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Barriers and drivers towards eco-innovation for SMEs: Evidence from the context

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Abstract

Eco-innovations have become a clear target of EU policy strategies. Consequently, measuring eco-innovation performance at the country level has become crucial to detect eco-innovation patterns and to design eco-innovation policy implementation. This paper focuses on EU small and medium enterprises (SMEs) with the aim to understand to what extent EU funding programmes influence barriers and drivers towards SMEs' eco-innovation performance. A correlation analysis between data from Eco-Innovation Scoreboard index and competitiveness and innovation framework programme/Entrepreneurship and innovation programme/Eco-innovation programme projects database reveals that the countries with the highest number of EU funded projects are those with the lowest levels of green early-stage investments. According to the findings, EU funding programmes reduce financial constraints that SMEs face for developing eco-innovations. This paper recommends that policymakers should keep in mind the dynamic interaction between private and public funding support, the latter is customised according to the entity of risk along the innovation cycle.

Keywords: Eco-innovation, barriers, drivers, policy strategies, index.

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1. Introduction

Innovation is the implementation of a new or significantly improved product, process, marketing technique or organisational method (OECD, 2005). Eco-innovation is 'any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources' (Decision No 1639/2006/EC of the European Parliament and of the Council).

In order to reach sustainable green growth, many observers ask for a policy framework that promotes more radical innovations (OECD, 2012). Numerous studies show that in order to realise sustainability, the current use of resources must reach an efficiency of up to 50 times greater (Hansen & Grosse-Dunker, 2013; Tukker & Tischner, 2006). Incremental innovations alone are not enough to reach such a level of efficiency: radical innovations are needed (Hansen & Grosse-Dunker, 2013).

Small and medium enterprises (SMEs), thanks to their lean structures together with the intrinsic entrepreneurial approach, rather than rigid large companies can deliver the needed radical innovations (Klewitz & Hansen, 2014; Moore & Manring, 2009; Schaltegger & Wagner, 2011). Many of the greener innovations have been developed by SMEs (Ghisetti, Mancinelli, Mazzanti & Zoli, 2016). Therefore, SMEs' innovation activity is a key element to boost sustainable development.

Barriers and drivers of eco-innovations have been widely explored by the literature (Bossle, De Barcellos, Vieira & Sauvee, 2016; Horbach, 2008; Horbach, Rammer & Rennings, 2012; Marin, Marzucchi & Zoboli, 2015; Montalvo, 2008), which has recognised the crucial role of the institutional side (e.g., regulatory environmental policy), supply side (e.g., technological capabilities), demand side (e.g., social awareness and environmental consciousness towards green products) and factors affecting the development of green innovations. Nevertheless, although financial constraints, i.e., difficulties to access external sources of funding, are a very important obstacle for companies willing to carry out eco-innovation projects, they have not been treated in such a thorough way (Cecere, Corrocher & Mancusi, 2018; Demirel & Parris, 2015; Ghisetti et al., 2016; Kapoor & Oksnes, 2011; Mazzanti, Antonioli, Mancinelli & Ghisetti 2014). Moreover, in the EU context, such barriers are serious impediments, particularly for the SMEs in delivering green innovations (Ghisetti et al., 2016). For these reasons, we have focused this study on financial constraints to eco-innovation.

In December 2011, the European Commission adopted the Eco-innovation Action Plan (EcoAP) with the aim of encouraging market uptake of green solution by tackling its barriers and drivers. Considering public funding support crucial to accelerate eco-innovation in the private sector, EcoAP contributed to mobilise financial instruments and support services for SMEs (COM, 2011). Eco-innovation has, therefore, become an explicit target of EU policy strategies as it is considered, enabling the transition to a green economy, a fundamental factor in order to recover from the current economic recession (Marin et al., 2015). Consequently, measuring the eco-innovation performance at the EU country level has become crucial to detect eco-innovation patterns and to design eco-innovation policy implementation. The eco-innovation index, used by the EU as an information tool for EcoAP (Park, Bleischwitz, Han, Jang & Joo, 2017), through 16 indicators monitored by the Eco-Innovation Scoreboard (ECO-IS), helps policymakers to understand, nation by nation, the overall eco-innovation performance tracing its drivers and barriers. One specific indicator, 'Total value of green early-stage investment', detects the financial factor referred to investors (Park et al., 2017).

Based on the previous arguments, the authors proposed the following research question: *Do the EU funding programmes reduce financial constraints that SMEs face for developing eco-innovations?*

Given the available data and because innovation intrinsically implies market success (Hansen, Grosse-Dunker & Reichwald, 2009; Klewits & Hansen, 2014; OECD, 2005), we focused our research towards the phases of the innovation chain consisting of first application and market uptake closer to the market green technologies.

