multilevel logit models. In detail, multilevel latent class analysis identified groups of firms and groups of European countries that are homogeneous for their attitude towards CE practices and green employment. The multilevel approach also estimated how the homogeneous groups of companies distribute across the groups of countries: this result, combined with the fact that companies having similar attitudes towards circular economy may have different demographic and business profiles across groups of countries, sheds further light on the topic of green behavior and green employment in Europe. Multilevel logit models estimated the effect of the perception of the need of environmental skills on the intention to implement resource-efficiency actions in the near future.

The rest of the paper is organized as follows. Section 2 reviews the relevant reference literature. Section 3 briefly describes the Eurobarometer surveys, the sample and the data used for subsequent analyses, and illustrates the methodology employed. Section 4 reports the results of the analyses, along with some meaningful comments. Section 5 concludes, outlines the limitations of this paper, and provides lines for future research.

2. Background Literature

CE is a widely accepted paradigm to achieve sustainability, setting limits to exploitation of resources without rejecting economic growth (Prieto-Sandoval et al. [11]). Consequently, this approach has spread quite rapidly in many areas of the industrialized world and it is starting to be applied also in developing countries: Abarca Guerrero et al. [12], for example, reviewed solid-waste management in urban areas of 22 developing countries, while Cecchin et al. [13] reported a case study of CE implementation in Ecuador.

A popular definition of CE refers to the easy-to-remember 3Rs: reduce, reuse, and recycle (see, for example, Liu et al., [14]). Geissdoerfer et al. [15] defined CE as "*a regenerative system in which resources input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling*", which covers almost all of the aspects indicated above. Kirchherr et al. [16] analyzed 114 definitions of CE and concluded that, although they combine reduce, reuse, and recycle activities, these may mean different things to different people. A number of complementary definitions of the concept emerged from the work of Lieder and Rashid [4], emphasizing its different but important facets. In one of the first definitions provided, Stahel [17] considered economic properties: "an economy based on a spiral-loop system that minimizes matter, energy-flow and environmental deterioration without restricting economic growth or social and technical progress". Liu et al. [18] drew attention to the theory and practice of CE: the theory encompasses the principles of ecological economics that recognize that the earth's ecological system has limited resources and environmental capabilities, and, in practice, CE refers to all activities aimed at environmental protection, pollution prevention, and energy efficiency. The Ellen MacArthur Foundation [19] defined circular economy as "*an industrial economy that is restorative or regenerative by intention and design*". Recently, the 3Rs principle was enlarged to 9Rs (Vermeulen et al. [20], among others). The 9Rs framework proposes ten actions that transform a linear production system into a circular one, from R0—refuse—to R9—recover. In the middle, we find: rethink and reduce to increase efficiency in products and services using fewer natural resources; reuse, repair, refurbish, and remanufacture in order to extend products' life; and recycle to reduce waste (Kirchherr et al. [16]).

In 2014, the European Commission published its 2015 Circular Economy Package with the objective of "closing the loop" of product lifecycles (European Commission [21]). In particular, the guidelines especially refer to product redesign in order that they are easy to maintain, repair, remanufacture, or recycle (3Rs principle, Hughes, [22]). Some EU countries, for example, Finland, the Netherlands, and the UK (when it was still belonging to the EU), have already adopted CE practices (Repo et al. [23]), and several studies (e.g., Stahel [24]) showed that a shift to circular economy would reduce gas emissions and increase employment. Nevertheless, implementing CE is a challenging task given the prevalence of a linear mindset in industry and society. Circular-economy practices often require extra investments that might not be considered profitable but, as highlighted in Bocken et al. [25], the possibility to become a sustainable economic activity requires business-model innovation through experimentation, within a continuous and collective learning process with stakeholders.

CE is strictly linked to maximization of resource efficiency starting from resource saving (refuse and reduce the use of unnecessary material) to reducing waste (recycle and recover). As Schulte [26] reported, the key principles of the circular business model are minimization of waste, understanding of the total ecosystem, flexibility of the design, using renewable energy. These principles enhance resource efficiency. According to the reference literature, public support is an important stimulus to implement actions to improve resource efficiency (see, for example, Nussholz et al. [27]). Schulte [26] called for attention on incentives and on taxation, suggesting to move taxes from labor to the use of non-renewable resources, in order to favor new business initiatives and obtain a positive impact on employment. Flynn et al. [28] analyzed how different governance choices may facilitate or constrain the transition to a circular economy, by comparing UK and China as models of liberal and authoritarian environmental governance. Specifically, in their study, the authors highlighted the role played by the key policy instrument of standards.

Daddi et al. [29] discussed procedures to evaluate environmental impact by European SMEs and policies to enhance green behavior. The design of efficient strategies requires a deep knowledge of the drivers of resource-efficiency actions. In this context, SMEs might be seen as a reference market that needs to be segmented in order to apply targeted policies (Triguero et al. [30]). Özbuğday et al. [31], for example, analyzing European SMEs in energy-intensive sectors, found that investing in resource efficiency has a significant effect on the growth of sales. However, as Jovè-Llopis and Segarra-Blasco [32] showed, not all eco-strategies affect sales in the same way. One sector of activity where there is great attention to the environment is that of accommodation and food services, at least for what concerns European firms, as emerged from the analyses by Becken et al. [33]. Colombelli et al. [34] analyzed the impact of eco-innovation on business performance on a sample of European firms, estimating a positive effect; similar results were obtained by Leoncini et al. [35] on a sample of Italian SMEs. As Bleischwitz [36] noticed, additional research is needed to assess the merits of different strategies and to identify suitable policies and levers of action. An example is Segarra-Blasco and Jovè-Llopis [37] on the factors driving the specific policy of adopting energy efficiency and renewable energy.

Another central aspect for CE implementation is green employment. First of all, it is necessary to define CE employment in terms of skills and abilities, as, for example, in Burger et al. [38]. One reduced definition of green jobs counts people employed in the environmental goods and services sector; however, this approach does not consider all those employees who use environmentally friendly processes and practices. There are various contributions in the reference literature dedicated to describing green jobs. A number of recent studies have shown that the growth of CE, among the benefits described above, produces job opportunities (Ghisellini et al. [39]). Recently, Horbach and Rammer [40], by analyzing data collected in Germany, showed that CE innovation significantly increases employment.

