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Do firms care about peers when choosing to go circular?
Peer effect among Italian firms in the introduction of circular innovation

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Abstract

The challenges posed by the achievement of the circular economy require the adoption of new innovative practices that are not simply green but specifically related to closing, narrowing, and extending resources cycles (Bocken et al., 2016). Understanding the relationship between eco-innovation and circular innovation and what factors favour their implementation is, therefore, pivotal. This paper offers new pieces of evidence on the role of social norms in increasing firms' propensity to adopt circular innovation. Drawing upon the literature corpus confirming the influence of the social context on firms' decision to innovate and enriching this analysis with recent evidence on the effect of peers in firm decision-making, the present study relies on survey data on 3270 Italian Small and Medium Enterprises with the extent to investigate the effect of peers behaviour in firms decision to adopt circular innovation. The empirical analysis shows a positive relationship between increased investment in circular innovation by peers and the decision of firms to innovate in the same realm. These results, therefore, offer a relevant starting point for the design of policy guidelines and organisational strategies in favour of the circular economy. Social norm information and comparison can be indeed complementary tools to the traditional market and regulatory levers for circular innovation adoption.

Keywords: *Circular innovation, Circular Economy, Eco-Innovation, Social Norm, Peer Effect*

1. Introduction

In 2019 the European Commission has launched the European Green Deal, which define Europe long-term growth roadmap to achieve carbon neutrality by 2050, resource efficiency, and social justice (European Commission, 2019). Part of it, the New Circular Economy Action Plan sets the ambition to minimize resource consumption in compliance with planetary boundaries and doubling the use of secondary raw materials in the next decade (European Commission, 2020). Clearly, achieving these objectives requires, among the others, the full mobilization of industry. The Circular Economy (CE) approach indeed challenges the modern design of products and strive toward new systems based on reuse, refurbishing, remanufacturing and the use of clean resources. New technologies and methods are therefore needed to increase the value retention of products and materials within value-chains, hence preserve the natural stock of resources.

It emerges that understanding which sources of innovation can accelerate business restructuring and create options and pathways for CE achievement is of paramount importance. Innovation, more specifically Eco-Innovation (EI), has been regarded as one of the most effective tools empowering firms capacity and seeds CE dynamics at firm level (Barbieri et al., 2016). Notwithstanding, still the overarching framework of eco-innovation typologies compatible with *closing*, *narrowing* and *extending* resources cycles (Bocken et al., 2016) is blurred. Moreover, evidence on what drives innovative changes related to CE is so far scant (Cainelli et al., 2020). On the other side, the possibility of achieving a circular production model rests heavily on the ability of firms to adopt innovative practices that steer them towards the transition. Therefore, understanding how to stimulate the adoption of Circular Innovation (CI) is a key element in the effective implementation of a CE.

In the present paper, we focus our attention on the quantitative analysis of CI adoption. In doing this we will try to move a step further the analysis on traditional market-pull and regulatory push-pull effect that might contribute to the adoption of innovation. Recent studies have indeed extended the investigation of innovation determinants, specifically EI, toward *open modes* of innovation, considering firms not only as isolated agents, but also as elements that are part of social contexts. The existing literature provides several contributions (e.g. Horbach, 2008; Horbach et al., 2012; Antonioli et al., 2013; Ghisetti et al., 2015) on the role of inter-firm/cluster linkages, knowledge/technology spill over, and firms' openness to external sources of knowledge in positively affecting EI adoption. In line with this, we will assume the existence of imitative tendencies during firms' innovative decision-making processes, by recognizing the social norm of the context in which companies operate crucial driver for Cis adoption. This notion draws on the strand of behavioural economics literature on consumers, which demonstrated how providing information on peers behaviours induce people toward pro-environmental behaviours. Indeed, people do care about their reputation and self-image, hence they will interpret the external environment in order to choose the right way to behave or believe and to conform with the group, in order to avoid disapproval (Thaler and Sustain, 2008). Several studies showed that the behaviour of peer agents is able to influence also firms' choices, contrasting the widespread idea that firms not operating in oligopolistic markets, make their decisions in isolation. For example, researches on firms' behaviour (i.e. Gyimah et al., 2020; Park et al., 2017; Francis and Kostova 2016; Liu and Wu, 2015; Chen and Ma, 2017; Tang et al., 2019) have demonstrated companies openness to external sources of information, especially deriving from their peers. According to these results, indeed, companies evaluate the appropriateness of current behaviors or future actions by comparing themselves to their peers.

Summing up, this study aims to analyse whether the decision of firms to introduce CI, is influenced by the behaviour of their peers. This is particularly relevant considering that policymakers could exploit instruments such as social norm information and social comparison to increase the effectiveness of traditional market levers and direct firms' choices towards more beneficial environmental conducts. We will use survey data collected in 2019 on Italian companies by the Centre for Research on Circular Economy Innovation and SMEs (CERCIS), and we will investigate whether considering peers having increased their investments in CI is a driving factor for CI adoption. This paper will therefore provides new insights on the levers for CIs adoption. It will fit into the strand of literature opening the study of EI forward traditional market, regulatory and technical-based drivers with the aim of extending their scope toward the analysis of peer effect, which has been studied by behavioural economics mainly on consumers and only recently by some studies at firm level.

The paper is structured as follows. Section 2 provides the theoretical background and the relevant literature linking the CE and EI concepts, and the array of studies which have recently focused on the peer effect at firm level. Section 3 presents the data and discusses the statistical and econometric analysis. Section 4 reports the econometric results. Section 5 leads the conclusions

2. Conceptual Background

2.1 Circular Innovation

The growing awareness that the planet's resources cannot be limitless has paved the way for the need for change in the global economy. A new model based on decoupling raw materials extraction from economic growth, and focused on the extension of resources cycles, remanufacturing, and recycling: the CE represents one of the main challenges of next decades (de Jesus, 2018). The rise and the adoption of new technologies has been recognized (Barbieri et al., 2016; de Jesus and Mendoça, 2018; de Jesus et al., 2018; de Jesus et al., 2019) as an essential condition for the adaptability of current products and process manufacturing toward efficiency, durability, recovery as well as the creation of new solutions (e.g. rent, share dematerialization) and the use of by-products as input.

Overall, the academic literature is therefore unanimous in recognizing EI to be instrumental in addressing CE challenges, nevertheless, the connection among EI and CE is not straightforward. Indeed, as de Jesus et al. (2018) recognize «not all EI is related to the CE, and EI might also have different impacts in several areas of the CE» (p. 3005). This could result from the broadness of the concept of CE (114 definitions have been identified in the work of Kirchher et al., 2017). Several contributions, for example, (e.g. Ellen MacArthur Foundation, 2013; EU Commission, 2015) describe CE as an approach aimed at achieving an alternative model based on reducing resources' exploitation and waste generation through the recirculation of end-of-life materials. Others have highlighted that the CE concept has a broader scope, that compasses a more complex reconfiguration of industrial and consumption routines embedding the three dimensions of sustainability, as discussed in Geissdoerfer et al., (2017). Consistently, the traditional branch of the EI literature, which distinguishes between product, process and organisational innovation, must necessarily be enriched when considering the link between EI and CE. Carrillo-Hermosilla et al., (2010) have indeed differentiated incremental EIs, i.e. improvements in product, process and organizational framework, and radical EIs, i.e. deep modifications providing the outbreaks of new systems of production. In this still open debate, a very informative definition of CI is that given by de Jesus et al., (2019), which define it as « new combinations of “harder” (R&D-driven products, cost-cutting processes, technical solutions embedded in cleaner products and processes) and “softer” types of knowledge (the institutional setups, business models and the behavioural patterns inscribed in circular organisational and marketing solutions). Fusing technological and nontechnological change into a new cleaner and more congruent techno-paradigm has been referred as “systemic EI”» (p. 1496). CI can therefore be defined as the interplay of incremental innovation on the one hand, based on redesign of existing products and process, and radical innovation on the other, focused on changing the overall system of supply and demand through the creation of new process and organizational solutions. It is worth noting that in this paper we will refer to the micro dimension of CE, since the attention is on innovation adopted by companies (de Jesus et al., 2018).

Moreover, although the role of innovation is acknowledged, not only a uniform methodology for integrated assessment of CE in the EI realm is lacking, but also evidences on the main factors driving the introduction of CI remain scarce. Accordingly, at the best of our knowledge only Cainelli et al., (2020) have empirically investigated the potential drivers of eco-innovative practices relevant to comply with CE. The authors have analysed the role of regulatory and demand-side drivers in the adoption of resource-efficiency related innovations, by relying on the work of De Jesus and Mendonça (2018), which distinguishes between “harder” factors (technical, economic), and “softer” ones (regulatory and institutional), favouring and hampering CE. On the other hand, we believe that developing a study that goes beyond the analysis of traditional enabling factors, may be important to enrich and extend the debate on innovation adoption, and especially CI. The present paper will therefore devote its attention toward the potential positive effect that social context could play on firms decisions for the introduction of CI.

To derive this prediction we have linked different strand of research. First, we refer to recent analysis that has extended the investigation of EI determinants, by examining the role of agglomeration economies and network relationships (Cainelli et al., 2012), knowledge-sharing and knowledge transfer (Ghisetti et al., 2015), organizational and human resource practices (Antonioli et al., 2013). These contributions have indeed shown that the environment in which firms operate can play a decisive role in the decision to adopt EI. The second field of analysis is related to the application of the so-called peer effect at firm level, to which we have devoted a separated paragraph since it deserves a more detailed description to build the foundations of our analysis. Overall, despite the existing theoretical differences between these two strands of the literature, it seems to be agreement on the potential positive influence of the social environment on firms’ behaviours. Coherently with these findings, we therefore expect these phenomena also to apply when firms must choose whether to adopt innovation linked to CE.