The rest of the paper is structured as follows. Section 2 synthesises the relevant literature used to pose our research question. Section 3 illustrates the data sources and methodology. Sections 4 and 5 describe and discuss the results. Section 6 concludes and suggests some policy implications.

2. Literature review

In general, access to financial resources is a critical element, whose lack often inhibits the development and deployment of innovative technologies (Cecere et al., 2018; Jacobsson & Bergek, 2011; Polzin, von Flotow & Klerkx, 2016). The financial constraints on eco-innovations, especially on the most disruptive ones, seem to be particularly relevant and more problematic than those on standard innovations (Aghion, Veugelers & Hemous, 2009; Cecere et al., 2018; Cuerva, Triguero-Cano & Corcoles, 2014; Mazzanti et al., 2014). Indeed, eco-innovations, implying costly investments and unpredictable returns, are considered highly risky and uncertain compared to the 'standard' innovations (Ghisetti et al., 2016) and this is mainly related to the relatively longer payback period together with the lower maturity of the green market (Corradini, Costantini, Mancinelli & Mazzanti, 2014; Ghisetti et al., 2016). Although forecasts on the growth of the green market are positive, the demand is often uncertain because customers are generally not yet willing to pay a premium price for eco-compatible products or services (Pinget, Bocquet & Mothe, 2015). Thus, the green market is still perceived by investors as immature and characterised by very uncertain business models, especially when compared to other sectors considered more mature, such as life sciences or biotechnologies, and whose expectations of financial returns are fairly well known (Ghisetti et al., 2016). Olmos, Ruester and Liong (2012) and Mazzucato (2015) underline the difficulties for private funders, which generally require very short investment lifespans, to internalise the long-term benefits of innovation of green innovations. As highlighted by Czarnitzki and Hottenrott (2011), the financial lacuna, determined by likely costs of the innovation process relative to its expected future revenues, is a typical characteristic of radical innovation.

Especially for SMEs, which have naturally limited internal funds, the support of external sources of financing is crucial to implement innovation projects (Cecere et al., 2018; Mazzanti et al., 2014). Due to their intrinsic riskiness and weaknesses, SMEs are less likely to have access to external finance and face more financial constraints than larger enterprises (Ghisetti et al., 2016; Klewitz & Hansen, 2014; OECD, 2012). Banks are more likely to finance larger companies that can guarantee investment with significant cash flows and with collateral options from fixed assets and patents (Nanda & Kerr, 2015). Indeed, SMEs suffer the so-called 'funding gap', a situation where a firm has a potentially gainful innovation project but insufficient financial resources to exploit it (Mina, Lahr & Hughesy, 2013).

According to the few literature studies, in order to overcome financial barriers, there is a need to develop adequate public funding schemes that complement, rather than replace, existing private funding (bank loans, venture capital and business angels' capital) (Cecere et al., 2018; Olmos et al., 2012).

Due to the lack of competitiveness of green technologies, characterised by higher risks and uncertainty compared to the standard alternatives, the eco-innovation activities need to be, at least in part, publicly funded (Cecere et al., 2018). Financial public support for innovation includes grants, subsidies, loans, tax credits or deductions (Cecere et al., 2018). Therefore, when the level of commercial attractiveness of the exploitation of innovations is low for private investors, public funds should be made available (Olmos et al., 2012). Moreover, in most countries, venture capital investments have not restored to pre-crisis levels (OECD, 2017).

Recent literature studies (Nanda & Kerr, 2015; Polzin et al., 2016) point out the importance of interplay between public financial support and private financial support along the 'innovation chain' that calls for different types of finances (from the basic R&D activities to the fully commercial phase). In general, the higher the risk, the greater the demand for public intervention. Particularly, since commercial viability is often uncertain and in need of complementary infrastructure assets, firms face great difficulty obtaining private finance support, thus determining the exploitation abandon of a very innovative project (Polzin et al., 2016). In order to overcome such 'valley of death' situations, public grants and subsidies are considered especially effective for mitigating SMEs' funding gap complementing bank credit or venture capital shortcomings for projects that imply higher risks (OECD, 2012).

3. Data collection and method

Dealing with the research question, in order to address EU public funding action, we used data collected through the competitiveness and innovation framework programme (CIP)/Entrepreneurship and innovation programme (EIP)/Eco-innovation programme projects database, a closed EU funding scheme (running from 2008 to 2013), principally dedicated to SMEs with the aim to encourage market uptake of green technologies.

