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How much do cluster institutions drive a firm's green innovation? A multi-level analysis

Jose-Antonio Belso^a , Isabel Díez-Vial^{b*} , Gregorio Martín-de Castro^b  and Jose-Luis Hervás-Oliver^c 

ABSTRACT

This research explores the complementary role of formal institutions at the macro-level and informal ones at the cluster level on a firm's green product innovation. Using mixed methods in a sample of 177 firms dedicated to the footwear industry, belonging to three clusters in three different countries, findings suggest that: (1) the cluster effect positively influences a firm's green product innovation; and (2) informal cluster-level institutions' effect on green product innovation is jointly and positively moderated by national institutions. Green innovation in clusters requires coupling different multi-scalar institutional systems effectively.

KEYWORDS

green innovation; clusters; informal institutions; formal institutions

JEL O32, R1

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1. INTRODUCTION

The world is increasingly demanding a radical transformation towards a green economy (Davies, 2013). Developing new products and processes that contribute to reducing environmental burdens or to specified sustainability targets, also known as eco or green innovations (Rennings, 2000), is increasingly considered a key aspect to promote sustainable economic success (Hiz et al., 2019). By including changes in the production process or in the product related to its recycling, packaging, eco-design, eco-efficiency, waste handling or life cycle analysis, among others (Klewitz & Hansen, 2014), firms not only contribute to social well-being but also can improve their performance and competitive positioning (Aragón-Correa & Sharma, 2003; Klewitz & Hansen, 2014).

In the exploration of the drivers of a firm's environmental innovation and responsiveness, research tradition on organisations and the natural environment puts the focus on institutional, normative and stakeholders' pressures (Delmas & Toffel, 2008). Literature on green innovation at this macro-level of formal institutions (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013) has gained momentum in recent years, complementing firms' green capabilities and performance (using the natural

resource-based view; e.g., Amores-Salvadó et al., 2014; Aragón-Correa & Sharma, 2003; Hart, 1995).

While most research on environmental or green innovation adoption in firms is based on *nation-level* institutional factors such as those related to environmental regulations, there is less research on the understanding of green innovation adoption in clusters and their mutual influence (e.g., Arbolino et al., 2018; Grimstad & Burgess, 2014). Positioned in this geography of innovation realm, this study goes beyond the nation level of the impact of institutional analysis and environmental innovation adoption in firms, adding novelty by introducing this intermediate level of institutional analysis, that is, clusters. As informal institutions in clusters, in this particular context, we refer to quality of local generation and exchange in local networks, facilitated or constrained by the local combination of shared goals, behaviours, and relations (in the sense of Harris, 2021), along *who we are* (Staber & Sautter, 2011).

Although innovation has been traditionally a main research topic in clusters and geographical agglomeration (Marshall, 1920; Porter, 1998), there is a scarcity of literature on green innovation and clusters (Daddi et al., 2012; Davies, 2013; Díez-Vial et al., 2022), and especially studies explaining why eco-innovations occur (Martínez-Pérez et al., 2015). The evidence gathered by Grimstad


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and Burgess (2014) suggests how collectively promoting green innovations is a source of regional competitive advantage with regard to the wine cluster in Australia. In the same vein, Martínez-Pérez et al. (2015) argue that clusters have the capacity to increase local environmental expertise and improve environmental proactiveness. The socio-spatial phenomenon of green technological clusters can drive the radical transformation towards a green economy that the world is demanding (Davies, 2013). While formal institutions have a clear national base, informal institutions have a closer link with the community in which these practices are identified and introduced. Informal institutions related to the community in which environmental and sustainability practices are identified and introduced is an increasingly relevant factor (van Wijk et al., 2019). Inside *clusters*, the conjunction of cognitive and institutional structures tends to develop a shared pattern of routines, norms and expected behaviour in a geographical space that conditions the environmental behaviour of their collocated firms (Hoffman, 1999; Scott, 1995). Both the national formal institutional context and the informal context of the cluster have a relevant impact on green innovation, but, to the best of our knowledge, their interrelationship has not been studied. This point of convergence constitutes our research gap. Thus, our research question is: How do national formal institutions and cluster informal institutions individually and jointly influence a clustered firm's green innovation performance? In this sense, we first aim to contribute to the existing literature on clusters and green innovations by including both the informal and the formal context on clustered firms, as well as their individual and joint effect. Notwithstanding the fact that localisation in a cluster fosters the adoption of green innovations by firms (Cainelli et al., 2012; Daddi et al., 2012; Davies, 2013; Horbach, 2014; Martínez-del-Río & Céspedes-Lorente, 2014; Sjutun & Njos, 2019), our study builds upon cross-fertilising macro-level institutions and cluster literature, thus intertwining institutions, clusters' and firms' green innovation. We present a complex and less-researched perspective: the combined effect of clusters' informal institutions and national-level formal institutions (macro-level, i.e., regulations, norms, etc.) on a firm's green innovation.