However, there is still a need of investigation about employment in CE and the perceived lack of environmental competence by enterprises. Moreover, there might be sensible differences among economic-activity sectors in terms of employment for CE purposes. Like CE itself, CE jobs or green jobs might be defined in several ways. The European Commission [21] suggests that green jobs include "all jobs that depend on the environment or are created, substituted or redefined in the transition process towards a greener economy". As Garcès-Ayerbe et al. [41] stated, empirical studies related to CE practices are scarce. A few have dealt with CE drivers and barriers; however, the majority concentrate on technical and economic factors. Lack of qualified personnel is mentioned only in Kirchherr et al. [42].

This study explored the size and potential of employment for CE in SMEs that are active in European Union (EU) member states (MSs), and investigated the association of green jobs and green skills with CE practices in European SMEs. Previous research has suggested that, although CE practices have been adopted by firms in all 27 European countries, there are differences both within countries due to firms' characteristics—size, age, turnover, type of activity—and between countries: environmental and energy-saving practices are not given the same attention everywhere in Europe (Bassi and Dias [10]).

The enterprises considered in this study belong to all activity sectors and are a representative sample in terms of size and age. The data were collected within the Eurobarometer surveys. The survey considered in this study refers to resource efficiency and green markets, and collects information on actions undertaken by European firms to increase resource efficiency, thus leading to the implementation of CE practices. Lack of environmental expertise is one of the factors that might be perceived as a difficulty when trying to set up resource-efficiency actions, and the number of full-time employees working in green jobs is one of the most relevant aspects to consider in this sense.

3. Data and Methodology

3.1. Sample Characterization

Eurobarometer surveys examine European opinion and behavior on many distinct topics ranging from the support for developing countries and opinions on EU policy to the implementation of new technology, and cover citizens, households, and firms.

The data used in our study came from the Flash Eurobarometer 456, conducted in September 2017, in the 28 EU MSs, data includes UK as they were collected before the so-called Brexit. The topic was SMEs' resource efficiency and green markets. Firms with between 1 and 250 workers, operating in manufacturing, retail, industry, and services were interviewed. Questions concerned actions to promote resource efficiency, green products or services, and green employment.

Table 1 reports the characterization of the sample of 13,117 SMEs operating in the 28 European MSs with reference to the number of employees, the age of the firm, and the sector of economic activity, along with some selected variables referring to resource-efficiency practices, green jobs, and green skills. Specifically, enterprises were classified by a number of resource-efficiency actions: saving water, saving energy, using renewable energy, saving materials, minimizing waste, selling scrap material, recycling, designing products easier to repair—already undertaken and planned for the subsequent two years; companies were also classified by the number (many, some, few, no) of these actions. Information on green employment comes from the number of full-time employees working in green jobs, some or all of the time, and the expressed perception that additional green skills could improve resources efficiency. For this survey, a green job was defined as a job that directly deals with information, technologies, or materials that preserve or restore environmental quality (This was the definition of a green job used in the data-collection phase of the survey (European Union [43])). This requires specialized skills, knowledge, training, or experience (e.g., verifying compliance with environmental legislation, monitoring resource efficiency within the company, promoting and selling green products and services). We weighted the data so that the sample was representative of the population of SMEs in each of the 28 countries.

Eight out of ten SMEs are very small with between one to nine employees and the great majority (80%) were founded before 2010. SMEs in the sample were active in all economic sectors, however, the majority belonged to retail and manufacturing. With regard to resource-efficiency practices, one third of the firms were implementing many of them, but still 10% were not undertaking any resource-efficiency action. The most common resource-efficiency practice being undertaken by European SMEs refers to saving inputs and to minimizing waste. Half of the companies did not employ workers in green jobs and only 20% of them perceived the lack of environmental skills. These evidences refer to the entire sample of SMEs, although there were many differences across the 28 European countries.

Table 2 describes the sample at the country level, providing insights into the variability between countries in terms of percentage of firms undertaking the surveyed resource-efficiency actions, declaring the need for environmental expertise in order to improve resource efficiency, and the number of full-time employees dedicated to green jobs. These figures are comparable since statistics were calculated with weighted data that account for the differences in the number of firms in the various countries. These three variables have significantly different distributions across the 28 EU MSs. Estonia was the country with, on average, fewer employees in green jobs: this was also the country where SMEs did not acknowledge the need of specific environmental expertise. Ireland had the highest percentage of firms with more than six green-job employees; in Spain, we observe the highest percentage of firms calling for additional environmental skills. Spain, the United Kingdom, Ireland, and Portugal showed high percentages of SMEs implementing many resource-efficiency actions; on the opposite side, we find Bulgaria, Estonia, Lithuania, and Romania.

Table 1. Characteristics of the SMEs in the sample.

Size	Percentage/Mean	Turnover Past Two Years	Percentage/Mean
1–9	80.4	Increased	42.5
10–49	15.5	Decreased	21.2
50–249	3.0	Unchanged	36.3
>249	1.1	**Lack of expertise**	20.1
Date of establishment		**Full-time employees in green jobs**	
Before 1 January 2010	76.9	0	57.4
1 January 2010–31 December 2012	9.3	1–5	36.0
1 January 2013–31 December 2017	12.3	6–9	3.1
After 1 January 2017	1.5	10–50	3.0
Last year turnover in EUR		51–100	0.3
<100,000	29.1	>100	0.1
100,000–500,000	37.4	**Activity sector**	10.1
500,000–2 million	23.2	Manufacturing	30.1
2–10 million	7.2	Retail	43.9
10–50 million	2.1	Services	15.9
>50 million	1.0	Industry	10.1
Actions to promote resource efficiency–present		**Actions to promote resource efficiency–future**	
Many	33.2	Many	35.0
Some	31.8	Some	23.3
Few	24.6	Few	22.3
No	10.5	No	19.4
Undertaken actions		**Future actions**	
Minimizing waste	65.5	Saving energy	58.8
Saving energy	63.2	Minimizing waste	56.6
Saving materials	56.8	Saving materials	50.8
Saving water	47.2	Saving water	45.1
Recycling or reusing waste	41.8	Recycling or reusing waste	37.9
Designing sustainable products	25.3	Designing sustainable products	24.6
Selling scrap material	21.1	Using renewable energy	22.4
Using renewable energy	14.0	Selling scrap material	21.0

Table 2. EU countries by the percentage of firms undertaking resource-efficiency practices, lacking environmental expertise, and number of employees with green jobs.