1. With the aim of tracking, at national level, the action of private investors supporting eco-innovations, we referred to the parameter number 1.3 'Total value of green early-stage investments', one of the 16 indicators that form the eco-innovation index, made available by the ECO-IS.

3.1. CIP/EIP/Eco-innovation programme projects database

The project database we referred to is related to the eco-innovation Initiative, sub-programme of EIP included in the CIP with the aim to foster the competitiveness of enterprises, in particular SMEs. The eco-innovation initiative was set up to bridge the gap between research and the market, supporting projects concerned with the first application or market replication of eco-innovative solutions of community relevance, which had already been successfully technologically demonstrated but which, owing to residual risk, had not yet penetrated the market (COM, 2008). In that database, we counted 184 projects involving 25 EU countries (actual EU-28 except Latvia, Malta and Slovakia) and 7 non-EU member states (Iceland, Israel, Montenegro, Namibia, Norway, Serbia and Turkey). The thematic priorities were as follows: materials and process recycling, buildings, food and drink, greening business, water efficiency, treatment and distribution.

3.2. Eco-innovation scoreboard

The ECO-IS[a] developed by the EIO[b] is an online tool to trace and measure eco-innovation performance across the EU member states. The ECO-IS, presenting comparable figures starting from 2010, asses how well single countries perform in different dimensions of eco-innovation compared to the EU average, thus showing their strengths and weaknesses. As mentioned above, the scoreboard comprises 16 indicators grouped into 5 main categories that present a holist view on economic, environmental and social EU countries performance. The eco-innovation input components comprising investments (financial or human resources) which aim at triggering eco-innovation activities include: 1.1 Governments environmental and energy R&D appropriations and outlays; 1.2 Total R&D personnel and researchers; and 1.3 Total value of green early-stage investments. The eco-innovation activities component consists of three indicators representing innovative activities carried out by enterprises: 2.1 Enterprises that introduced an innovation with environmental benefits obtained within the enterprise; 2.2 Enterprises that introduced an innovation with environmental benefits obtained by the end user; and 2.3 ISO 14001 registered organisations. The eco-innovation output components representing the level of advancement and implementation of eco-innovation includes 3.1 Eco-innovation-related patents; 3.2 Eco-innovation-related academic publications; and 3.3 Eco-innovation-related media coverage. The resource efficiency outcomes relating to wider effects of eco-innovation of improved resource productivity includes 4.1 Material productivity; 4.2 Water productivity; 4.3 Energy productivity; and 4.4 Greenhouse gas emissions intensity. The socio-economic outcome components representing wider effects of eco-innovation activities for society and the economy embrace three indicators relating to eco-industry area: 5.1 Exports of products from eco-industries; 5.2 Employment in eco-industries and circular economy; and 5.3 Revenue in eco-industries and circular economy.

ECO-IS is not a static tool, but continuously adapted and improved, as new data sources become available (Giljum, Lieber, Gozet & Doranova, 2018a). Technically, specific figures of the single indicators are weighted with the share of population in order to calculate an EU average that corrects the bias of smaller countries. Consequently, each indicator is re-scaled to the EU average settled at 100. The higher the indicator value, the higher the relative eco-performance. The overall eco-innovation index of each EU member state is calculated by the unweighted mean of the 16 sub-indicators in order to avoid bias between the five thematic areas of the index and then is scaled to the reference EU average settled at 100, thus in order to facilitate index understanding and comparison between countries. Countries with higher figures than the EU's average obtain a higher score than 100 and countries with lower figures achieve less, depending on the deviation from the EU average. Countries are thus grouped into three clusters: 'Eco-innovation leaders', scoring significantly higher than the EU average (i.e., a score of >115); 'Average eco-innovation performers' with scores around the EU average (i.e., between 85 and 115); 'Countries catching up with eco-innovations'.

The eco-innovation observatory is an initiative financed by the European Commission's Directorate-General for the environment from the CIP. The observatory functions as a platform for the structured collection and analysis of an extensive range of eco-innovation integrated information, targeting business, policymakers, researchers and analysts catching up in eco-innovation, with around 85% or less performance compared to the EU average (i.e., a score of 85) (Giljum, Gozet & Doranova, 2018b).