We test our theoretical expectations on 177 clustered footwear manufacturers located in Portugal, Colombia and Brazil. In short, our findings suggest that not all clusters influence green innovation equally but rather depend on their specific institutional quality.

2. FIRMS' GREEN INNOVATION AND THE INSTITUTIONAL CONTEXT

Green innovations are defined as the development of 'new ideas, behaviour, products and processes, applying or introducing them, and which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets' (Rennings, 2000, p. 322). Although green innovations can be a source of competitive advantage

(Hart, 1995), firms may be reluctant to undertake them due to the well-known problem of double externalities (Rennings, 2000; Zubeltzu-Jaka et al., 2018). Introducing innovations in general involves the appropriability problems related to knowledge externalities, so competitors benefit from them as well as the innovative firm. Firms can also have reduced incentives to implement green innovations because they are simply considering their own benefits – profitability from new green products, or enhanced green corporate image, reputation and legitimacy, among others – rather than the benefits to society as a whole (Horbach, 2008; Lambertini et al., 2017; Rennings, 2000).

Institutional Theory considers that this double externality problem can be reduced as firms conform to social norms because they cannot survive without a certain level of external social approval (DiMaggio & Powell, 1983; Scott, 1995). Institutionalists focus on how certain practices become social facts, become embedded in institutions so that these practices 'are taken for granted as "the way we do these things"' (Wallsten, 2001, p. 57), creating a 'collective identity' based on common values through networks created among small and medium sized companies within a cluster (Daddi et al., 2012). In dealing with sustainable, responsible or green innovations, national formal institutions but especially clusters' informal institutions can incorporate rules that reduce the threat of exploitation due to appropriability problems (Teece, 1986) by establishing practices that force firms to respect others and ensure to safeguard green innovations (Devarakonda et al., 2018) under a logic of responsible research and innovation (Sjutun & Njos, 2019). Since the legitimization of a particular social practice or social goal is emphasised, institutions, at a national but especially at a cluster level, play a key role in increasing the demand and acceptance of these green innovations (Daddi et al., 2012; Davies, 2013). As these environmental practices conform the expectations of customers, suppliers and other stakeholders, firms can appropriate part of the social benefits of green innovation (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013).

In a broad sense, the literature usually distinguishes between formal and informal institutions (North, 1990). Formal institutions include normative structures and rules that have been designed consciously while informal institutions fundamentally comprise the sociocultural characteristics present in each space, such as shared values and norms, as well as parts of the social structure, including family and kinship. There is abundant research on how regulation has fostered green innovation (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; Christmann, 2004).

The primary aim of environmental regulations is to exert a supportive impact and to compel firms to make their processes and products greener (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013). In their study in several East Asian newly industrialised countries, Angel and Rock (2009) evaluate how a strong institutional reform to reduce pollution was undertaken mainly based on building a robust environmental regulatory system similar to

those developed in the United States and other Organisation for Economic Co-operation and Development (OECD) economies.

Informal institutions foster environmental practices through normative and cognitive pillars (Scott, 1995). The normative pillar includes values and norms in social life that would legitimate not only the objectives but also the way to pursue them. They define the normative expectations of the community – what actors are supposed to do – and can take multiple forms such as rules-of-thumb, standard operating procedures, occupational standards and educational curricula (Hoffman, 1999). The cognitive pillar embodies symbols – words, signs and gestures – as well as cultural rules and frameworks that shape the understanding of the nature of reality and the frames through which that meaning is developed. Organisations will often abide by them without conscious thought.

Each of these three aspects affects legitimacy in different ways: the regulative emphasis on the conformity to rules; the normative one related to the interiorisation of moral obligations; and the cognitive view focusing on the legitimacy that comes from adopting a common frame of reference.