Country	Lacking Environmental Expertise	Undertaken Actions				Employees in Green Jobs		
		Many	Some	Few	No	0	1–5	6+
		Percentages						
Austria	18.1	38.1	32.0	22.2	7.7	55.2	35.1	9.7
Belgium	16.9	38.7	30.8	21.5	9.1	64.8	31.2	4.0
Bulgaria	11.1	9.4	23.2	33.1	34.3	73.5	20.0	6.5
Republic of Cyprus	9.5	14.8	22.2	40.7	22.2	81.5	11.1	7.8
Czech Republic	21.8	30.5	34.7	21.2	13.5	77.2	18.7	4.1
Germany	14.9	30.6	36.1	25.9	7.4	58.1	32.1	9.8
Denmark	13.2	27.2	29.6	28.0	15.2	67.7	24.4	7.9
Estonia	0	2.9	5.9	38.2	52.9	85.3	14.7	0
Spain	31.6	45.0	27.3	21.9	5.7	48.0	43.2	8.8
Finland	13.9	23.5	28.8	31.1	16.7	44.9	51.2	4.8
France	33.7	40.9	38.1	15.4	5.6	68.9	26.3	4.8
United Kingdom	15.4	46.0	32.5	16.9	4.6	70.6	25.6	3.8
Greece	22.9	20.6	24.4	28.6	26.4	51.9	35.4	12.7
Croatia	13.2	26.2	39.3	25.0	9.5	36.4	58.4	5.2
Hungary	11.0	16.3	27.6	38.2	18.0	76.8	16.9	6.3
Ireland	24.0	44.4	37.0	13.0	5.6	56.5	30.4	13.1
Italy	12.1	29.0	29.9	31.5	9.7	42.7	51.8	5.5
Lithuania	7.1	5.9	23.5	37.6	32.9	81.0	14.3	4.7
Luxemburg	17.6	30.0	25.0	30.0	15.0	57.9	36.8	5.3
Latvia	14.6	17.0	32.1	28.3	22.6	30.0	58.0	12.0
Malta	7.7	21.4	35.7	35.7	7.1	92.9	7.1	0
The Netherlands	13.1	29.6	37.9	25.1	7.4	63.0	30.6	6.4
Poland	27.7	24.3	31.8	27.3	16.7	58.5	34.7	6.8
Portugal	17.2	48.6	28.5	18.3	4.6	48.4	46.0	5.6
Romania	17.3	8.5	17.7	37.9	35.9	62.3	28.5	9.2
Sweden	13.9	41.3	35.4	16.7	6.6	40.1	51.4	8.5
Slovenia	17.5	26.0	27.4	24.7	21.9	72.9	25.7	1.4
Slovakia	7.9	21.8	27.7	36.8	13.6	38.8	52.6	8.6

3.2. Methodology: Multilevel Modeling

3.2.1. The Multilevel Latent Class Model

Latent class (LC) analysis provides models that consider explicitly the effect of one or more latent variables when studying relationships between observed variables, and accounts for the categorical nature of these variables.

Latent class models were introduced by Lazarsfeld and Henry [44] to express latent attitudinal variables from dichotomous survey items, then they were extended to nominal variables by Goodman ([45,46]), who also developed the maximum-likelihood algorithm for estimating latent class models that serves as the basis for much software with this purpose. Later, these models were further extended to include observable variables of mixed scale type, such as ordinal, continuous, and counts.

Let:

Y_{ijk}, $i = 1, \ldots, I$, $j = 1, \ldots, J$, $k = 1, \ldots, K$, denote the response of individual or level-1 unit i within group or level-2 unit j on indicator or item k;
$s_k = 1, \ldots, S_k$, a particular level of item k;
Z_{ij}, a latent variable with L classes;
l, a particular latent class, $l = 1, \ldots, L$;
$\underline{Y}_{ij}$, the full vector of responses of case i in group j;
$\underline{s}$, a possible response pattern.

The probability structure defining a simple LC model may be expressed as follows:

$$P(\underline{Y}_{ij} = \underline{s}) = \sum_{l=1}^{L} P(Z_{ij} = l) P(\underline{Y}_{ij} = \underline{s} | Z_{ij} = l) = \sum_{l=1}^{L} P(Z_{ij} = l) \prod_{k=1}^{K} P(Y_{ijk} = s_k | Z_{ij} = l) \quad (1)$$

As specified in Equation (1), the probability of observing a particular response pattern is a weighted average of class-specific probability $P(Y_{ijk} = s_k | Z_{ij} = l)$, weight being the probability that unit i in group j belongs to latent class l. As the local independence assumption implies, indicators Y_{ijk} are assumed to be independent conditional on LC membership. This model is also referred to as the traditional LC cluster model within the relevant literature.

Multilevel latent class modelling (Vermunt [47]) is an approach based on the assumption that some model parameters can vary across groups, clusters, or level-2 units. As an example of hierarchical data, operations are nested in a bank's customers: operations are level-1 units, clients are level-2 units (Bassi [48]). This is different from traditional latent class modelling, which assumes that the parameters are the same for the whole sample. The multilevel approach allows for variation across level-2 units for the intercept (threshold) of each latent class indicator. This makes it possible to examine how level-2 units influence the level-1 indicators that define latent class membership. This method adopts a random-effects approach rather than a fixed-effects approach, enabling the effects of level-2 covariates to be verified on the probability of belonging to a given latent class.

As firms from the same country share a set of characteristics, the traditional assumption of independence, on which non-hierarchical statistical modeling techniques are based, is violated. Such a nested structure is taken into account by the multilevel modeling, making it a particularly suitable model to apply in our analysis.

A multilevel LC model (Vermunt [47]) consists of a mixture model equation for level-1 and level-2 units, in which a group-level discrete latent variable is introduced so that the parameters are allowed to differ across latent classes of groups:

$$P(\underline{Y}_{ij} = \underline{s}) = \sum_{h=1}^{H} \left[P(W_j = h) \prod_{i=1}^{n_j} \left[\sum_{l=1}^{L} P(X_{ij} = l | W_j = h) \prod_{k=1}^{K} P(Y_{ijk} = s_k | Z_{ij} = l) \right] \right] \quad (2)$$

where:

W_j denotes the latent variable at the group level, assuming value h, with $h = 1, \ldots, H$; and
n_j is the size of group j.

Equation (2) is obtained with the additional assumption that n_j members' responses are independent of one another conditional on group class membership.

A natural extension of the multilevel LC model involves including level-1 and level-2 covariates to predict membership, such as an extension of the LC model with concomitant variables (Dayton and McReady [49]).

In the terminology of MLLC modelling, the categories of the latent variable for level-1 units are called clusters, while the categories of the latent variable for level-2 units are called classes. In our application, level-1 units were companies and level-2 units were European countries.