2.2 Peer comparison influencing firms decision-making

Studies on peer influences go back to Di Maggio and Powell (1983) which have shown that firms belonging to the same business line are subjected to forces that lead them to become more similar to one another. More precisely, same conditions push rational organizations toward homogeneous forms and practices. What is relevant, is that this process of isomorphism has been recognized to partially derive from an imitation mechanism, which actually suggests that firms look at other firms to emulate their behaviors under certain circumstances. More recently, researches have demonstrated the existence of peers' imitation for diverse decisional process as *investment banking* (Chen and Ma, 2017), *corporate financial policy* (Gyimah et al., 2020; Tang, et al., 2019; Park, et al., 2017; Francis, et al., 2016; Kaustia and Rantala, 2015; Liu and Wu, 2015), *R&D investments* (Kelchtermans et al., 2020), and *environmental-based policies* (Wu et al., 2020).

These studies provided the evidence that firms refer to their peers behaviour when they formulate decisions especially in highly competitive environments. For example, in corporate decisions Gyimah, et al. (2020) postulate that the trade credit policies of peers is able to influence a firm's own trade credit policy. In turn, Liu and Wu (2015) suggest that when Corporate Social Responsibility (CSR) is considered a competitive tool, the behaviour of firms is positively affected by the CSR level of their competitors. This is consistent with the results in Chen and Ma (2017) and Gyimah et al., (2020) that highlight that firms imitate others either to maintain their market position or to cope with rivals' action, consistent with the rival-based-theory. On the other side, the more uncertain the environment in which firms operate is, or the more ambiguous the goals of an organization are, the greater the extent to which a firm perceive imitation to be a successful strategy. Indeed, according with the results in Gyimah et al., (2020), Chen and Ma (2017) and Francis et al., (2016) the peer effect proceeds from a leader-follower relationship, as suggested by the information-based literature. Follower firms are those with low market share, low liquidity, low profitability, more generally, those lacking market experience and resources. In these situations, learning from peers that possess superior information help small firms building their reputation and avoiding investments uncertainty. Moreover, in Kelchtermans et al., (2020) is found evidence that in situation of uncertain information, for example due to the complexity of public R&D support measures, social interactions do not spread among random peers, but rather among firms characterized by preferential connections, particularly those active in the same industry.

It is worth highlighting that, for the scope of this study, the term "*peer"* indicates firms competing in the same market and sharing similar characteristics, rather than firms situated on different levels (e.g. leader-follower), Wu et al., (2020) have indeed proved that providing firms with information on decisions made by their *similar,* through social comparison or aggregate peer actions, is able to increase the effectiveness of environmental policies in case of firms' heterogeneity. The results suggest that companies align their decisions with peers not only for strategical reasons, but also according to social pressures.

Table 1: Peer effect evidence at company level in the literature

Evidence of Peer effect *(When?)*	Related Literature	
Competitive markets	*Gyimah et al., (2020)*	Trade credit policies of peers influence a firm's own trade credit policy
	Liu and Wu (2015)	The behaviour of firms' is positively affected by the Corporate Social Responsibility level of their competitors.
	Chen and Ma (2017); Gyimah et al., (2020)	Firms' imitate others to maintain their market position or to cope with rivals' action,
Uncertain situations	*Gyimah et al., (2020)* *Sikochi (2020)* *Chen and Ma (2017)* *Francis et al., (2016)*	Firms lacking of market experience and resources by learning from leaders that possess superior information can build their reputation and avoid investments uncertainty.
Among similar peers	*Wu et al., (2020)*	Firms provided with information on decisions made by their similar increase the effectiveness of environmental policies in situation of firms heterogeneity.

Authors' own elaboration from the literature

Relaying on these studies, next sections will empirically examine through statistical and econometric analysis whether peers' behavior affects firms in the adoption of CI.

3. Research Methodology

The empirical investigation has been conducted through the elaboration of a questionnaire on Italian manufacturing Small and Medium Enterprises (SMEs) during 2019, with the financial support from "Dipartimenti di Eccellenza 2018-2022" project of the Department of Economics and Management of the University of Ferrara. The aim is collecting information on the state-of-art of the CE transition at firm level, in Italy. Particular interest is addressed to the role of innovation and the level of implementation of eco-innovative practices linked to CE. In accordance, SMEs represent a large part of Italian business, yet their involvement in the CE remains limited. The main barriers identified by the EI literature, on EU firms, are the difficult access to finance, the lack of enforcement and incentives, low technological competences and expertise, the low priority assigned to environmental protection and low perception of benefits, the reluctance toward change and the lack of confidence (Mazzanti et al., 2020). On the other hand, the CE brunch of the literature identifies the lack of demand, scarce financial resources and skills, and administrative burdens as the most pressing obstacles hindering CE activities within EU firms (Rizos et al., 2015). However, given the significant participation of SMEs in the Italian economy, their involvement is considered decisive to alter market pathway toward CE transition. Therefore, a deeper understanding of the current engagement of firms and existing bottlenecks and drivers is needed to gather data in support of policy-making, hence to direct most conscious efforts towards a systemic CE transition.

3.1 The questionnaire

The questionnaire has been developed building on and extending the information of existing official EU sources, such as CIS waves and Eurobarometer surveys. Specifically, it is structured in the following four modules: 1) Firms' characteristics 2) Innovation and Investments 3) Circular Economy 4) Training and Industrial Relations.

The first section is aimed at collecting firms' general information, such as geographical localization, sector classification, data of the respondent person, firms' turnover (2017, 2018), firms' age, export level, number of employees (2017, 2018) and their degree of training. The second section measures, on the one hand, innovation activity, distinguishing between process and product and their level of radicalness, depending on whether the EI is new to the firm or to the market. On the other hand, it investigates firms' investment capacity in R&D, R&D devoted at reducing the environmental impacts of production, and patents' adoption. The third part of the questionnaire is specifically focused on CE and CI adoption. The types of CI included are innovations focused on (a) minimizing the use of water within productive process (b) minimizing materials' usage (c) using renewable energy (d) minimizing energy use (d) minimizing waste use, reuse and selling to other companies (e) re-designing products to reduce the use of materials and enhancing their recyclability (f) reducing greenhouse gases emissions. This section also scrutinizes potential drivers for innovation adoption, making reference to market *vs*. non-market instruments. Finally, the last section examines the importance of green high performance practices, such as organizational training and reskilling activities aimed at coping with the transition to CE, and the role of industrial relations for the adoption of CIs.

3.1.1.Questions about CI adoption

CIs implementation was measured by considering the following question: *"Has the firm introduced innovations aimed at achieving the following CE objectives, in the biennium 2017-2018?"*. A list of CE-oriented innovations was subsequently provided and respondent firms had to choose *"Yes"* in case of adoption and *"No"* otherwise. For the scope of the analysis, a limited set of CIs was selected in correspondence with peers-related questions, specifically: *reducing waste per output produced*; *reusing waste within own productive process*; and *delivering waste to other companies to be reused in their productive process*. This has allowed to investigate the relation between CI adoption and the peer-effect, that otherwise would not have been possible considering the full array of innovations provided by the questionnaire. Although limited to the waste management sphere, selected CIs are not only concerned with incremental changes supporting waste prevention, reuse and recycling. But they also convey radical modifications, by supporting the creation of firms' networks characterized by integrated productive systems based on the continuous exchange of materials. The CIs chosen are, indeed, examples of product, process and organizational EIs.

3.1.2. Questions about peer effect

The peer-effect has been measured resorting to the following questions: 1) "*Do you think that your peers have increased or decreased their investments in innovations aimed at reducing waste per output produced, in the biennium 2017-2018?"*; 2) "*Do you think that your peers have increased or decreased their investments in innovations aimed at reusing waste within firm's productive process, in the biennium 2017-2018?"*; 3) "*Do you think that your peers have increased or decreased their investments in innovations aimed at delivering waste to other companies to be reused in their productive process, in the biennium 2017-2018*. Respondents had therefore to express their knowledge on peers' behaviours, especially on peers' investments in waste-related innovations, considered in this study as a proxy for CIs. To note that, "peer" is the indicator of companies competing in the same market and with similar characteristics. The scope is understanding whether firms that reported introducing at least one CIs think their peers have increased investments directed toward that same type of innovation. As a consequence, whether peers behavior affects firms in the adoption of CIs.

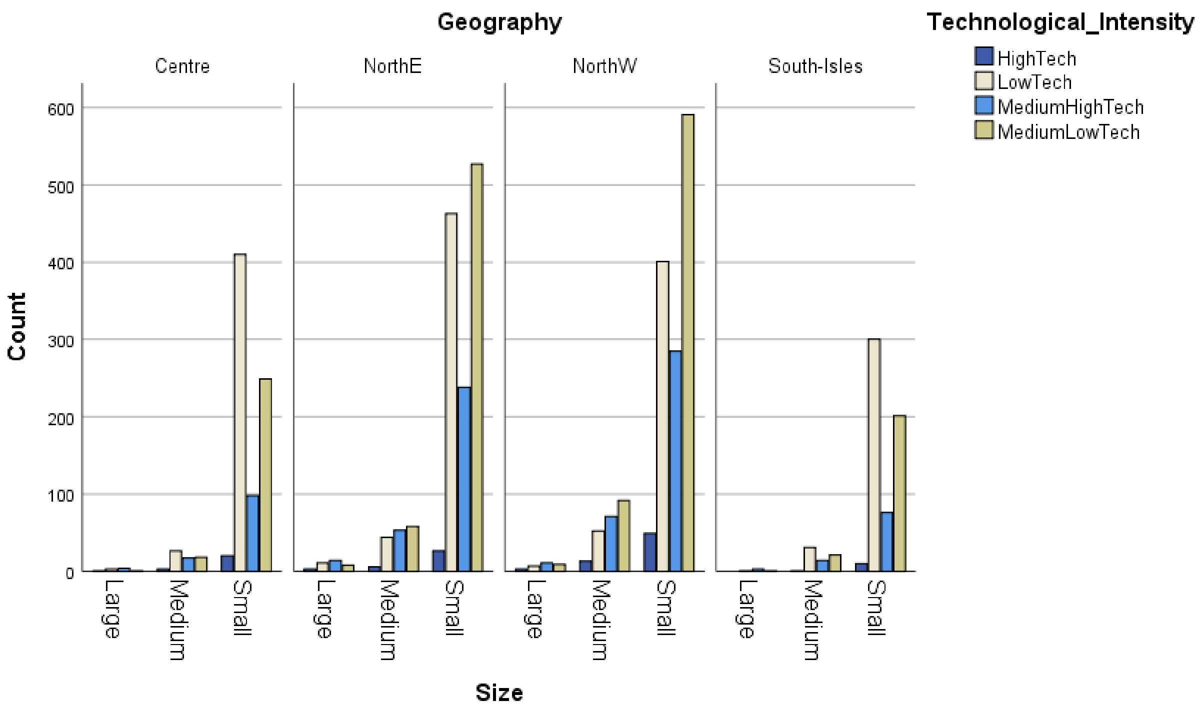
3.2 Survey presentation

The survey has been organized on Italian manufacturing firms, with at least ten employees, during 2019 by the survey company Izi s.p.a. Data have been gathered through a Computer Assisted Web Interview (CAWI), by providing firms with a questionnaire. The period of time covered is the biennium 2017-2018. The objective was collecting data for at least 4500 firms, which has been overcome, since the final sample counts 4565 respondent companies. The sample has been subsequently stratified by geographical localization (macro area, Istat), sector (technological intensity, Eurostat[1]), dimension (10-49 employees; 50-249 employees; >250 employees). Fig. 1 shows that respondent firms are mainly situated in North Western Italian regions, followed