3.3. Methods

In order to investigate to what extent EU funding programmes reduce SMEs' financial constraints for developing eco-innovations, we focused our study on the overall eco-innovation performance at the country level and to do so we set up the analysis on EU countries belonging to higher eco-innovation performing groups, i.e., the aforesaid 'eco-innovation leaders' cluster and 'average eco-innovation performers' cluster. The EU funding support action, assessed for the purpose of this study by the number of funded projects presented by these countries (both as coordinators and partners) in the aforementioned funding programme, was compared with the score of the same countries in the aforementioned indicator 1.3 which represents investors' support action. Then, in order to evaluating the degree of linear association between these two variables, we used the Spearman's rank correlation coefficient. This non-parametric correlation technique operates on the ranks of the data rather than on raw data; it is unaffected by the distribution of the population; it is quite insensitive to outliers; and it is relatively simple to apply (Gautheir, 2001).

4. Results

The first evidences of the analysis are shown in Figure 1, which show EU countries' number of projects funded by CIP/EIP/Eco-innovation programme compared to the total value of green early-stage investments provided by the 1.3 indicator of ECO-IS starting from 2010. Since the funding programme, which lasted from 2008 to 2013, was considered as a whole, an average value of the indicator 1.3 was also used.

As previously asserted, the research was settled on those EU countries which belonged to the clusters characterised by high eco-innovation global performance (for all the years from 2010 to 2013), i.e., Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden and United Kingdom.

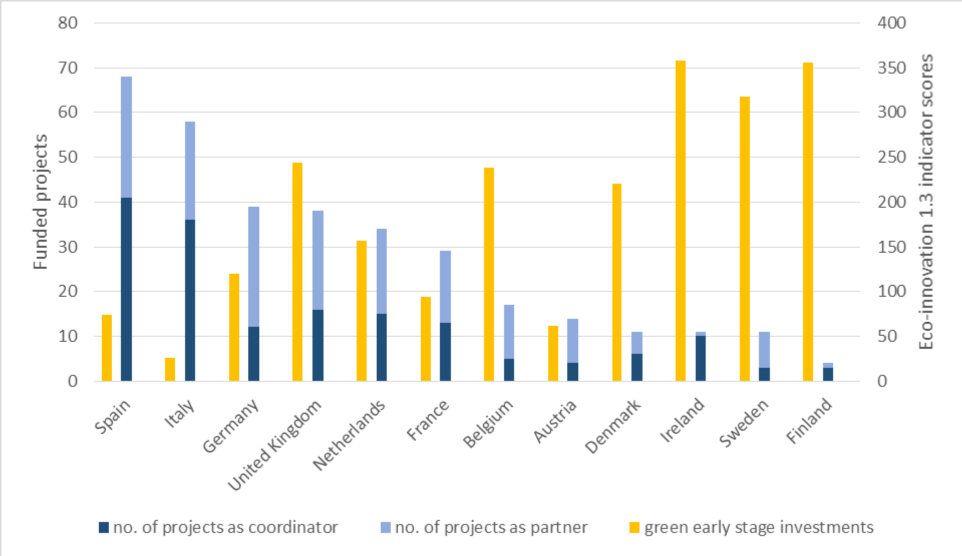

Figure 1. EU-countries' number of projects funded by CIP/EIP/Eco-innovation programme vs ECO-IS 1.3 indicator 'Total value of green early-stage investments per capita' – mean value period 2010–2013, EU average = 100

It is interesting to note, at a glance, that Italy and Spain have the largest number of funded projects (both case as a coordinator and as a partner are provided), but at the same time they have the lowest values of green early-stage investment indicator. Conversely, countries with a high level of green early-stage investments (Finland, Ireland, Sweden, Denmark and Belgium) have the lowest number of projects funded by the EU programme. Germany and France also show a moderate reverse trend. For The Netherlands, the trend is less evident. In order to measure the strength of the association between the two aforementioned variables, we calculated the Spearman's rank correlation coefficient using the dataset presented in Table 1, where X stands for the number of funded projects and Y stands for a score of the 1.3 indicator. As n = 12 and the sum of squared difference between ranks is 478, the Spearman's coefficient is equal to –0.671. Since the absolute value of the Spearman's coefficient is larger than the critical value that is equal to 0.503 for n = 12 and α =0.05 (Gautheir, 2001), the calculated value is significant at the 95% probability level. The found negative correlation shows a reverse trend: the higher the value of the country's total funded projects, the lower the country's level of green early-stage investments.