3.2.2. The Multilevel Logit Regression Model

Multilevel regression models (Hedeker and Gibbons [50]; Hox, 2002 [51]; Snijders and Bosker [52]) estimate simultaneously at two levels. Level-1 units are represented by firms, level-2 units by countries. Using the same notation introduced in the preceding paragraph, a multilevel regression model is specified by:

$$y_{ij} = \beta x_{ij} + u_j + \varepsilon_{ij} \quad (3)$$

where x_{ij} is the vector containing the values of the covariates for observation i in cluster j, β is the vector of parameters (fixed effects), u_j is the random effect for group j—this random effect represents factors affecting y_{ij} that are shared within class j, after controlling for individual covariates-, and ε_{ij} is the error term with the usual assumptions: errors are independently distributed as Normal with 0 mean and equal variance.

4. Results

4.1. Multilevel Latent Class Model

In this section, we report the results of two multilevel LC analyses that have been conducted on the data (Model estimation was performed with Latent Gold (Vermunt and Magidson [53])). These involve undertaken and future actions of resource efficiency across SMEs in the EU countries.

In order to perform the analysis, we also considered other SMEs characteristics as age, size, and sector of economic activity, that might explain both between-country and within-country variability.

4.1.1. Resource-Efficiency Actions across SMEs and EU Countries: Undertaken Actions

The first model aimed at identifying groups of SMEs that are homogeneous for the number and type of resource-efficiency actions already undertaken. Indicators were the eight binary variables describing the resource-efficiency actions proposed in the questionnaire. The best-fitting multilevel latent class (MLLC) model identified six clusters of firms and four classes of countries. This was the model that showed the lowest BIC index, comparing specifications with different combinations of the number of clusters and classes. The statistically significant variables were SME turnover, age, sector of economic activity, and the number of full-time employees dedicated to green jobs.

Clusters in Table 3 are ordered by the number of resource-efficiency actions already implemented by the group of SMEs. Percentages in bold indicate figures greater than the sample mean and aim at favoring interpretation. In cluster 1, almost 14% of SMEs were classified. These firms undertook all eight resource-efficiency actions considered in the Eurobarometer survey. SMEs in cluster 2 (14%) were already undertaking all actions, except the use of predominantly renewable energy. SMEs classified in cluster 3, that accounts for 21% of the sample, were implementing practices for saving production inputs, water, energy, materials, and for minimizing waste, which is an action strictly related to savings. In cluster 4, we find 14% of firms, that were mainly concentrated in reducing waste. In cluster 5 (7%), SMEs adopted the only policy of using predominantly renewable energy, and finally, cluster 6, the largest one, contained those firms that were not implementing any of the proposed green actions. The statically significant covariates indicate that some characteristics of the European SMEs had an impact on their attitude towards the implementation of those CE practices. Specifically, for example, the fact of being established before 2010, having a yearly turnover greater than EUR 500,000, having employees devoted to green jobs, and operating in the sectors of manufacturing and industry, had a positive impact on belonging to cluster 1. On the contrary, SMEs classified in cluster 6 were established after 2010, did not have employees for green jobs, yearly turnover was below EUR 500,000, and operated mainly in the sector of services. As general evidence, the number of employees for green jobs, size, and age of the firm had a positive impact on the number of resource-efficiency actions undertaken, as well as operating in the sector of manufacturing and industry.

Table 3. MLLC model—estimation results: cluster profiles for undertaken actions.

	Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**	**Cluster 5**	**Cluster 6**
	All actions	*All actions except renewable energy*	*Saving actions*	*Reducing-waste actions*	*Renewable-energy action*	*No actions*
Size	13.74	14.23	20.39	14.76	7.23	29.63
			Conditional probabilities %			
Class 1	5.57	8.72	**23.91**	8.56	1.53	**51.72**
Class 2	9.85	14.59	**20.87**	**23.04**	4.50	**27.15**
Class 3	**33.61**	1.96	16.24	7.25	**26.10**	14.84
Class 4	11.50	**37.39**	18.19	**21.74**	0.00	11.17
Indicators						
Saving water	**58.71**	**91.10**	**78.16**	26.35	9.43	2.86
Saving energy	**87.88**	**94.96**	**99.10**	30.33	59.46	14.15
Using renewable energy	**44.30**	9.25	11.15	0.00	**39.58**	2.58
Saving materials	**87.95**	**90.56**	**63.02**	50.98	43.55	9.5
Minimizing waste	**91.70**	**93.38**	**74.54**	**75.36**	48.66	12.74
Selling scrap material	**53.18**	**28.83**	10.66	18.55	12.77	6.69
Recycling or reusing waste	**70.05**	**71.66**	27.44	**44.41**	28.54	11.36
Designing sustainable products	**46.88**	**51.23**	12.23	22.18	17.54	4.75
Covariates						
Activity sector						
Manufacturing	**14.33**	**11.95**	6.73	**11.85**	8.07	7.83
Retail	27.98	**34.41**	**34.16**	26.85	18.51	30.80
Services	29.12	43.77	**48.33**	40.31	**48.45**	**51.31**
Industry	**28.56**	9.87	10.78	**21.00**	**24.97**	10.07
Date of establishment						
Before 1 January 2010	**82.06**	75.80	**78.30**	74.40	75.95	73.06
1 January 2010–31 December 2012	7.39	**10.15**	7.07	**9.68**	8.07	**11.82**
1 January 2013–31 December 2016	10.30	11.37	12.21	**13.31**	11.51	**13.74**
After 1 January 2017	0.14	**1.84**	**1.77**	**2.03**	**3.43**	0.77
Full-time employed green jobs						
0	27.58	39.19	**58.01**	**63.90**	**62.33**	**70.25**
1–5	**53.48**	**46.54**	30.38	29.36	29.59	17.31
6–9	**5.25**	**3.31**	**3.58**	1.33	1.94	2.16
10–50	**6.61**	**5.52**	1.98	0.07	1.90	1.11
51–100	0.00	0.76	**0.37**	0.02	0.12	0.03
>100	**0.78**	0.00	0.00	0.00	0.00	0.00

Table 3. *Cont.*

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Last year turnover in EUR						
<100,000	20.83	18.01	**27.45**	22.85	20.53	**32.34**
100,000–500,000	26.08	**33.23**	**36.00**	30.79	26.27	**31.72**
500,000–2 million	**27.19**	**22.24**	11.60	18.35	**32.86**	15.08
2–10 million	9.99	4.97	5.58	**6.47**	**8.42**	3.71
10–50 million	8.35	0.06	0.18	0.41	**4.70**	0.28
>50 million	0.21	**2.30**	**1.03**	0.23	0.00	0.61