3. CLUSTERS, INSTITUTIONS AND GREEN INNOVATION: HYPOTHESES DEVELOPMENT

3.1. The institutional context of clusters

Considering the clusters and IDs as a unit of analysis or an 'organizational field' (Scott, 1985), the understanding of their local functioning and innovation cross beyond the interests of individual firms towards the establishment of a community-based interest, where most of the stakeholders (e.g., employees, suppliers, community) reside in the same location where firms interact, conforming to the local institutions or *rules of the game* (Marquis et al., 2007).¹ This local, mostly informal, institutional pressure tends to be stronger in highly geographical concentrations of firms and other agents (McCann & Folta, 2011; Saxenian, 1994). The informal institutional context in clusters is made up of different local factors such as 'social capital' (Coleman, 1986), 'untraded interdependencies' (Storper, 1995) or a 'collective identity' (Daddi et al., 2012), among others. These components configure the local traditions, norms, and trust that are taken for granted in the local inter-firm and interpersonal ties.

Referring to the case of industrial districts, firms tend to imitate each other on moral bases – 'What is right to do around here?' (Marquis et al., 2007, p. 934). This effect is also highly reinforced by the *imitation* effect in clusters (Saxenian, 1994; Staber, 2009), where evidence points out that there is not only inter-firm interaction for learning but imitation.

Following this chain of thought, we develop an argument for incorporating informal institutional setting conditions on green innovations and how the socio-spatial phenomenon of clusters can foster the transformation, understood as a comprehensive socio-economic, political

and socio-cultural process of change, towards a green economy (Davies, 2013). We build upon the idea of imitation that is pervasive in clusters and industrial districts, as knowledge flows more rapidly than in other contexts (Baptista, 2000; Hervás-Oliver et al., 2018a) due to the existing 'collective identity' based on shared common values (Daddi et al., 2012). As competitors incorporate green innovations, more firms would resemble them by doing the same (Husted et al., 2016). Managers are more likely to regard new green products undertaken by proximate firms operating in the same context as more appropriate and legitimate than those undertaken by distant firms with which they are not related (Marquis et al., 2007). It is through the development of local traditions, new practices and competences, and interpersonal networks that green innovations can diffuse and incorporate these practices inside the cluster (Ornetzeder & Rohracher, 2013). On the other hand, local supporting organisations inside clusters have an active role in defining routines, norms, authority flows, or beliefs of the social system in which the local community is established (van Wijk et al., 2019). Supporting organisations can enhance the possibility of defining common effective policies and strategies which can improve green innovations inside clusters (Battaglia et al., 2010). Legitimation for belonging to and accessing knowledge from local networks is also a reason to adopt new accepted practices (Dhanasai & Parkhe, 2006). All in all, clusters have the capacity to increase local environmental expertise and improve environmental proactiveness (Martínez-Pérez et al., 2015). This way, the socio-spatial phenomenon of clusters can drive the radical transformation towards a green economy that humanity is demanding (Davies, 2013). Under a logic of evolutionary economic geography and transition studies towards green clusters (Sjotun & Njos, 2019), they describe how green reorientation happens by aligning green technologies, new environmental marketing demands, green user practices and policies, cultural discourses, and institutions, under a socially constructed process.

Cluster effect, in this context, means not only the imitation of green innovation adoption among clustered firms but also how much more rapidly green innovation can be diffused among clustered firms. Evidence points out the faster dissemination of best practices within clusters, vis-à-vis non-cluster ones (Baptista, 2000; Hervás-Oliver et al., 2018b). Proximity between firms, customers and competitors in a location allows the identification of new demand requirements for green innovations (Kammerer, 2009).

All in all, this *cluster effect* or the quality of the cluster's informal institutional environment facilitates the individual and collective generation of green innovations, as is the case of S. Croce sull'Arno in Tuscany,² where the local cluster has built in around 30 years of *collective actions* to adopt green innovations such as the Aquarno wastewater treatment plant. Based on that, we propose that:

Hypothesis 1. The informal institutional context of clusters facilitates firms' green product innovation.

3.2. The role of clusters under different institutional national contexts

Differences in law and regulatory pressures across countries determine firms' green innovations (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; Christmann, 2004). Nevertheless, the general positive effect of national regulation on green innovation is not straightforward (Delmas et al., 2007). Indeed, stringent regulations oblige firms to follow the strict specifications of the law instead of focusing on more proactive environmental practices, such as green product innovation (Rennings et al., 2006), under a 'just-compliance logic' (Murillo-Luna et al., 2008) investing in 'end-of-pipe' technologies (Hart, 1995). That is, firms solely invest in regulatory compliance (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013) losing the potential benefits of proactively investing in green innovations.