[1] Eurostat classification https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:High-tech_classification_of_manufacturing_industries

by North Eastern, Central and Southern regions (including Sicily and Sardinia). Furthermore, prevail firms belonging to low and medium low technology sectors and firms of small dimension.

Figure 1 Firms categorization by geographical localization, size, and technological intensity



Own elaboration using SPSS software

Table 2: Sample description

Variable	Desccription	Mean	Std. dev.	Min	Max
AGE	Firm age	3.050.515	2.133.896	0	221
SIZE	Firm dimension	2.701.351	3.191.188	7	250
GEO	Firm geographical localization	234.463	1.139.827	1	4
TECH	Technological intensity of the firm sector	1.866.041	.8215258	1	4
REGTURN	% distribution of firm turnover at regional level	5.685.149	3.765.265	0	100
NATTURN	% distribution of firm turnover at national level	413.969	3.135.749	0	100
EUTURN	% distribution of firm turnover at European level	1.858.727	2.144.403	0	100

The 37% of Italian SMEs declared having introduced product innovation between 2017-2018, and the 40% have implemented process innovation in the same period. Concerning specific EI typologies, the 19% of firms adopted innovation to reduce waste, 12% to reuse waste within their productive process, and 17% to deliver waste to other firms. In addition, respondent firms reported that reducing waste has mainly concerned process and organizational EIs in order to increase the effectiveness of resource use. On the other hand, reusing waste has mainly involved changes in firms' manufacturing processes that guarantee circularity of materials. Finally, delivering waste to other firms implies major process and organizational changes, especially due to the creation of firms' networks.

3.3 ***Peer effect and CE-oriented innovations: Descriptive statistics analysis***

The empirical analysis is specifically aimed at investigating whether is there any relation between the increasing in CIs investments by peers and the introduction of CE-oriented innovations by respondent firms. The goal is understanding whether firms imitate their peers in the adoption of innovations for the CE. In this view, it will be carried out first a descriptive statistic analysis, and building on the obtained results an econometric analysis will be conducted in the next section.

For the research purpose, two main variables of interest were created to conduct the descriptive statistic analysis. On the one hand, the CE-related innovation variable examines innovation adoption in terms of intensity. It indeed considers overall CIs (namely, waste reduction, waste reuse, and waste delivery) and the number of innovations' typology introduced per single firm. **Table 3** reports 3.182 firms having introduced 0 CIs, 754 firms having introduced one out of three CI typologies, 455 firms two, and 174 firms all three CIs types, between 2017-2018. On the other hand, the peer-effect variable was coded dichotomously in the database to assume the value of 1 if the firm thinks its peers having increased investments in CIs, between 2017-2018, and 0, otherwise. Totally, 2.903 firms have reported an increase in peers' investments, and 1.662 a decrease.

Subsequently, the number of non-innovators was excluded from both CE-related innovations and peer-effect variables. Then, the number of innovative firms was divided, first, by the peer-effect variable when it assumes the value 1 and second, when it assumes the value 0. This calculates, on the total of innovators, how many introduced CIs while thinking that their peers have increased their investments in the same CI typologies, and by contrast, how many firms have innovated while thinking their peers having decreased their investments in CIs.

The first noteworthy results shows that the strong majority (71%) of those who have introduced at least one typology of CE-related innovation considers its peers having increased its investments in the same types of innovation.

Table 3: Cross tabulation between Peer-effect variable and firms introducing CI

How many Circular-oriented Eco-Innovations typologies has the firm introduced, in the biennium 2017-2018?

		0	1	2	3	Total	% Peer Innovators
Do you think that your peers have increased or decreased their investments in Circular-oriented Eco-innovations?	No	1262	232	121	47	1662	**28,9%**
	Yes	1920	522	334	127	2903	**71,1%**
Total		3182	754	455	174	4565	

The same operation was conducted considering separately each CI. In this case, the innovation variable assumed value 1 when firms introduced the innovation (for waste reduction, waste reuse, and waste delivery to other firms), and 0 otherwise. **Tables 4-6** confirm that most innovators believe that their peers have increased investments in the same type of CI.

Table 4: Cross tabulation between Peer-effect variable and firms innovation to reduce waste per output produced

Has the firm introduced innovations aimed at reducing waste per output produced, in the biennium 2017-2018?					
		No	Yes	Total	**% Peer Innovators**
Do you think that your peers have increased or decreased their investments in Circular-oriented Eco-innovations?	No	1429	233	1662	**26,6%**
	Yes	2260	643	2903	**73,4%**
Total		3689	876	4565	

Table 5: Cross tabulation between Peer-effect variable and firms innovation to reuse waste within firm's productive process

Has the firm introduced innovations aimed at reusing waste within firm's productive process, in the biennium 2017-2018?					
		No	Yes	Total	**% Peer Innovators**
Do you think that your peers have increased or decreased their investments in Circular-oriented Eco-innovations?	No	1496	166	1662	**30,3%**
	Yes	2522	381	2903	**69,7%**
Total		4018	547	4565	

Table 6: Cross tabulation between Peer-effect variable and firms innovation to deliver waste to other firms that use it as input in their productive process

Has the firm introduced innovations aimed at delivering waste to other firms that use it as input in their productive process, in the biennium 2017-2018?					
		No	Yes	Total	**% Peer Innovators**
Do you think that your peers have increased or decreased their investments in Circular-oriented Eco-innovations?	No	1446	216	1662	**28,3%**
	Yes	2356	547	2903	**71,7%**
Total		3802	763	4565	

It emerges that, according with descriptive statistic results the peer-effect and CIs variables are positively related. Notwithstanding, in order to obtain stronger evidence on the causality effect of peer behaviours in driving CIs, an econometric analysis is required.

3.4 Peer effect and CE-oriented innovations: Econometric Analysis

This study is aimed to determine the impact of peers' behaviour on the adoption of CI using a probit regression. The probit model is a statistical probability model with a binary dependent variable. Indeed, given the dichotomous nature of the choice to innovate or not to innovate, *y* is valued zero and one. The probit analysis provides results on which determinants increase or decrease the probability of innovating.

Three binary dependent variables will be considered for specific waste- related innovations. For each CI, respondent firms have to decide whether to introduce the innovation related to this field (Y=1) or not introducing it (Y=0). Different factors may influence this decision, and they are indicated with a vector *x*. Therefore, the analysis deals with an estimation of the probability:

$$p_i = prob[Y_i = 1|x] = F(x,\beta)$$

A normal distribution is assumed. The β parameter indicates the effect of changes in *x* on the probability. Subsequently, the relationship between explanatory variables and the outcome of probability has been interpreted using the average marginal effect, which considers the partial change in the probability when *x* increases by one unit, holding the other variables constant. The marginal effect suggests how the explanatory variables shift the probability of being an innovator. Hereinafter the equation of the empirical analysis:

$$CI_i = \alpha + \beta_1 PEER_i + \beta_2 SIZE_i + \beta_3 AGE_i + \beta_4 RED_i + \beta_5 INDUSTRY4.0_i + \beta_6 TECH_i + \beta_7 COSTWAS_i + \beta_8 POLICY_i + \beta_9 NORTH_i + \beta_{10} CENTRE_i + \beta_{11} SOUTH_i + \varepsilon_i$$

The dependent variables introduced to capture CI, are *WASRED* (Innovation to reduce waste per output produced), *WASREUSE* (Innovation for reusing waste within own productive process), *WASDELIV* (Innovation for delivery waste to other companies to be reused in their productive process). *PEER* is the main driver under scrutiny indicating the influence of peers' behaviour for the introduction of innovation. The dependent variables intending to capture CI are the following: (i) *SIZE* a continuous variable indicating firms' dimension accounting for the number of employees in 2017. (ii) *AGE* a continuous variable expressing the age of respondent firms. (iii) *RED* a dummy variable with value of 1 if the firm undertakes R&D investments between 2017-2018. (iv) *INDUSTRY4.0* a dummy variable taking value of 1 if the firm introduced technological innovations by exploiting the opportunities of the Industry 4.0 program in 2017-2018; (v) *TECH* a categorical variable measuring in ascending order the technological intensity of the sector which the firm belongs to i.e. low technology, medium-low technology, medium-high technology, high-technology. (vi) *COSTWAS* refer to firms' perception of the increase in future waste disposal costs for the biennium 2019-2020. It captures the impact of market-oriented factors as a pressure instrument in firms' decision for introducing CIs. Firms have to respond to the following question: *How much do you think the cost of waste disposal relevant to your business will increase in the 2019-2020 biennium?*. Respondents could specify the percentage of increase (from 0%-100%) or opt for "*I do not know*". Data have been collected in a categorical variable accounting for different steps of increase. Observations deriving from the option "*I do not know*" have been considered as 0, since not being aware of increased disposal costs has been considered as having no effect on the decision to innovate due to market pressures[2]. *POLICY* is a continuous variable indicating the total management costs of mixed municipal waste (€/hab. per year) in 2017. Data have been collected using a database of ISPRA the Italian Istituto Superiore per la Protezione e la Ricerca Ambientale. The variable has been interpreted as a policy stringency indicator of the municipality in which firms operate. *NORTH*, *SOUTH* and *CENTRE* are three dummy variables that take value of 1 depending on whether the firm is located in regions of Northern, Central or Southern Italy. All variables influencing firms decision to innovate included in the model are summarized in **Table 7** with a summary statistics.