The upper part of Table 3 shows how the six clusters of SMEs were distributed across homogeneous groups of European countries. The four homogeneous classes of European countries were composed as follows. Class 1 was composed of Bulgaria, Cyprus, Estonia, Greece, Hungary, Latvia, Lithuania, Romania, and Slovakia. Class 2 was composed of Czech Republic, Denmark, Finland, Croatia, Italy, Luxemburg, Poland, and Slovenia. In class 3, we find Austria, Belgium, Germany, Malta, The Netherlands, and Sweden. In class 4, Spain, France, the United Kingdom, Ireland, and Portugal. It is interesting to note that these four groups of countries, that were homogenous for the type of firms operating on their territory, did not coincide with the usual geographical classification of EU MSs in the four areas: North, South, East, and West, used at international statistical level. The conditional probabilities reported in Table 3 show that countries in class 1 were associated with SMEs of the type in cluster 6 (no actions); countries in class 2 were associated with firms in clusters 3 (saving), 4 (waste), and 6 (no actions); this was the group of countries with the largest amount of heterogeneity in the type of firms. In countries of class 3, we find SMEs that paid the greatest attention to resource efficiency, those of cluster 1 (all actions). However, there was also a non-negligible percentage of firms classified in cluster 5 (renewable energy). Lastly, in class 4, SMEs belonged to clusters 2 (all actions except use of renewable energy) and 4 (waste). However, in all classes of countries there, were non-negligible percentages of SMEs belonging to all clusters, except for cluster 5 in class 4, indicating an important level of heterogeneity within countries with reference to the attitude of SMEs towards resource efficiency and CE in general.

4.1.2. Resource-Efficiency Actions across SMEs and EU Countries: Future Actions

The second multilevel latent class model identified groups of SMEs on the basis of their intention to implement the eight resource-efficiency actions in the next two years. Again, the best-fitting model, in terms of BIC index, had six clusters and four classes, but in this case, two new variables were statistically significant in forming the clusters: a binary variable indicating if the firm recognizes the lack of specific environmental skills in order to set up resource-efficiency actions, and the change in turnover over the past two years. Results are reported in Table 4.

Table 4. MLLC model—estimation results: cluster profiles for future actions.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
	All actions	*All actions except renewable energy*	*Saving and waste-reduction actions*	*Some actions*	*Waste-reduction actions*	*No actions*
Size	16.81	8.22	16.77	6.53	10.22	41.46
Conditional probabilities %						
Class 1	12.55	4.01	9.77	6.08	7.14	**60.44**
Class 2	14.87	7.32	**27.17**	1.71	**15.09**	**33.84**
Class 3	15.52	4.92	12.90	**24.82**	9.25	**32.59**
Class 4	**33.46**	**24.51**	15.79	0.01	8.41	17.82

Table 4. *Cont.*

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Indicators						
Saving water	**86.17**	**85.74**	**77.34**	27.00	4.22	2.06
Saving energy	**98.35**	**92.47**	**88.59**	**92.73**	14.32	11.76
Using renewable energy	**48.79**	7.32	**25.95**	**63.26**	3.59	8.43
Saving materials	**98.43**	**73.44**	**68.76**	46.89	47.41	3.96
Minimizing waste	**97.20**	**90.89**	**78.17**	52.49	**69.15**	1.97
Selling scrap material	**56.09**	**31.37**	7.50	**27.84**	17.71	2.83
Recycling or reusing waste	**88.90**	**52.16**	29.61	25.55	**42.47**	6.61
Designing sustainable products	**68.52**	**28.21**	15.98	**27.27**	21.60	1.79
Covariates						
Activity sector						
Manufacturing	**13.36**	0.09	7.73	**13.24**	**11.66**	8.73
Retail	30.37	30.88	**32.07**	**35.41**	27.96	28.17
Services	38.57	38.59	**49.64**	42.94	36.80	**48.48**
Industry	**17.70**	**21.52**	10.56	8.41	**23.58**	14.62
Date of establishment						
Before 1 January 2010	71.32	**84.07**	74.68	**79.84**	**78.24**	76.03
1 January 2010–31 December 2012	**10.24**	5.51	**10.46**	7.53	7.32	**10.51**
1 January 2013–31 December 2016	**16.57**	7.11	12.09	**12.61**	11.65	11.86
After 1 January 2017	1.46	3.24	**1.60**	0.00	**1.72**	0.97
Full-time employees in green jobs						
0	26.41	**74.11**	53.56	43.64	53.96	**64.90**
1–5	**56.91**	18.43	**34.02**	**36.10**	**38.99**	23.53
6–9	**3.71**	2.25	**3.72**	**8.79**	0.86	1.85
10–50	**7.33**	1.40	1.36	**4.62**	0.51	1.88
51–100	**0.30**	0.00	**0.04**	**0.95**	**0.47**	0.18
>100	0.00	0.74	0.04	0.00	0.00	0.04
Last year turnover in EUR						
<100,000	21.00	15.70	**31.46**	12.48	21–31	**29.36**
100,000–500,000	26.91	**32.56**	**35.78**	24.12	30.59	**33.00**
500,000–2 million	**24.34**	**29.25**	7.52	**37.36**	**22.39**	14.85
2–10 million	**7.90**	6.23	4.89	**11.18**	4.29	5.15
10–50 million	**3.61**	1.35	0.10	**9.17**	0.73	0.63
>50 million	0.34	0.38	**2.26**	0.00	1.30	0.53
Turnover over the past two years						
Increased	**45.04**	34.80	38.91	**52.03**	36.74	37.25
Decreased	14.34	**28.79**	17.71	19.17	17.28	**21.50**
Unchanged	**34.09**	29.52	33.35	27.35	**39.62**	**35.06**
Need of expertise	**22.66**	**61.60**	0.00	**22.12**	14.82	7.51

Clusters in Table 4 are ordered by the number of resource-efficiency actions that the group of SMEs planned to implement in the next two years. Percentages in bold indicate figures greater than the sample mean, in order to aid interpretation. Nearly 17% of SMEs were classified into cluster 1. These firms intended to implement all eight resource-efficiency actions considered in the Eurobarometer survey. SMEs in cluster 2 (8%) were planning all actions except the use of predominantly renewable energy. In cluster 3, we find 17% of firms, that were mainly concentrated in input saving and waste reduction for the near future. SMEs classified in cluster 4, that represents 6% of the sample, aimed at introducing practices with regard to the use of energy, products, and scrap material. In cluster 5 (10%), SMEs would adopt policies concerning waste and, finally, cluster 6 contained those firms that would not implement any of the proposed green actions This was the largest group (41%). As observed before, the number of employees in green jobs, and the dimension and the age of the firm had a positive impact on the number of resource-efficiency actions in the program, as well as operating in the sectors of manufacturing and industry. Perceiving the lack of green skills also had a positive effect on belonging to clusters 1, 2, and 4, where more resource-efficiency actions were on the way to be implemented. Specifically, in cluster 2, we find SMEs, for the majority, with no employees in green jobs but with a clear perception that this type of skill would improve resource efficiency.