Following Delmas and Toffel (2008), institutional market pressures, especially coming from firms' customers and competitors, drive the adoption of beyond compliance environmental practices and innovation, indicating high-calibre management with a business risk mitigation strategy in place. This way, a proactive environmental stance taken by the firm in the form of green product innovations can reinforce firms' competitiveness and performance (Aragón-Correa & Sharma, 2003; Hart, 1995) both by reducing costs through the use of fewer inputs, recycling by-products, the increase of operational efficiency, or reducing waste (Christmann, 2000). Furthermore, firms can also increase the value of their products in the market and increase their market share thanks to their new environmentally responsible products, or their improved environmental legitimacy and reputation (e.g., Amores-Salvado et al., 2014).

The informal institutional context of the clusters can reinforce the previously commented rival and customer demand dynamics and may exert a new unexplored key role in developing firms' green proactive behaviour among co-located firms (Díez-Vial et al., 2022). Indeed, leading environmental firms can boost the circular economy and industrial symbiosis via the links between upstream and downstream clustered firms (Yuan et al., 2020). Co-located firms in a cluster can develop new green technologies to incorporate new components, technologies or efficiencies in the process based on their existing experience in the industry (Hansen & Coenen, 2015; Rennings, 2000).

While the informal institutional context of the cluster can facilitate opportunities for environmental practices, it can also end up blocking their development through institutional lock-in (Rodríguez-Pose, 2013). This happens in the presence of rigid institutions that can neither anticipate nor respond to new environmental requirements. Local networks of dominant industrial production can become so narrowly focused on a particular type of retrogressive economic activity that production is unable to shift into a new restructuring track (Lund-Thomsen et al., 2016). As a consequence, regulations play a key role in the cluster embarking on a change toward new environmental practices. As long as countries establish

new regulations that foster environmental practices, firms and local supporting organisations inside clusters can use their existing relationships, trust and proximity to incorporate them in a more proactive manner. The proximity between firms, customers and competitors in a location allows new demand requirements to be identified for green innovations (Kammerer, 2009).

According to Sjøtun and Njos (2019), the effective transition and reorientation of clusters toward sustainability is complex, requiring a 'normative route', mainly driven by local clusters' informal institutions working under a 'collective identity' (Daddi et al., 2012), as previously analysed in hypothesis one, jointly with a 'policy mix' driven by national formal institutions, as we argue.

Thus, extending Institutional Theory at two levels of analysis – national and industrial clusters – on firms' environmental innovative behaviour (Delmas & Toffel, 2008), we theorise that national formal institutions moderate the effect of more informal cluster-level institutions on green innovation adoption. Put differently, national institutions where clusters are embedded can be of the utmost importance and also influence the effect of clusters. Thus, the second hypothesis is stated as follows:

Hypothesis 2. The national formal institutional context positively moderates the relationship between the informal institutional context of the clusters and firms' green product innovations.

4. DATA, METHODS AND RESULTS

The footwear industry is a mature and traditional sector in which the geographical concentration of highly fragmented production is a common feature across regions and countries. To explore the heterogeneity of both national formal institutions and cluster informal institutions, our field research has been carried out in multiple footwear clusters from three different countries: Portugal, Colombia and Brazil. For more about the clusters of each country, see Table A2 in Appendix A in the supplemental data online.³

4.1. Sample and methods

The fieldwork was planned in two stages. First, interviews with 13 managers and experts conducted in early 2021 provided details of environmental innovation strategies and practices within firms and the territories. We complement these interviews with environmental and industry reports from countries' footwear associations, participation on green technological or scientific events, and direct observation of eco-innovation practices. In the second stage, a firm-level survey was conducted using a self-designed questionnaire previously applied in the Spanish footwear industry (Belso-Martínez et al., 2020; Díez-Vial et al., 2022); the questionnaire was submitted online to footwear firms in clusters.

We submitted an online structured questionnaire to footwear firms located in clusters. Respondents were forced to fill in all items before progressing to prevent rejections, although they were allowed to go back and

change answers. This empirical strategy may suffer from endogeneity and reverse causality. For this reason, we deal with these issues, as shown in the Appendix. A total of 177 questionnaires were completed by 87.4% footwear manufacturers and 15.3% suppliers (82.5% from Latin America). The sample shows a slight overrepresentation of Colombian firms, accounting for 63.8%, compared with Portuguese and Brazilian manufacturers, 18.6% and 17.5%, respectively. A total of 30.5% of the firms had a turnover of less than US\$1 million, and only 21.5% had fewer than 50 employees. For more about the sample, see supplemental data online. All firms are located in clusters.