Table 7: Descriptive statistics

Variable	Description	Mean	Std. dev.	Min	Max
PEER	Firms perception of increase/decrease of peers investments on waste-related innovations (2017-2018)	0.636	0.481	0	1
SIZE	Firm dimension (2017)	2.733	3.269	7	250
AGE	Firm age	3.212	21.681	1	222
RED	Investments in R&D (2017-2018)	0.313	0.463	0	1
INDUSTRY4.0	Introduction of technological innovations using the Program Industry 4.0 (2017-2018)	0.208	0.406	0	1
TECH	Technological intensity of the sector	1.898	0.827	1	4
ATECO	ATECO code of the sector	2.233	6.600	10	33
COSTWAS	Firms' expectation of the increasing of future cost of waste disposing of primary importance to their activity (2019-2020)	0.276	0.588	0	4
POLICY	Total management costs of mixed municipal waste (€/hab. per year) (2017)	4.595	2.573	2.63	213.18
NORTH	Regions of Northern Italy	0.707	0.455	0	1
CENTRE	Regions of Central Italy	0.178	0.382	0	1
SOUTH	Regions of Southern Italy	0.114	0.318	0	1

[2] To correct the potential inaccuracy of this information we have lead a robustness check with costwas≠0 and we obtain estimates qualitatively consistent with the original model, available under request.

4. Empirical Results

The main econometric results are reported in **Table 8** . Each column indicates the average marginal effect of Probit estimates (Refer to Table in Appendix for Probit estimates results) for all firms of the sample regarding the introduction of the three typologies of CIs. It clearly emerges that PEER is positively and significatively correlated with the adoption of all CIs. Indeed, considering peers having raised investments for the three typologies of innovations in questions increases on average the probability of introducing innovation for waste reduction by 6% , for waste reuse by 2,6%, for waste delivery by 5,6%. The results comply with the findings in Wu et al., (2020) which found out that information on decisions taken by similar firms increases the probability of adopting an innovation.

Table 8: Determinants of CI: marginal effect

Estimation Method:	Probit	Probit	Probit
Dependent Variable:	Innovation to reduce waste per output produced	Innovation for reusing waste within own productive process	Innovation for delivery waste to other companies to be reused in their productive process
PEER	**0.0639*****	**0.0259****	**0.0565*****
	(0.0140)	(0.0118)	(0.0137)
SIZE	-0.0000607	0.0000461	-0.00000681
	(0.000195)	(0.000163)	(0.000200)
AGE	0.000383	0.000688***	0.000564*
	(0.000295)	(0.000253)	(0.000291)
RED	0.147***	0.0859***	0.0421***
	(0.0139)	(0.0121)	(0.0144)
INDUSTRY4.0	0.0589***	0.0373***	0.0574***
	(0.0156)	(0.0131)	(0.0155)
TECH_mediumLow	0.000999	0.0225*	0.00602
	(0.0157)	(0.0135)	(0.0152)
TECH_mediumHigh	-0.0344*	-0.0237	-0.0268
	(0.0183)	(0.0146)	(0.0177)
TECH_high	-0.0737**	-0.0679***	-0.0585*
	(0.0312)	(0.0215)	(0.0312)
COSTWAS	0.0564***	0.0285***	0.0415***
	(0.01000)	(0.00837)	(0.00987)
POLICY	0.000604**	0.000510**	0.0000157
	(0.000272)	(0.000228)	(0.000269)
NORTH	0.00469	-0.00917	-0.0147
	(0.0234)	(0.0195)	(0.0220)

CENTRE	-0.0171	-0.0487**	-0.00880
	(0.0259)	(0.0220)	(0.0246)
SOUTH	0	0	0
	(.)	(.)	(.)
N. Obs	3270	3270	3270

Notes: Reported are average marginal effects. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Another factor explaining the adoption of CI is investment in R&D (RED), the variable is indeed positive and highly significative for all CIs' typologies. Accordingly, having invested in R&D between 2017-2018 increases on average the probability of adopting innovation for waste reduction by 14,7%, for by-product reuse by 8% and for waste exchange to other production processes by 4%. This indicates that CIs requires the availability of knowledge capital as a condition to be implemented, indeed as identified in De Jesus and Mendonça (2018), an adequate support of R&D activities positively increases the knowledge base necessary for CE. Notwithstanding, still the positive role of R&D investments has not been completely confirmed for EIs in the realm of CE. Indeed, these findings are in contrast with those presented in Cainelli et al., (2020), in which R&D results negatively affect EI-related to RE. This demonstrates the need to provide more robust results on the role of R&D among CI drivers. On the other side, there is large consensus in the EI literature, among the others in Horbach (2008) and in Horbach et al., (2012), that R&D investments have been recognized having a positive role on firms' technological capabilities, which plays a crucial role in the realization of EI.

Table 8 shows that the introduction of CI aimed at both waste reduction and reuse receives the positive, albeit weak, effect of stringent policies. Indeed, operating in a municipality with higher waste management costs increases on average the probability of introducing innovation for waste reduction by 0,06% and for waste reuse by 0,05%. Differently, the regulation does not seem to affect the adoption of innovation in favour of by-products exchange. On the one hand, these findings are in line with the literature on EI, recognizing a positive effect of environmental policy in determining the adoption of eco-innovative solutions. Indeed, since companies are not motivated to adopt EI, as they would enhance the quality of environment at their cost while producing societal benefits, stricter environmental policies and regulations have been proved to be crucial to increase firms' incentive to adopt EI in order to decrease compliance costs. (Rennings, 2000). As pointed out in Barbieri et al. (2016) p. 607 «*by changing the relative prices of production factors or by setting new (environmental) standards, existing as well as forthcoming policies induce (environmental) innovations in each of the phases of the Schumpeterian innovation process, from invention to adoption and diffusion*». On the other hand, such results comply with a branch of literature more strictly connected to EI and CE. For example, in De Jesus and Mendonça (2018), the authors identify a positive link between eco-innovative practices leading to CE and soft drivers, such as regulatory and institutional. Also in Cainelli at al. (2020) the positive effect of environmental policy has been verified for the introduction of innovation encouraging recycling, waste reduction and the decrease resources' use. Further to this, the fact that stringent policies are not sufficient to justify firms’ exchanges of waste, demonstrates the existence of heterogeneity between different typologies of CI introduction. This specific CI may be more costly in terms of both economics and effort. Especially, with regard to the latter, the supply of own waste to other companies asks for the presence of networks and a well-established structure that regulates the matching of waste supply and demand, for which more targeted policy interventions are needed. It is worth noting, however, that the variable POLICY focuses on the management cost of mixed waste, which constitutes only a part of the overall waste typology generated by companies, mostly dealing with special waste. For this reason, in order to control for this potential limit, the analysis also takes into consideration the perceived increase of the cost of managing waste of first importance for responding companies. This allows to detect, whether the expected change of relative prices for their specific waste management, which may occur with the imposition of more stringent environmental standards, significantly affects firms through innovation reactions. This effect is confirmed as demonstrated by the variable COSTWAS, indicating that a perceived increase of the relative prices induces on average innovation for waste reduction by 5,6%, innovation for waste reuse by 3%, innovation for waste exchange by 4%.

An additional positive effect generated by the policy, this time activated by a subsidy, is suggested by the positive and significant relation among CE-innovation adoption and the exploitation of Italian program of *Industry 4.0*. This plan is aimed at providing incentives to firms for the introduction of new technological regimes. Industry 4.0 covers all aspects of the lifecycle of companies, offering support for investment, digitization of production processes, enhancing worker productivity, and training appropriate skills (e.g. through hyper and super depreciation plans, tax credit for R&D, incentives for investments in innovative start-ups and SMEs). **Table 8** shows that using the incentives provided by the plan of Industry 4.0 increases on average the probability of adoption respectively of innovation to reduce waste per output produced by 6%, of innovation for reusing waste within own productive process by 4%, and of innovation for delivery waste to other companies to be reused in their productive process by 6%. Following this, interestingly, TECH indicates a negative relation with the technological intensity of the sector in which firms operate and the introduction of CIs. In accordance, belonging to high technology sectors on average decreases the probability of introducing innovations for waste reduction by 7%, innovation for waste reuse by 6%, and innovation for delivery waste to other companies by 6% compared to operating in low-technology sectors. In addition, belonging to medium-high technology sectors on average decreases the probability of introducing innovations for waste reduction by 3% compared to operating in low-technology sectors. Further analysis is therefore required to better investigate this relation. In first instance, it is necessary to understand whether the same effect persists in relation to the introduction of innovation in general within the same sample of firms. This will allow to verify whether the negative relationship between the sector's technology and innovative capacity relates specifically to innovations linked to the CE or to all innovations’ typologies. The dependent variables of CI have been therefore substituted with two dummy variables indicating the introduction or not of product and process innovations (i.e. *Has the firm introduced product innovations in the biennium 2017-2018*? ; *Has the firm introduced product innovations in the biennium 2017-2018*?) .