The upper part of Table 4 shows how the six clusters of SMEs were distributed across homogeneous groups of European countries. The four homogeneous classes of European countries were composed as follows. Class 1 was composed of Bulgaria, Cyprus, Denmark, Estonia, Finland, Greece, Hungary, Luxemburg, Malta, Portugal, Sweden, and Slovenia. Class 2 was composed of Czech Republic, Croatia, Hungary, Italy, Latvia, Lithuania, Poland, Romania, and Slovakia. In class 3, we find Austria, Belgium, Germany, and The Netherlands. In class 4, Spain, France, the United Kingdom, and Ireland. The conditional probabilities reported in Table 5 show that countries in class 1 were associated with SMEs of the type in cluster 6 (no actions); countries in class 2 were associated with firms in clusters 3 (saving and waste), 5 (waste), and 6 (no actions). In class 3, SMEs belonged to clusters 4 (energy, products, scrap material) and 6 (no actions). In countries of class 4, we find SMEs that paid the greatest attention to resource efficiency, those of clusters 1 (all actions), and 2 (all actions except the use of renewable energy). However, in all classes of countries there were non-negligible percentages of SMEs belonging to all clusters, indicating an important level of heterogeneity within countries with reference to the attitude of SMEs towards resources efficiency and CE in general.

The four classes of countries showed some differences in their composition in the two analyses (for present and future actions). For example, class 1 in the second MLLC model appeared as a combination of two groups of countries: those where SMEs, in a great percentage, did not implement nor intend to introduce CE practices (Bulgaria, Cyprus, Estonia, Greece), and those where many SMEs were already active on the environmental side but did not intend to add other resource-efficiency actions (Slovenia, Denmark, Finland, Luxemburg, Malta, Sweden). A deeper insight into the data reports that correlation coefficients among each couple of variables referring to the same action, undertaken and planned, were not so high, lower than 0.6, and that there were important percentages of SMEs that intended to implement a new action. These percentages ranged from 8.2 with reference to selling scrap material to another company, to 27.5 for saving energy. These proportions, moreover, varied across the 28 European countries and were significantly associated with the number of full-time employees working in green jobs and the perception of lack of specific environmental expertise. A cluster analysis of countries, using as input the above-described variables, identified three homogeneous groups. In the first cluster, we find Bulgaria, Cyprus, Denmark, Estonia, Hungary, Latvia, Malta, and Slovenia, countries with the lowest percentage of SMEs that planned to implement an additional resource-efficiency action. The smallest group, Spain, France, United Kingdom, and Ireland, had the highest percentages of intention to adopt new CE practices. A third cluster, Austria, Belgium, Czech Republic, Germany, Finland, Greece, Hungary, Italy, Luxemburg, Latvia, The Netherlands, Poland, Portugal, Romania, Sweden, and Slovakia, had an intermediate proportion.

Table 5. ML logit model—estimation results: future actions.

	Actions	Saving Water	Saving Energy	Renewable Energy	Saving Materials	Minimizing Waste	Selling Scrap	Recycling	Products
Intercept		−0.211 *	−0.001	−0.634 *	−0.375 *	−0.028	−0.635 *	−0.242 *	−0.617 *
Some	0.431 *								
Many	−0.034 *								
Few	0.087 *								
No	−0.483 *								
Activity sector									
Manufacturing	−0.149 *	0.097 *	0.120 *	0.052	0.252 *	0.214 *	0.466 *	0.155 *	0.311 *
Retail	0.029 *	0.037	0.015	−0.020	−0.148 *	−0.039	−0.056	−0.039	−0.164 *
Services	0.117 *	−0.013	−0.070 *	−0.049	−0.165 *	−0.166 *	−0.554 *	−0.232 *	−0.213 *
Industry	0.003	−0.120 *	−0145 *	0.017	0.0620	−0.009	0.144 *	0.116 *	0.067
Date of establishment									
Before 1 January 2010	−0.021	0.023	0.104	0.066	0.015	0.055	0.107	0.009	−0.027
1 January 2010–31 December 2012	0.0267	−0.202 *	−0.080	0.003	−0.021	−0.028	0.028	−0.019	0.055
1 January 2013–31 December 2016	−0.024	−0.045	0.046	0.080	0.106	0.118	0.147	0.050	0.049
After 1 January 2017	0.019	0.225	−0.071	−0.149	−0.100	−0.146	−0.283	−0.041	−0.077
Employees in green jobs									
0	0.355 *	−0.550 *	−0.454 *	−0.692 *	−0.476 *	−0.535 *	−0.508 *	−0.608 *	−0.583 *
1–5	0.004	−0.024	0.082	−0.074	0.022	0.003	−0.029 *	0.011	0.086
6–9	−0.091	0.131	0.107	0.223 *	0.292 *	0.054	0.014	−0.015	0.027
10–50	−0.102 *	0.134 *	0.212 *	0.229 *	0.058	0.113	0.116	0.110	0.166 *
51–100	−0.012	−0.002	−0.062	0.105	0.023	0.034	0.002	0.038	0.017
>100	−0.153 *	0.313 *	0.116 *	0.209	0.081	0.331 *	0.404 *	0.464 *	0.288 *
Turnover in EUR									
<EUR 100,000	0.145 *	−0.061	−0.211 *	−0.154 *	−0.161 *	−0.265 *	−0.549 *	−0.172 *	−0.156 *
100,000–500,000	0.124 *	0.092 *	−0.221 *	−0.217 *	−0.144 *	−0.107 *	−0.369 *	−0.137 *	−0.009
500,000–2 million	0.050 *	−0.145 *	−0.108 *	−0.062	−0.053	−0.056	0.014	0.017	0.018
2–10 million	0.015	−0130 *	−0.037	0.085	−0.0.45	−0.017	0.147 *	−0.064	−0.046
10–50 million	−0.114 *	0.053	0.203 *	0.103	0.140 *	0.143 *	0.390 *	0.087	−0.028
>50 million	−0.220 *	0.375 *	0.374 *	0.225 *	0.263 *	0.302 *	0.367 *	0.270 *	0.221 *
Turnover over the past two years									
Increased	−0.069 *	0.042	0.092 *	0.130 *	0.073 *	0.091 *	0.107 *	0.101 *	0.144 *
Decreased	0.058 *	−0.020	−0.066 *	−0.088 *	−0.089 *	−0.114 *	−0.096 *	−0.118 *	−0.117 *
Unchanged	0.010	−0.022	−0.026	−0.042	0.016	0.023	−0.011	0.017	−0.027
Need of expertise	−0.280 *	0.429 *	0.378 *	0.354 *	0.473 *	0.584 *	0.547 *	0.343 *	0.452 *
Var(u_j)	0.054 *	0.251 *	0.277 *	0.180 *	0.319 *	0.309 *	0.250 *	0.230 *	0.292 *
ICC	0.051	0.201	0.217	0.152	0.242	0.236	0.200	0.187 *	0.226