4.2. Measurement of the variables

4.2.1. Dependent variable

Green product innovation depicts a reliable multi-item construct obtained by factor analysing answers about the extent to which the firm implements green product measures to reuse, recycle or recover inputs (Zhu et al.,

2008), applies systems to quantify the amount of waste per product unit (Jasch, 2000), has set up green product actions to reduce or eliminate the use of hazardous materials (Zailani et al., 2011), and designs or improves the environmental sustainability of its packaging (Sharma & Vredenburg, 1998). Table 1 provides further details of the measurement of our variables.⁴

4.2.2. Independent variables

In this research, we focus on the *Cluster informal institutional context* (Díez-Vial et al., 2022) as a main variable. Our variable measures the sense of belonging, which reflects not only the location but also the identification with and perception of the beliefs and orientation or goal of the cluster (Molina-Morales & Expósito-Langa, 2013). We built a solid multi-item construct by factor analysing answers about whether or not their firm is part of an area of high concentration of firms, the degree of agreement with three statements about the awareness of whole cluster objectives, the shared ambition and vision

Table 1. Constructs and variables.

Dependent variable

Green product innovation

Answers to questions about a firm's involvement in product innovation over the last three years:

- The firm consciously implements green product measures to reuse, recycle or recover inputs
 - The firm deliberately applies systems to quantify the amount of waste per product unit
 - The firm has set up green product actions to reduce or eliminate the use of hazardous materials
 - The firm designs or improves the environmental sustainability of its packaging, for instance using recycled or biodegradable materials
- Five-point Likert scale (1 = Totally disagree to 5 = Totally agree). Alpha = 0.86. Factor analysed for a unique construct (KMO = 0.809; sphericity test = 295.102; p -value < 0.01)

Independent variables

Informal institutional context of clusters

Answers to the following questions about a firm's location:

- Your firm is located in an area of high concentration of firms (binary Y/N)
 - Your firm knows what the objectives of the cluster are
 - You and your firm share the same ambition and vision as the other firms in the cluster
 - People in your firm are encouraged and motivated to pursue the collective goals and mission of the cluster as a whole
- Five-point Likert scale (1 = Totally disagree to 5 = Totally agree). Alpha = 0.71. Factor analysed for a unique construct (KMO = 0.636; sphericity test = 35.947; p -value < 0.01)

National formal institutional context

Country's average score for the six categories of Worldwide Governance Indicators (WGI) elaborated yearly by the World Bank in 2021. The six categories of measuring formal governance were:

- Voice and accountability
- Political stability and absence of violence
- Government effectiveness
- Regulatory quality
- Rule of law
- Control of corruption

(Continued)

Table 1. Continued.**Control variables***Firm's involvement in local projects*

Answer to a question about the degree of agreement with the following statement: 'Your firm developed projects and policies that favour the local social and environmental context during the last three years (e.g., purchasing).'

Five-point Likert scale (1 = Totally disagree to 5 = Totally agree)

Firm's involvement in local social action

Answer to a question about the degree of agreement with the following statement: 'Your firm engaged in activities for the benefit of the community and the local environment assuming their costs during the last three years.'

Five-point Likert scale (1 = Totally disagree to 5 = Totally agree)

Local open innovation

Answers to questions about the degree of agreement with the following statements referred to the last three years:

- Your firm monitors the compliance of environmental standards of customers and suppliers
- Your firm promotes environmental responsibility of customers and suppliers
- Your firm incorporates key customers and suppliers in the development of environmental solutions
- Your firm has an effective complaints system with suppliers and customers
- Your firm tries to raise awareness among its customers and suppliers on environmental responsibility

Five-point Likert scale (1 = Totally disagree to 5 = Totally agree). Alpha = 0.81. Factor analysed for a unique construct (KMO = 0.860; sphericity test = 725.629; p -value < 0.01)

Size

- Factor mixing ORBIS's latest data on the firm's number of employees and revenues

Suppliers' industry

- Dummy variable that takes a value of 1 if the firm furnishes inputs such as heels, lasts, leather, textiles, etc.; 0 if the firm manufactures shoes

LATAM country

- Dummy variable that takes a value of 1 if the firm is Colombian or Brazilian; 0 otherwise

Technical capabilities

Answer to a question about the degree of agreement with the following statement:

- Your firm has the environmental skills and knowledge to develop new green products

Five-point Likert scale (1 = Totally disagree to 5 = Totally agree)

Environmental HRM

Answers to questions about the degree of agreement with the following statements:

- Your firm conveyed the importance of environmental responsibility through internal communication and participation during the last three years
- Your firm implemented remuneration and/or promotion plans that consider environmental criteria and goals during the last three years

Five-point Likert scale (1 = Totally disagree to 5 = Totally agree). Alpha = 0.72. Factor analysed for a unique construct (KMO = 0.500; sphericity test = 66.064; p -value < 0.01)

with other cluster firms, pursuit of the collective goals, and the mission of the cluster.