Table 9: Determinants of the introduction of product and process innovations

Estimation Method:	Probit	Probit
Dependent variable:	Introduction of product innovation	Introduction of process innovation
PEER	0.167***	0.199***
	(0.0514)	(0.0500)
SIZE	-0.0000332	0.000513
	(0.000744)	(0.000757)
AGE	0.00165	-0.000826
	(0.00116)	(0.00110)
RED	1.396***	1.009***
	(0.0553)	(0.0542)
INDUSTRY4.0	0.230***	0.755***
	(0.0630)	(0.0620)
TECH_mediumLow	-0.153***	0.148***
	(0.0583)	(0.0556)
TECH_mediumHigh	0.227***	0.0563
	(0.0688)	(0.0694)
TECH_high	0.271*	0.0722
	(0.139)	(0.141)
COSTWAS	0.0605	0.154***
	(0.0425)	(0.0407)
POLICY	0.00133	0.0000998
	(0.00105)	(0.00102)
NORTH	-0.0102	0.0833
	(0.0843)	(0.0825)
CENTRE	-0.113	0.0450
	(0.0943)	(0.0922)
SOUTH	0	0
	(.)	(.)
Constant	-1.025***	-1.026***
	(0.111)	(0.110)
N. Obs.	3270	3270

Notes: Reported are Probit Model estimations. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 9 shows that, on average, operating in higher technology sectors generally increases the probability of introducing both production and process innovation between 2017-2018. These results confirm that the negative relation between technological intensity and innovation adoption is specifically related to CIs, and therefore that CI are mainly introduced by low-technological firms. This may depend on the specific activities carried out by low-technology firms which may work in fields directly related to CE, or in which introducing CI requires less effort, perhaps for the nature of the waste to manage. In order to check for this, the study considers a further categorization of sectors, which includes the ATECO codes.

Table 10: Robustness check with ATECO codes

Estimation Method:	Probit	Probit	Probit
Dependent variable:	Innovation to reduce waste per output produced	Innovation for reusing waste within own productive process	Innovation for delivery waste to other companies to be reused in their productive process
SIZE	-0.000251	-0.000105	-0.0000548
	(0.000801)	(0.000905)	(0.000850)
AGE	0.00180	0.00399***	0.00187
	(0.00121)	(0.00139)	(0.00125)
RED	0.591***	0.453***	0.166***
	(0.0585)	(0.0652)	(0.0606)
INDUSTRY4.0	0.228***	0.182***	0.224***
	(0.0639)	(0.0703)	(0.0654)
PEER	0.259***	0.136**	0.236***
	(0.0571)	(0.0634)	(0.0572)
COSTWAS	0.224***	0.135***	0.156***
	(0.0414)	(0.0456)	(0.0421)
POLICY	0.00235**	0.00273**	0.0000276
	(0.00112)	(0.00124)	(0.00113)
NORTH	0.0332	-0.0675	-0.0603
	(0.0966)	(0.107)	(0.0940)
CENTRE	-0.0477	-0.286**	0.00640
	(0.107)	(0.121)	(0.104)
SOUTH	0	0	0
	(.)	(.)	(.)
Constant	-1.486***	-1.769***	-1.200***
	(0.142)	(0.161)	(0.136)
Sectorial dummy	Yes	Yes	Yes
N. Obs.	3265	3265	3265

Notes: Reported are Probit Model estimations. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Sectorial dummies are dummies per each ATECO code

Table 10 shows that by introducing sectoral dummies corresponding to firms' ATECO codes, the peer effect is positively confirmed per each CE innovation.

Table 11: Robustness check in ATECO subsamples: Innovation to reduce waste per output produced

Sector:	Food Industry	Textile Industry	Clothing manufacture	Manufacture of leather goods	Wood industry excluding furniture	Paper Industry	Press	Manufacture of chemicals	Manufacture of rubber articles	Manufacture of other mineral products
Sectors' technological intensity:	LT	LT	LT	LT	LT	LT	LT	MHT	MLT	MLT
ATECO code:	10	13	14	15	16	17	18	20	22	23
Innovation to reduce waste per output produced	0.125	0.620**	0.594*	0.0893	0.449	0.195	1.046**	0.695	0.331	0.0877
	(0.179)	(0.302)	(0.310)	(0.308)	(0.318)	(0.413)	(0.457)	(0.463)	(0.212)	(0.354)
N.obs	298	137	142	127	112	65	91	70	208	113

Sector:	Metallurgy	Manufacture of metal products	Manufacture of pc and electronic products	Manufacture of electrical equipment	Manufacture of machinery and equipment	Manufacture of motor vehicles	Manufacture of other transport equipment	Manifacture of furniture	Other manifacturing industries	Machine repair, maintenance and installation
Sectors' technological intensity:	MLT	MLT	HT	MHT	MHT	MHT	MHT	LT	LT	MLT
ATECO code:	24	25	26	27	28	29	30	31	32	33
Innovation to reduce waste per output produced	0.338	0.0935	0.260	0.299	0.521***	-0.730	-0.124	-0.233	0.543	0.268
	(0.648)	(0.114)	(0.376)	(0.298)	(0.185)	(0.499)	(.)	(0.361)	(0.396)	(0.285)
N.obs	46	806	93	143	358	38	21	115	70	135

Notes: Reported Probit Model. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Low Technology sector(LT); Medium-Low Technology sector (MLT); Medium-High Technology sector (MHT); High Technology sector (HT). ATECO 11, 12, 19,21, 30 not reported due to insufficient observations.

Table 12: Robustness check in ATECO subsamples: Innovation to reuse waste within own productive process

Sector:	Food Industry	Textile Industry	Clothing manufacture	Manufacture of leather goods	Wood industry excluding furniture	Paper Industry	Press	Manufacture of chemicals	Manufacture of rubber articles	Manufacture of other mineral products
Sectors' technological intensity:	LT	LT	LT	LT	LT	LT	LT	MHT	MLT	MLT
ATECO code:	10	13	14	15	16	17	18	20	22	23
Innovation for reusing waste within own productive process	0.116	0.121	0.558	0.153	-0.127	0.153	2.545***	0.734	0.203	0.361
	(0.212)	(0.336)	(0.581)	(0.363)	(0.334)	(0.447)	(0.669)	(0.602)	(0.206)	(0.372)
N.Obs	298	130	113	109	105	65	84	70	208	113

Sector:	Metallurgy	Manufacture of metal products	Manufacture of pc and electronic products	Manufacture of electrical equipment	Manufacture of machinery and equipment	Manufacture of motor vehicles	Manifacture of furniture	Other manifacturing industries	Machine repair, maintenance and installation
Sectors' technological intensity:	MLT	MLT	HT	MHT	MHT	MHT	LT	LT	MLT
ATECO code:	24	25	26	27	28	29	31	32	33
Innovation for reusing waste within own productive process	-0.108	-0.103	0.654	-0.148	0.191	-875.7	-0.0498	1.315**	0.439
	(0.563)	(0.125)	(0.514)	(0.300)	(0.207)	(.)	(0.423)	(0.536)	(0.424)
N.Obs	49	806	84	143	358	10	115	70	103

Notes: Reported Probit Model. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Low Technology sector(LT); Medium-Low Technology sector (MLT); Medium-High Technology sector (MHT); High Technology sector (HT). ATECO 11, 12, 19,21, 30 not reported due to insufficient observations.

Table 13: Robustness check in ATECO subsamples: Innovation for delivery waste to other companies

Sector:	Food Industry	Beverage Industry	Textile Industry	Clothing manufacture	Manufacture of leather goods	Wood industry excluding furniture	Paper Industry	Press	Manufacture of chemicals	Manufacture of rubber articles
Sectors' technological intensity:	LT	LT	LT	LT	LT	LT	LT	LT	MHT	MLT
ATECO code:	10	11	13	14	15	16	17	18	20	22
Innovation for delivery waste to other companies to be reused in their productive process	0.568***	0	0.0860	0.174	0.192	0.135	0.310	1.527***	0.00679	0.329
	(0.197)	(.)	(0.294)	(0.302)	(0.348)	(0.280)	(0.401)	(0.480)	(0.495)	(0.208)
N.obs.	298	10	130	142	127	126	65	84	66	208
Sector:	Manufacture of other mineral products	Metallurgy	Manufacture of metal products	Manufacture of pc and electronic products	Manufacture of electrical equipment	Manufacture of machinery and equipment	Manufacture of motor vehicles	Manifacture of furniture	Other manifacturing industries	Machine repair, maintenance and installation
Sectors' technological intensity:	MLT	MLT	MLT	HT	MHT	MHT	MHT	LT	LT	MLT
ATECO code:	23	24	25	26	27	28	29	31	32	33
Innovation for delivery waste to other companies to be reused in their productive process	1.000***	1.208**	0.169	0.361	0.289	0.150	-3.388***	-0.339	0.251	0.131
	(0.312)	(0.610)	(0.113)	(0.402)	(0.322)	(0.169)	-1.053	(0.300)	(0.367)	(0.335)
N.obs.	113	49	806	84	143	358	38	115	77	135

Notes: Reported Probit Model. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Low Technology sector(LT); Medium-Low Technology sector (MLT); Medium-High Technology sector (MHT); High Technology sector (HT). ATECO 12, 19,21, 30 not reported due to insufficient observations.