Table 1. Spearman's rank correlation dataset (*X* = total number of funded projects; *Y* = ECO-IS 1.3 indicator: total value of green early-stage investments

EU country	X	Y	rank X	rank Y	d	d^2
Austria	14	61,5	8	11	3	9
Belgium	17	238,25	7	5	-2	4
Denmark	11	220,25	10	6	-4	16
Finland	4	355,5	12	2	-10	100
France	29	94,5	6	9	3	9
Germany	39	120,25	3	8	5	25
Ireland	11	358	10	1	-9	81
Italy	58	26	2	12	10	100
Netherlands	34	156,25	5	7	2	4
Spain	68	74,25	1	10	9	81
Sweden	11	318,25	10	3	-7	49
United Kingdom	38	244,25	4	4	0	0

Moreover, we applied the Spearman's rank correlation technique also to the number of projects in which countries got involved as coordinators (new *X* variable) compared to the same *Y* variable of the previous case (dataset shown in Table 2).

Table 2. Spearman's rank correlation dataset (*X* = number of funded projects as coordinator; *Y* = ECO-IS 1.3 indicator: total value of green early stage investments)

EU country	X	Y	rank X	rank Y	d	d^2
Austria	4	61,5	10	11	1	1
Belgium	5	238,25	9	5	-4	16
Denmark	6	220,25	8	6	-2	4
Finland	3	355,5	11,5	2	-9,5	90,25
France	13	94,5	5	9	4	16
Germany	12	120,25	6	8	2	4
Ireland	10	358	7	1	-6	36
Italy	36	26	2	12	10	100
Netherlands	15	156,25	4	7	3	9
Spain	41	74,25	1	10	9	81
Sweden	3	318,25	11,5	3	-8,5	72,25
United Kingdom	16	244,25	3	4	1	1

This time the sum of squared differences between ranks is 430.5 and the Spearman's coefficient is equal to –0.505; therefore, in this case, the negative correlation significant at the 95% probability level.

5. Discussion

An interesting result emerged from the study. Using Spearman's technique we found, at the country level, confirmed at the 95% probability level, a negative correlation between the number of funded projects by CIP/EIP/Eco-innovation programme, assessing the EU funding support action, and the level of green early-stage investments, representing investors' financing support action. According to this empirical evidence, because countries investigated show the best eco-innovation performance, the findings reveal that EU funding programmes reduce financial constraints that SMEs face for developing eco-innovations. We found that the lower the level of green early-stage investments, performing private financial support, the greater the action of EU funding programme. Indeed, our findings show a complementary action of public funding with respect to private investors' financial support in order to reduce financial barriers towards eco-innovation; this is in line with relevant literature according to which public support of green innovation must complement the availability of private funds (Cecere et al., 2018; Olmos et al., 2012). In light of these findings, and given that private innovation investors have not recovered to pre-crisis levels in most countries (OECD, 2017), policymakers are asked to implement effective public funding in order to close the gap between the cost of innovation activities and the amount of financial resource private parties are willing to provide (Olmos et al., 2012). Thus, considering that when the interest in the commercial exploitation of highly immature, risky and capital-intensive innovation is lower than that of other innovations, public funds to be effective should be granted to the former (Olmos et al., 2012).

6. Conclusion

The aim of this study, addressing the question of eco-innovation financial barriers and drivers, was to investigate the influence of EU funding programmes on eco-innovation performance of SMEs with respect to the availability of green early-stage investments on eco-innovation. Our findings show a complementary action of public funding with respect to private investors in order to reduce financial barriers towards eco-innovation and this is in line with relevant literature according to which public support towards green innovation must complement the availability of private funds (Cecere et al., 2018). This study provides empirical evidence, focused on SMEs, on the public-private funding support interplay in the first market uptake of green technologies (from laboratory to the market). Policymakers should keep in mind the dynamic interaction between private and public funding support, the latter is customised according to the entity of risk along the innovation cycle.

Limits of the study are ECO-IS data available only for the years starting from 2010 and the fact that even the non-SME organisations (around 32%) participated in the selected funding programme.

The authors hope that the results shown in this paper can stimulate further studies in the field of barriers and drivers towards eco-innovation focused on financial factors. Thus, considering that there is a growing research interest in multi-stage financing of innovation (Nanda & Kerr, 2015). Understanding the effects of public-private funding interplay along the various stages of the innovation process (from exploration to exploitation) could help policymakers to design effective contracts and policies to improve innovation processes. Optimal eco-innovation policies, taking into account that public funding should complement rather than substitute private funding (Cecere et al., 2018; Olmos et al., 2012), should implement funding schemes with a holistic approach to the entire innovation process (from applied research to commercialisation and market penetration phase), providing different forms of financial support according to the various innovation phases, each characterised by different levels of uncertainty and risk, through the so-called 'financial innovation chain' (Polzin et al., 2016).

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