* Statistically significant effect p-value < 0.05.

The above results suggest that the number of employees dedicated to green jobs and the perception of need of green skills among the labor force are associated to the decision to introduce new resource-efficiency actions by European SMEs. The employment of these skills could be encouraged in order to promote CE adoption. This could be part of green policies especially in those European countries where the composition of SMEs is more in favor of the type not devoted to green actions.

4.2. Multilevel Regression Models: Green Jobs and Skills for Resource Efficiency

In this section, we present the estimates of nine multilevel regression models, in particular, we aimed at investigating which factors might affect the decision to implement resource-efficiency actions in the near future, with special attention to the number of workers employed in green works and the perceived need of environmental skills.

Table 5 provides the estimates of the proposed multilevel regression models. In the first column, the dependent variable is ordinal, indicating the number of actions (no, few, some, many) that SMEs were planning to implement as additional resource-efficiency initiatives in the next two years. In the other eight models, the dependent variable assumed a value of 1 if the firm would implement the resource-efficiency action reported in each column. The independent variables characterizing the firms were: the number of employees working in green jobs, the age of the firm, the total turnover in 2016, the sector of economic activity, the change in turnover over the past two years, and the perception of lack of environmental skills. In all models, a random effect at the country level was specified in order to account for differences across countries. The coefficients reported were estimated with effect coding, i.e., the parameters referring to one covariate sum up to 0 so that the category-specific effects should be interpreted in terms of deviation from the average. The intra-class correlation coefficient (ICC) is the proportion of the total dispersion that is explained by the country level. The multilevel regression model estimated the effect of firms' characteristics on resource-efficiency behavior, considering the fact that SMEs operating in the same country may show similarities.

Results show that the age of the SMEs had no effect on undertaking future actions to increase resource efficiency, and the same result appears also in the multilevel logit regression model for all eight single actions. Other interesting results in common with the eight logit models are that not having full-time employees dedicated to green jobs decreased the number of resource-efficiency actions for the future and a positive effect on the independent variable was estimated for the fact that the SME declared a lack of specific environmental skills. Yearly turnover greater than EUR 10 million had a positive effect, and turnover lower than EUR 500,000 had a negative impact. Change in the turnover had a significant impact on the number of actions that the SME was planning for the future. This result was replicated also for the single actions except saving water. The fact that the firm operates in the manufacturing sector increased the intention to implement actions. The contrary was estimated for retail and services. As the variance of the random effect was positive and significantly different from 0, there was heterogeneity in this behavior between countries. The intra-class correlation coefficient (ICC) was 0.0540, i.e., the country level accounted for 5.12% of the variability. As a general remark, the result confirms the evidence reported in the previous analysis.

4.2.1. Saving Water

An average of 47.2% of firms in Europe implemented water-saving policies and 54.9% were planning to implement these in the future as an additional policy. Total turnover had a negative significant effect for firms with a turnover between EUR 500,000 and 10 million. The age of the SME had a negative statistically significant effect for firms established between 2010 and 2012. If the firm belonged to the manufacturing activity sector, it had a greater probability to implement this action in the future. The contrary was true for the industrial sector. Workers in green jobs had a significant and positive impact on the probability of undertaking this policy, while the effect was negative if there were no workers with this type of duty. A positive influence of perceiving the need of environmental skills was present for all eight actions. The number of workers in green jobs had a positive effect only if they were at least 10. An important percentage of heterogeneity was estimated: the ICC was equal to 0.2009.

4.2.2. Saving Energy

63.2% of European SMEs were undertaking measures to save energy and 41.2% planned to implement measures as an additional resource-efficiency action, as the EU is suggesting. The economic sector had a significant positive effect for manufacturing, while the effect was negative for industry and services. Having at least 10 workers in green jobs had a positive impact. The negative effect of turnover stopped at EUR 2 million and started with a turnover greater than 10 million. For this and the following actions, an increase in turnover corresponded to an increase in the probability of implementation. Heterogeneity between European countries amounted to 27.68%.

4.2.3. Using Predominantly Renewable Energy

The European Community Directive on renewable energy (European Community [21]) required that at least 20% of Europe's total energy needs were met with renewables by 2020. As can be seen from our data, only 14% of firms had adopted this CE framework in 2017, but 77.6% intended to adopt it. The results of the estimation of the logit regression model show that total turnover had a negative effect on the adoption of this policy when turnover was very low, below EUR 500,000, but a positive effect when turnover was very high, over EUR 10 million. No workers in green jobs had a negative effect, while it had a positive effect for firms with between 6 and 50 workers. Heterogeneity among EU MSs was estimated equal to 17.93%, the lowest level of all estimated models.

4.2.4. Saving Materials

Saving materials was favored by operating in the manufacturing sector, while retail and services had a negative effect; having a yearly turnover lower than EUR 500,000 had a negative effect, while the effect was positive for turnover higher than EUR 50 million. There was no significant effect of the age of the firm. A positive effect was estimated when between six and nine workers were employed in green jobs, and a negative effect for no workers. This action was undertaken by 56.4% of firms with an ICC equal to 24.21. A total of 50.8% of firms would adopt this additional action.