Furthermore, **Tables 11-13** check the peer effect within the different ATECO subsamples in order to verify in which specific sectors the introduction of innovation follows peers' imitation logic. The results demonstrate that: for waste reduction, the peer effect is positively and significantly related to innovation introduction in the textile industry, clothing manufacture, press, and manufacture of machinery and equipment; for waste reuse the peer effect is positively and significantly related to innovation introduction in the press and other manufacturing industries, and for waste exchange the peer effect is significantly and positively related to innovation introduction in the food industry, press, manufacture of mineral products, metallurgy, and negatively and significantly related to innovation introduction in manufacture of motor vehicles. To note that, the majority of the above-mentioned activities corresponds to low technology and medium-low technology sectors, confirming previous results (refer to **Table 8**). More specifically, peers' behaviours seem to particularly influence CI introduction in the press sector. Although a targeted analysis is required in order to establish the reasons for this relation, the nature of paper which is renewable recyclable, biodegradable and compostable likely facilitate waste-related innovations adoption. For example, cellulose pulp can be immediately reused for new production cycles. This creates advantages for waste paper and its industrial byproducts, in terms of inflow of secondary raw material used both by paper manufacturers for multiple process or to be sold to other industries, indeed paper sludge is nutritious for plants, hence crop productivity. In turn, this creates further positive impacts on the reduction of waste amount production. On the other hand, CIs related to waste reduction appear positively influenced by peers' actions in the textile industry and clothing manufacture. In this concern, the European Union recognises the high environmental impact of the textile and clothing industry in terms of raw material use and waste production. Many actions have been taken to transform this sector in compliance with CE objectives, the most recent being the EU Strategy for Sustainable Textiles. The impulse of European policies is therefore providing the push for the diffusion of new policies also at national level, aimed at modifying traditional production and consumption systems. For example, the introduction of the obligation to collect textile waste separately, in Italy, which will come into force on 1 January 2022, as provided for in Legislative Decree 116/2020, while at European level, separate collection of this type of waste will become mandatory by 2025. In this context, therefore, it is likely that companies are beginning a process of progressive adaptation that requires, among the other, the adoption of new supporting innovations, which may be guided also by examples of good practice among their peers. Finally, peer behaviours result to positively influencing the introduction of innovation related to food waste exchange. Food waste represents indeed another critical channel for the increase in the amount of waste generated, which has therefore required the European Union to intervene with specific measures. Specifically, Directive 851/2018/EU defines targets for the prevention and reduction of food waste by 2030. In this area, probably stricter regulations and the increase of the social norm in this direction is positively stimulating the exchange of food waste in order to allocate it to other sectors in a bio-economy perspective.

5. Conclusions

The breaking-out of circular trajectories requires changes in the prevailing socio-economic dimensions. The role of radical and incremental EI is decisive for this transition to happen. The aim of this paper is to examine how the innovation pathway can be fostered at the firm level, with positive effects on the ability of firms to adapt to the requirements of the circular paradigm. More studies are required to understand how to combine the concept of CE and EI on a theoretical level. In this concern, our paper begins with the assumption that understanding the factors involved in firms' decisions to innovate could shed more light into the theory and practice of this evolving research area. The value-added contribution of this study stems first from the investigation of the drivers behind CI adoption, still scarcely explored, and from the use of social norms as enabling factors in firms' decision to innovate. Borrowing the concepts of social norm information and peer comparison from behavioural economic studies, recent research has shown that also firms' choices are influenced by the behaviour of their peers. We have, therefore, empirically analysed whether the context in which firms operate makes firms susceptible to CI adoption. The main results of our analysis show the relevance of peer effect in driving CI, intended as innovation aimed at reducing waste generated per output produced, reusing waste within firm's productive process, and delivering waste to other firms that use it as input in their productive process. Accordingly, considering peers having raised investments for the three typologies of CI in questions increases on average the probability of introducing the same typologies of CI. These insights bring us to the practical implication of the study. Accordingly, whether the social environment surrounding firms plays a role in their decision-making process, as some studies on the introduction of EI have shown, then this must be exploited to design more coherent policies and complement the traditional array of instruments used to spur CI.

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Appendix

Table 14 Determinants of CI

	Innovation to reduce waste per output produced	Innovation for reusing waste within own productive process	Innovation for delivery waste to other companies to be reused in their productive process
PEER	0.259***	0.138**	0.235***
	(0.0570)	(0.0627)	(0.0571)
SIZE	-0.000246	0.000245	-0.0000283
	(0.000790)	(0.000867)	(0.000832)
AGE	0.00155	0.00365***	0.00234*
	(0.00120)	(0.00134)	(0.00121)
RED	0.594***	0.456***	0.175***
	(0.0583)	(0.0647)	(0.0601)
INDUSTRY4.0	0.238***	0.198***	0.239***
	(0.0636)	(0.0695)	(0.0647)
TECH_mediumLow	0.00392	0.113*	0.0242
	(0.0615)	(0.0678)	(0.0613)
TECH_mediumHigh	-0.143*	-0.136	-0.115
	(0.0776)	(0.0860)	(0.0776)
TECH_high	-0.335**	-0.483**	-0.273*
	(0.163)	(0.203)	(0.165)
COSTWAS	0.228***	0.151***	0.173***
	(0.0408)	(0.0444)	(0.0412)
POLICY	0.00245**	0.00270**	0.0000651
	(0.00110)	(0.00121)	(0.00112)
NORTH	0.0190	-0.0486	-0.0611
	(0.0948)	(0.103)	(0.0917)
CENTRE	-0.0691	-0.258**	-0.0366
	(0.105)	(0.117)	(0.102)
SOUTH	0	0	0
	(.)	(.)	(.)
Constant	-1.542***	-1.724***	-1.311***
	(0.125)	(0.137)	(0.119)
N	3270	3270	3270

Notes: Reported Probit model estimations. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 15: Robustness check with ATECO codes

	Innovation to reduce waste per output produced	Innovation for reusing waste within own productive process	Innovation for delivery waste to other companies to be reused in their productive process
SIZE	-0.000251	-0.000105	-0.0000548
	(0.000801)	(0.000905)	(0.000850)
AGE	0.00180	0.00399***	0.00187
	(0.00121)	(0.00139)	(0.00125)
RED	0.591***	0.453***	0.166***
	(0.0585)	(0.0652)	(0.0606)
INDUSTRY4.0	0.228***	0.182***	0.224***
	(0.0639)	(0.0703)	(0.0654)
PEER	0.259***	0.136**	0.236***
	(0.0571)	(0.0634)	(0.0572)
ATECO=10	0	0	0
	(.)	(.)	(.)
ATECO=11	0.318	0.158	0.0843
	(0.328)	(0.381)	(0.345)
ATECO=12	0	0	0
	(.)	(.)	(.)
ATECO=13	-0.103	0.0610	-0.178
	(0.156)	(0.178)	(0.160)
ATECO=14	-0.196	-0.174	-0.292*
	(0.161)	(0.196)	(0.163)
ATECO=15	-0.136	0.108	-0.428**
	(0.168)	(0.195)	(0.180)
ATECO=16	-0.124	0.152	0.0853
	(0.159)	(0.178)	(0.153)
ATECO=17	-0.0711	0.308	0.194
	(0.204)	(0.212)	(0.192)
ATECO=18	0.00390	0.0336	-0.268
	(0.176)	(0.204)	(0.186)
ATECO=19	0	0	0
	(.)	(.)	(.)
ATECO=20	-0.0470	0.288	-0.170
	(0.189)	(0.201)	(0.199)
ATECO=21	-0.390	-0.309	-0.215
	(0.413)	(0.501)	(0.416)
ATECO=22	0.128	0.645***	0.176
	(0.132)	(0.142)	(0.130)
ATECO=23	-0.397**	0.113	-0.153
	(0.181)	(0.183)	(0.168)
ATECO=24	-0.334	0.121	0.0270
	(0.240)	(0.237)	(0.217)
ATECO=25	-0.0765	0.0710	-0.0994
	(0.103)	(0.120)	(0.102)

ATECO=26	-0.402**	-0.419*	-0.382**
	(0.189)	(0.237)	(0.192)
ATECO=27	-0.205	0.0599	-0.243
	(0.158)	(0.174)	(0.160)
ATECO=28	-0.260**	-0.164	-0.182
	(0.122)	(0.142)	(0.121)
ATECO=29	0.0791	0.00744	0.141
	(0.246)	(0.275)	(0.245)
ATECO=30	-0.458	-0.713*	-1.030**
	(0.290)	(0.431)	(0.438)
ATECO=31	-0.186	-0.152	0.00575
	(0.167)	(0.201)	(0.164)
ATECO=32	0.0478	0.428**	-0.165
	(0.188)	(0.200)	(0.198)
ATECO=33	0.0309	0.00830	-0.248
	(0.157)	(0.191)	(0.165)
COSTWAS	0.224***	0.135***	0.156***
	(0.0414)	(0.0456)	(0.0421)
POLICY	0.00235**	0.00273**	0.0000276
	(0.00112)	(0.00124)	(0.00113)
NORTH	0.0332	-0.0675	-0.0603
	(0.0966)	(0.107)	(0.0940)
CENTRE	-0.0477	-0.286**	0.00640
	(0.107)	(0.121)	(0.104)
SOUTH	0	0	0
	(.)	(.)	(.)
Constant	-1.486***	-1.769***	-1.200***
	(0.142)	(0.161)	(0.136)
N.Obs.	3265	3265	3265

Notes: Reported are Probit Model estimations. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 16: Robustness check in ATECO subsamples: Innovation to reduce waste per output produced