4.2.5. Minimizing Waste

Many EU documents (see, for example, European Commission [54]) refer to the problem of waste reduction. The EU plans for measures to increase waste reuse offer a range of environmental, economic, and social benefits. Our analyses show that only 65.5% of EU firms had adopted this action. This was the most diffused action, however, heterogeneity between countries was the highest, 22.83%. The probability of implementing this activity increased with the firms' turnover over EUR 10 million—there was negative effect up to EUR 500,000. The positive effect of workers in green jobs to the intention to implement the policy in the future started when the number of workers exceeded 100. Age had no effect. ICC was equal to 0.2362.

4.2.6. Selling Scrap Material to Other Companies

In this case, model estimation shows a significant positive effect on the probability of undertaking the action for manufacturing, and a negative for services, turnover greater than EUR 2 million, and being founded before 2010. The effect was negative for retailing and services, the youngest age, and yearly turnover lower than EUR 500,000. The role of green workers on the intention was positive only where there were more than 100. The ICC was 0.1999.

4.2.7. Recycling or Reusing Waste

SMEs operating in the manufacturing sector had a higher probability to implement this action in the future, while the probability was lower in the services sector. Firm's age had no significant effect, while yearly turnover increased the probability only for the highest level, and decreases probability when turnover was lower than EUR 500,000. As for the other actions, if there were no workers employed in green jobs, the probability decreased, and the effect was positive for over 100 employees. This is another action that requires a very big number of workers in green jobs, and consequently big dimension, to be planned for the future. Heterogeneity at country level amounted to 22.94%.

4.2.8. Designing Sustainable Products

By the end of 2017, 1/4 of EU firms were implementing the resource-efficiency practice related to designing sustainable products. The positive determinants of this behavior in the future according to the model estimation were a firm's turnover being over EUR 50 million, manufacturing as activity, and more than 10 workers in green jobs. It had a quite-large country-level impact (ICC = 0.2262).

5. Discussion

This article provides a contribution to the topic of the adoption of actions to increase resource efficiency in the European Union, with a specific focus on green employment and environmental skills. Actions related to resource efficiency are still employed by a small number of firms, especially if we consider small and medium enterprises.

In this paper, we analyzed survey data collected by the European Commission (Flash Eurobarometer 456, European Commission [55]). Data were collected in September 2017 and the sample was made up of over 10,000 SMEs active in the 28 EU Member States. To ensure that the sample was representative of the entire population, it was comprised of firms with different sizes, ages, and types of activity. The survey data allowed us to explore the spread of resource-efficiency practices and implementation of environmental skills in firms across EU countries, and to evaluate the determinants of this behavior, with specific attention to the characteristics of the SMEs, green employment, and eventual homogeneity within countries.

We estimated a multilevel latent class model in order to identify groups of European companies that were homogeneous in their implementation and intention to implement resource-efficiency practices, and groups of countries that were homogeneous in the composition of companies operating on their territory. Companies were classified into six clusters both for their observed behavior and for intentions. Countries were classified into four classes, but the compositions of these groups differed if we looked at undertaken actions and intentions for the future. The analyses show that there was a non-negligible portion of heterogeneity within and between countries in the adoption of CE practices, as other research has suggested (see, for example, Triguero et al. [30]), and that the number of workers employed in green jobs and a positive attitude towards environmental skills played a role in determining segments' belonging.

These results are confirmed by the estimation of multilevel regression models to explain the number and type of resource-efficiency actions in the plans of European SMEs. A general important observation was that having no workers dedicated to green jobs had a negative effect in all models, while perceiving the need of extra environmental skills had a positive effect on the intention to implement all eight actions in the future. Other characteristics of the firm had a significant impact on resource efficiency. In general, older and bigger firms, with larger yearly turnover, were more prone to implement resource-efficiency actions. The type of actions chosen varied across activity sectors.

More than 30% of SMEs in our sample were classified in cluster 6 of Table 3 (no resource-efficiency actions implemented), and over 40% of SMEs were classified in cluster 6 of Table 4 (no resource-efficiency actions planned for the near future). In order to devise policies that favor resource-efficiency implementation, it is important for European countries to know what is the level of implementation of CE practices by SMEs in their territory and also if there are ongoing plans to increase this behavior. SMEs are influenced in this decision by internal and external factors, and the identification of these factors suggests the most efficient policies to implement (European Committee of the Regions [56]). As findings of this paper underline, green employment and green skills are strictly linked to the decision on eco-innovation in SMEs, so acquisition and diffusion of environmental skills deserves attention and investment at European level.

Moreover, we found that some specific structural characteristics of the SMEs had a significant effect on the decision and the intention to implement CE practices. For example, the economic-activity sector revealed its importance. Almost half of European SMEs are active in the service sector, which was the one with the highest percentage of firms not implementing resource-efficiency actions, and not intending to do so; many of these SMEs were located in Italy, Germany, Poland, Spain, France, and Greece.

6. Concluding Remarks

As the results of this paper show, there is a significant association between green jobs, environmental skills, circular-economy practices adoption. Furthermore, our findings suggest an interaction effect with other characteristics of the firms, such as age, size, turnover, and economic-activity sector. Thus far, the topic has received limited attention in the reference literature, and our contribution seeks to provide a first perspective on it.

More specifically, our analyses show heterogeneity within and between European countries in the implementation of CE actions by SMEs and confirm that the number of employees in green jobs and the fact that companies require workers with environmental skills played a significant role in determining this behavior. An important observation is that having no workers dedicated to green jobs had a negative effect on the probability of adopting CE practices, while perceiving the need of extra environmental skills had a positive effect on the intention to implement actions in the future. Other characteristics of the firms had a significant impact on resource efficiency: older and bigger firms, with larger yearly turnover, were more prone to implement actions. The type of chosen action varied across activity sectors.

However, more investigation on the direction of this association is needed. The main question is: does the number of workers in green jobs stimulate the adoption of resource-efficiency practices or, is it that as SMEs start to adhere to CE, more workers are employed in green activities? To properly answer to this question, longitudinal data are necessary, although some insights could also be inferred from cross-sectional data. In this work, we focused on the intention to implement resource-efficiency actions in the near future. Future research may exploit data collected over time by the Eurobarometer on equivalent, although not the same, samples.

A second topic of further research could explore the potential effect on implementation of resource-efficiency action of covariates at country level such as economic and social indicators from European official statistics.

A third topic for future research that could help understanding of the relationship between green jobs and sustainability might be evaluating circular economy at firm level as suggested by Vinante et al. [57], who proposed to build CE detailed indicators, able to take into account firm characteristics.

Clearly, a future development more strictly related to the results of this research refers to an update of the analyses on a set of more recent data, as soon as a new Eurobarometer survey is available.

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