Sector:	Food Industry	Textile Industry	Clothing manufacture	Manufacture of leather goods	Wood industry excluding furniture	Paper Industry	Press	Manufacture of chemicals	Manufacture of rubber articles	Manufacture of other mineral products
Sectors' technological intensity:	LT	LT	LT	LT	LT	LT	LT	MHT	MLT	MLT
ATECO code:	10	13	14	15	16	17	18	20	22	23
Dependent variable:	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED
SIZE	0.000545	-0.00292	-0.0000324	0.000264	-0.00181	0.0116*	0.00413	0.00207	-0.00223	0.00241
	(0.00271)	(0.00364)	(0.00648)	(0.00317)	(0.00606)	(0.00653)	(0.00607)	(0.00411)	(0.00310)	(0.00382)
AGE	0.000700	0.00469	-0.000978	0.00617	0.00235	0.000207	-0.00854	0.0117	-0.00586	-0.0114*
	(0.00328)	(0.00542)	(0.00598)	(0.00774)	(0.00646)	(0.00913)	(0.00970)	(0.00791)	(0.00664)	(0.00636)
RED	0.682***	0.621**	0.811***	0.456	0.532*	-0.150	0.254	0.895**	0.777***	0.583
	(0.192)	(0.289)	(0.295)	(0.316)	(0.323)	(0.420)	(0.397)	(0.381)	(0.219)	(0.356)
INDUSTRY 4.0	0.0730	0.666**	0.317	0.462	0.256	0.872**	0.843**	0.177	-0.0499	0.0917
	(0.249)	(0.334)	(0.448)	(0.367)	(0.382)	(0.411)	(0.388)	(0.439)	(0.223)	(0.472)
PEER	0.125	0.620**	0.594*	0.0893	0.449	0.195	1.046**	0.695	0.331	0.0877
	(0.179)	(0.302)	(0.310)	(0.308)	(0.318)	(0.413)	(0.457)	(0.463)	(0.212)	(0.354)
COSTWAS	0.301*	0.334	-0.384	0.0128	0.526***	0.00207	-0.0982	0.176	0.225*	0.665***
	(0.159)	(0.226)	(0.386)	(0.232)	(0.179)	(0.216)	(0.256)	(0.218)	(0.126)	(0.248)
POLICY	0.00480*	0.00730	-0.00364	-0.000741	-0.0108	0.000559	0.00978	0.00455	-0.00210	0.00744
	(0.00286)	(0.00597)	(0.00611)	(0.00628)	(0.00708)	(0.00666)	(0.00636)	(0.00915)	(0.00465)	(0.00589)
NORTH	0.0685	0.117	-0.0308	0.395	-0.266	0.104	0.0783	-0.0815	-0.0199	0.935
	(0.208)	(0.944)	(0.438)	(0.515)	(0.371)	(0.636)	(0.488)	(0.844)	(0.411)	(0.659)
CENTRE	-0.0386	-0.493	-0.178	-0.244	0	-0.0674	-0.337	-1.210	-0.0807	0.663
	(0.255)	(0.907)	(0.467)	(0.531)	(.)	(0.799)	(0.790)	-1.021	(0.473)	(0.657)
SOUTH	0	0	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Constant	-1.557***	-2.198*	-1.534***	-1.526**	-1.073*	-1.657**	-2.237***	-2.363**	-0.857	-2.611***
	(0.288)	-1.124	(0.553)	(0.672)	(0.630)	(0.778)	(0.680)	-1.014	(0.539)	(0.845)
Observations	298	137	142	127	112	65	91	70	208	113

Sector:	Metallurgy	Manufacture of metal products	Manufacture of pc and electronic products	Manufacture of electrical equipment	Manufacture of machinery and equipment	Manufacture of motor vehicles	Manufacture of other transport equipment	Manifacture of furniture	Other manifacturing industries	Machine repair, maintenance and installation
Sectors' technological intensity:	MLT	MLT	HT	MHT	MHT	MHT	MHT	LT	LT	MLT
ATECO code:	24	25	26	27	28	29	30	31	32	33
Dependent variable:	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED	WASRED
SIZE	-0.00560	-0.00167	0.00373	0.00282	0.000512	-0.00236	-3.357	-0.0106*	0.00375	-0.0106*
	(0.00524)	(0.00194)	(0.00493)	(0.00366)	(0.00192)	(0.00438)	(.)	(0.00606)	(0.00804)	(0.00635)
AGE	0.0109	0.00322	-0.000451	0.00482	-0.000322	0.0111	0.204	0.0138**	-0.00162	0.00517
	(0.00943)	(0.00299)	(0.00903)	(0.00801)	(0.00297)	(0.0113)	(.)	(0.00609)	(0.00876)	(0.00773)
RED	1.372**	0.768***	-0.122	0.301	0.295*	1.139**	113.5	1.329***	0.656*	0.245
	(0.542)	(0.120)	(0.330)	(0.266)	(0.167)	(0.580)	(.)	(0.340)	(0.377)	(0.307)
INDUSTRY 4.0	-0.502	0.314***	0.236	0.286	0.0101	-1.034	-8.443	1.117***	0.206	-0.452
	(0.584)	(0.121)	(0.363)	(0.319)	(0.185)	(0.662)	(.)	(0.339)	(0.515)	(0.461)
PEER	0.338	0.0935	0.260	0.299	0.521***	-0.730	-0.124	-0.233	0.543	0.268
	(0.648)	(0.114)	(0.376)	(0.298)	(0.185)	(0.499)	(.)	(0.361)	(0.396)	(0.285)
COSTWAS	-0.717	0.205***	0.452	0.0916	0.253	2.204***	55.36	0.432**	0.163	0.386*
	(0.604)	(0.0770)	(0.280)	(0.284)	(0.158)	(0.730)	(.)	(0.180)	(0.466)	(0.218)

POLICY	0.00345	0.00457*	0.000657	0.00795	-0.00546	-0.00775	0.0299	-0.00558	-0.00446	0.00439
	(0.0105)	(0.00249)	(0.00584)	(0.00546)	(0.00419)	(0.00935)	(.)	(0.00898)	(0.0107)	(0.00558)
NORTH	0	-0.112	0.252	-0.364	0.00461	-0.460	0	-0.206	-0.295	0.0647
	(.)	(0.215)	(0.586)	(0.427)	(0.436)	-1.024	(.)	(0.473)	(0.405)	(0.428)
CENTRE	0	-0.135	0.373	-0.632	0.236	1.155	48.66	-0.441	0	0.0890
	(.)	(0.238)	(0.635)	(0.488)	(0.486)	-1.091	(.)	(0.565)	(.)	(0.469)
SOUTH	0	0	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Constant	-2.001**	-1.517***	-1.692**	-1.644***	-1.349***	-0.739	-17.40	-1.571***	-1.045	-1.297**
	(0.801)	(0.281)	(0.702)	(0.596)	(0.514)	-1.237	(.)	(0.556)	(0.776)	(0.576)
Observations	46	806	93	143	358	38	21	115	70	135

Notes: Reported Probit Model. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Low Technology sector(LT); Medium-Low Technology sector (MLT); Medium-High Technology sector (MHT); High Technology sector (HT). ATECO 11, 12, 19,21 not reported due to insufficient observations.

Table 17: Robustness check in ATECO subsamples: Innovation to reuse waste within own productive process

Sector:	Food Industry	Textile Industry	Clothing manufactu re	Manufactu re of leather goods	Wood industry excluding furniture	Paper Industry	Press	Manufactur e of chemicals	Manufactu re of rubber articles	Manufactur e of other mineral products
Sectors' technologica l intensity:	LT	LT	LT	LT	LT	LT	LT	MHT	MLT	MLT
ATECO code:	10	13	14	15	16	17	18	20	22	23
Dependent variable:	WASRE USE	WASREU SE	WASREU SE	WASREU SE	WASREU SE	WASREU SE	WASREU SE	WASREU SE	WASREU SE	WASREU SE
SIZE	-0.0000468	0.00337	-0.0147	-0.000222	0.00145	0.00871	0.0354**	0.00904**	-0.00280	0.000579
	(0.00319)	(0.00306)	(0.0136)	(0.00353)	(0.00536)	(0.00603)	(0.0152)	(0.00400)	(0.00313)	(0.00401)
AGE	0.00482	0.00660	0.0105	-0.00235	-0.00915	0.00900	0.0147	0.00588	-0.0000713	-0.00598
	(0.00342)	(0.00617)	(0.00698)	(0.00892)	(0.00798)	(0.00889)	(0.0115)	(0.00861)	(0.00652)	(0.00714)
RED	0.551**	0.518*	1.148**	-0.00211	0.352	0.311	0.669	0.458	0.522**	0.496
	(0.218)	(0.296)	(0.460)	(0.368)	(0.395)	(0.388)	(0.578)	(0.428)	(0.216)	(0.366)
INDUSTRY 4.0	-0.188	0.335	0	0.223	0.520	0.673	0.904	0.286	0.182	0.412
	(0.277)	(0.364)	(.)	(0.401)	(0.496)	(0.414)	(0.601)	(0.473)	(0.216)	(0.459)
PEER	0.116	0.121	0.558	0.153	-0.127	0.153	2.545***	0.734	0.203	0.361
	(0.212)	(0.336)	(0.581)	(0.363)	(0.334)	(0.447)	(0.669)	(0.602)	(0.206)	(0.372)
COSTWAS	0.299*	-0.386	0	-0.547	0.380	-0.209	0.747*	0.312	0.0381	0.831***
	(0.160)	(0.328)	(.)	(0.375)	(0.237)	(0.208)	(0.399)	(0.257)	(0.129)	(0.264)
POLICY	0.00296	0.0100	-0.0278***	-0.00702	-0.00651	-0.00450	-0.00252	0.0111	0.00552	0.00778
	(0.00330)	(0.00624)	(0.0103)	(0.00889)	(0.00880)	(0.00653)	(0.00861)	(0.00974)	(0.00459)	(0.00474)
NORTH	-0.119	0.163	-0.754	0.778**	0.146	0.0289	-2.317***	-0.511	0.474	0.343
	(0.249)	(0.370)	(0.582)	(0.329)	(0.582)	(0.640)	(0.712)	(0.874)	(0.436)	(0.530)
CENTRE	-0.0208	0	-1.247	0	0	0.126	0	-0.850	0.264	-0.413
	(0.295)	(.)	(0.799)	(.)	(.)	(0.822)	(.)	(0.942)	(0.486)	(0.687)
SOUTH	0	0	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Constant	-1.842***	-2.453***	-0.623	-1.282**	-0.853	-1.687**	-3.450***	-2.503**	-1.554***	-2.378***
	(0.311)	(0.636)	(0.591)	(0.567)	(0.836)	(0.858)	-1.006	(0.985)	(0.595)	(0.663)
Observations	298	130	113	109	105	65	84	70	208	113

Sector:	Metallurg y	Manufactu re of metal products	Manufactu re of pc and electronic products	Manufactu re of electrical equipment	Manufactu re of machinery and equipment	Manufactu re of motor vehicles	Manifactur e of furniture	Other manifacturi ng industries	Machine repair, maintenan ce and installation	

Sectors' technological intensity:	MLT	MLT	HT	MHT	MHT	MHT	LT	LT	MLT
ATECO code:	24	25	26	27	28	29	31	32	33
Dependent variable:	WASREUSE	WASREUSE	WASREUSE	WASREUSE	WASREUSE	WASREUSE	WASREUSE	WASREUSE	WASREUSE
SIZE	-0.00491	-0.00829**	-0.0109	0.00418	0.00325	-4.553	-0.0150	0.00711	-0.00947
	(0.00580)	(0.00378)	(0.00914)	(0.00392)	(0.00216)	(.)	(0.0116)	(0.00809)	(0.00618)
AGE	0.00838	0.00222	-0.00883	-0.00432	0.00418	13.12	0.0297**	0.0119	0.0153
	(0.00903)	(0.00327)	(0.0139)	(0.00757)	(0.00389)	(.)	(0.0133)	(0.00895)	(0.0112)
RED	1.003*	0.539***	0.225	0.521*	0.415**	0	1.590***	0.730*	0
	(0.540)	(0.138)	(0.406)	(0.291)	(0.202)	(.)	(0.462)	(0.407)	(.)
INDUSTRY 4.0	0.503	0.367***	-0.0359	0.139	-0.180	0	0.700	-1.477**	0.180
	(0.553)	(0.136)	(0.540)	(0.338)	(0.221)	(.)	(0.506)	(0.638)	(0.468)
PEER	-0.108	-0.103	0.654	-0.148	0.191	-875.7	-0.0498	1.315**	0.439
	(0.563)	(0.125)	(0.514)	(0.300)	(0.207)	(.)	(0.423)	(0.536)	(0.424)
COSTWAS	0.0430	0.180**	0.588*	0.516*	-0.112	524.6	0.180	0.0939	0.0898
	(0.500)	(0.0898)	(0.334)	(0.281)	(0.238)	(.)	(0.271)	(0.484)	(0.266)
POLICY	0.00946	0.00856***	0.0000562	0.00306	-0.00536	45.92	-0.0380***	-0.0000943	-0.00385
	(0.0114)	(0.00273)	(0.00943)	(0.00581)	(0.00487)	(.)	(0.0142)	(0.0117)	(0.00619)
NORTH	-0.368	-0.379*	0.279	0.636	-0.0272	0	-1.792**	0.229	-0.316
	(0.651)	(0.220)	(0.611)	(0.460)	(0.510)	(.)	(0.883)	(0.454)	(0.497)
CENTRE	0	-0.700***	0	0.418	-0.305	0	-1.366	0	0.0459
	(.)	(0.271)	(.)	(0.594)	(0.579)	(.)	(0.837)	(.)	(0.559)
SOUTH	0	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Constant	-1.901*	-1.394***	-2.035**	-2.208***	-1.626***	-1738.7	-0.330	-2.628***	-1.349**
	(0.974)	(0.309)	(0.920)	(0.600)	(0.562)	(.)	(0.744)	(0.928)	(0.590)
Observations	49	806	84	143	358	10	115	70	103

Notes: Reported Probit Model. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Low Technology sector(LT); Medium-Low Technology sector (MLT); Medium-High Technology sector (MHT); High Technology sector (HT). ATECO 11, 12, 19,21, 30 not reported due to insufficient observations.

Table 18: Robustness check in ATECO subsamples: Innovation for delivery waste to other companies

Sector:	Food Industry	Beverage industry	Textile Industry	Clothing manufacture	Manufacture of leather goods	Wood industry excluding furniture	Paper Industry	Press	Manufacture of chemicals	Manufacture of rubber articles
Sectors' technological intensity:	LT	LT	LT	LT	LT	LT	LT	LT	MHT	MLT
ATECO code:	10	11	13	14	15	16	17	18	20	22
Dependent variable:	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL
SIZE	0.00395*	0.895	0.00623*	0.00665	-0.00376	0.00530	0.00871	-0.00486	0.00250	0.000404
	(0.00221)	(.)	(0.00367)	(0.00599)	(0.00370)	(0.00557)	(0.00635)	(0.0121)	(0.00410)	(0.00250)
AGE	-0.00485	-0.0698	-0.0102	0.00440	0.00581	0.0110*	-0.0141	0.00575	0.00725	-0.00496
	(0.00327)	(.)	(0.00683)	(0.00486)	(0.00896)	(0.00636)	(0.0124)	(0.0101)	(0.00798)	(0.00618)
RED	0.188	-7.937	0.0762	0.821***	-0.409	0.256	-0.582	0.500	0.893**	0.0611
	(0.202)	(.)	(0.312)	(0.295)	(0.393)	(0.318)	(0.403)	(0.483)	(0.443)	(0.216)
INDUSTRY 4.0	-0.00103	4.992	0.346	0.274	0.242	-0.706*	0.876*	0.333	0.414	0.389*
	(0.268)	(.)	(0.344)	(0.414)	(0.441)	(0.419)	(0.474)	(0.482)	(0.443)	(0.216)
PEER	0.568***	0	0.0860	0.174	0.192	0.135	0.310	1.527***	0.00679	0.329
	(0.197)	(.)	(0.294)	(0.302)	(0.348)	(0.280)	(0.401)	(0.480)	(0.495)	(0.208)
COSTWAS	0.252	7.149	-0.101	0.309	0.532**	0.574***	-0.253	0.731**	0.0688	0.120
	(0.155)	(.)	(0.230)	(0.368)	(0.245)	(0.180)	(0.188)	(0.324)	(0.243)	(0.132)

POLICY	0.00595**	1.153	-0.00811	-0.00360	0.00518	-0.00158	-0.000125	0.0132	-0.00354	-0.000629
	(0.00280)	(.)	(0.00644)	(0.00621)	(0.00712)	(0.00553)	(0.00554)	(0.00877)	(0.0132)	(0.00470)
NORTH	-0.120	41.81	-0.294	-0.0307	0.359	-0.0243	-0.188	-0.110	0.704	0.369
	(0.217)	(.)	(0.320)	(0.479)	(0.450)	(0.470)	(0.547)	(0.561)	(0.664)	(0.443)
CENTRE	0.177	79.84	0	0.109	0.333	0.151	-0.606	0	0	0.847*
	(0.248)	(.)	(.)	(0.466)	(0.413)	(0.574)	(0.655)	(.)	(.)	(0.487)
SOUTH	0	0	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Constant	-1.653***	-119.3	-0.430	-1.872***	-2.183***	-1.559**	-0.357	-3.516***	-2.471**	-1.336**
	(0.278)	(.)	(0.509)	(0.580)	(0.643)	(0.653)	(0.640)	(0.877)	-1.037	(0.619)
Observations	298	10	130	142	127	126	65	84	66	208

Sector:	Manufacture of other mineral products	Metallurgy	Manufacture of metal products	Manufacture of pc and electronic products	Manufacture of electrical equipment	Manufacture of machinery and equipment	Manufacture of motor vehicles	Manifacture of furniture	Other manifacturing industries	Machine repair, maintenance and installation
Sectors' technological intensity:	MLT	MLT	MLT	HT	MHT	MHT	MHT	LT	LT	MLT
ATECO code:	23	24	25	26	27	28	29	31	32	33
Dependent variable:	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL	WASDEL
SIZE	0.000892	-0.00788	-0.00515**	0.00609	-0.000736	0.000167	-0.0231	-0.0154*	-0.0121	-0.0111*
	(0.00381)	(0.00623)	(0.00203)	(0.00515)	(0.00325)	(0.00218)	(0.0156)	(0.00868)	(0.0112)	(0.00664)
AGE	0.00502	0.000862	0.00157	-0.00591	-0.00335	0.00555*	0.186***	0.0139**	0.00871	0.0127
	(0.00569)	(0.00789)	(0.00291)	(0.00917)	(0.00955)	(0.00303)	(0.0603)	(0.00568)	(0.00911)	(0.00916)
RED	0.000692	-0.124	0.261**	-0.0176	0.600**	0.00125	6.707***	0.600*	-0.279	-0.277
	(0.390)	(0.457)	(0.124)	(0.378)	(0.289)	(0.174)	-2.417	(0.312)	(0.492)	(0.361)
INDUSTRY 4.0	0.121	0.0474	0.379***	0.229	0.0124	-0.0121	1.343	0.369	1.228**	-0.249
	(0.488)	(0.459)	(0.120)	(0.425)	(0.332)	(0.197)	(0.915)	(0.400)	(0.523)	(0.355)
PEER	1.000***	1.208**	0.169	0.361	0.289	0.150	-3.388***	-0.339	0.251	0.131
	(0.312)	(0.610)	(0.113)	(0.402)	(0.322)	(0.169)	-1.053	(0.300)	(0.367)	(0.335)
COSTWAS	0.0796	0.906**	0.0761	0.308	0.00287	0.262	-7.980***	0.0931	0.482	0.587***
	(0.271)	(0.406)	(0.0872)	(0.275)	(0.312)	(0.161)	-2.663	(0.177)	(0.385)	(0.209)
POLICY	0.00554	-0.0102	0.00351	-0.0137	0.00628	-0.00524	-0.0874***	-0.00779	-0.00854	-0.00935
	(0.00477)	(0.0101)	(0.00252)	(0.00940)	(0.00620)	(0.00416)	(0.0317)	(0.00818)	(0.00919)	(0.00739)
NORTH	0.237	-0.774	-0.161	-0.187	0.157	-0.0309	-9.453***	-0.288	-0.750	-0.329
	(0.497)	(0.669)	(0.194)	(0.510)	(0.473)	(0.399)	-2.613	(0.617)	(0.662)	(0.455)
CENTRE	0.316	0	-0.396*	0	0.100	0.263	-10.12***	0.0153	-1.376*	0.265
	(0.514)	(.)	(0.235)	(.)	(0.536)	(0.457)	-2.906	(0.669)	(0.752)	(0.526)
SOUTH	0	0	0	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Constant	-2.531***	-0.567	-1.205***	-0.849	-1.920***	-1.173**	2.902***	-0.636	-0.299	-0.761
	(0.603)	(0.860)	(0.255)	(0.774)	(0.635)	(0.474)	-1.052	(0.675)	-1.135	(0.530)
Observations	113	49	806	84	143	358	38	115	77	135

Notes: Reported Probit Model. Standard errors in parentheses . *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Low Technology sector(LT); Medium-Low Technology sector (MLT); Medium-High Technology sector (MHT); High Technology sector (HT). ATECO 12, 19,21, 30 not reported due to insufficient observations.

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