Researchers and policymakers claim a comprehensive assessment of differences in the formal institutional conditions that govern a social and economic life. As the adoption of green innovation practices is the result of the solidness of formal institutions at a national level (Zhu et al., 2010),

We built an aggregated *National Formal Institutions* index calculated as the average value of the six categories elaborated by the World Bank since 1996; the Worldwide Governance Indicators (WGI) combine secondary data produced by survey institutes, think tanks, non-governmental organisations, international organisations, and private sector firms (Kaufmann et al., 2011). Information is organised in six broad sectors of governance (Voice and accountability; Political stability and absence of violence; Government effectiveness; Regulatory quality; Rule of law; and Control of corruption).

4.2.3. Control variables

Geographical proximity in clusters facilitates knowledge exchanges and common learning through interactions, particularly within the environmental sphere (Yoon & Nadvi, 2018). Similar to Moyano Fuentes et al. (2019), we capture these practices through a solid composite construct labelled *Local Open Innovation*. Furthermore, through interactions with the local community, firms accrue and adapt new knowledge to eco-innovate and achieve competitiveness (Porter & Kramer, 2011; Porter & Van der Linde, 1995). Therefore, we controlled for involvement in local projects and participation in activities for the benefit of the community using the variables *Firm's*

involvement in local projects and *Firm's involvement in local social action* (Azzone et al., 1996; Bhattacharyya & Cummings, 2015).

Size captures the rationale that small firms face greater resource constraints and costs to green product innovation (Stucki, 2019), while large firms are under pressure to lead sustainable strategies (Zhu & Sarkis, 2007). The dummy *Suppliers' industry* checks for the influence of the position within the value chain. To address relevant idiosyncrasies of Latin American countries, we entered the dummy variable *LATAM country*. A robust repertoire of technical capabilities can better exploit eco-innovation opportunities as they refer the abilities to develop new products. In this vein, the dummy *Technical capabilities* was incorporated. Firms are shaped by internal factors such as environmental management when entering the eco-innovation field (Rennings et al., 2006). Previous research documents a positive impact on performance resulting from an environmental focus on human resource management (HRM) (Egri & Hernal, 2002). To evaluate this influence, a reliable construct *Environmental HRM* comprised answers about firms' degree of implementation of communication and sensibilisation of environmental practices among their employees (Singh et al., 2020).

4.3. Results

Table A1 in Appendix A in the supplemental data online depicts the descriptive statistics and the Pearson correlations for all the variables. Positive relationships between explanatory variables ranging from $r = 0.153$ (p -value < 0.05) to $r = 0.673$ (p -value < 0.01) suggest the existence of a solid group of firms strongly anchored in the territory and induced by an institutional context to implement

Table 2. Regression results: green product innovation.

	Model 1			Model 2		
	B	SD	Significance	B	SD	Significance
(Intercept)	-0.815	0.885	0.358	-1.321	0.923	0.154
Size	0.036	0.051	0.487	0.032	0.051	0.530
Suppliers' industry	**0.356	0.142	0.013	**0.315	0.142	0.029
LATAM country	*-0.268	0.154	0.087	*-0.288	0.154	0.064
Environmental HRM	***0.270	0.080	< 0.01	***0.239	0.081	0.004
Local open innovation	***0.433	0.083	< 0.01	***0.468	0.084	< 0.01
Technical capabilities	***0.127	0.045	0.006	***0.126	0.045	0.006
Firm's involvement in local projects	** -0.127	0.063	0.046	** -0.141	0.063	0.027
Firm's involvement in local social action	**0.124	0.056	0.029	**0.137	0.056	0.016
Cluster informal institutional context	**0.129	0.054	0.017	-2.146	1.256	0.009
National formal institutional context	0.149	0.228	0.514	0.291	0.240	0.227
Cluster informal institutional context*National formal institutional context				*0.600	0.331	0.071
Clustered standard errors		No			No	
Adjusted R ²		0.588			0.594	
F-statistic		***23.379			***21.893	
N		177			177	

Note: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

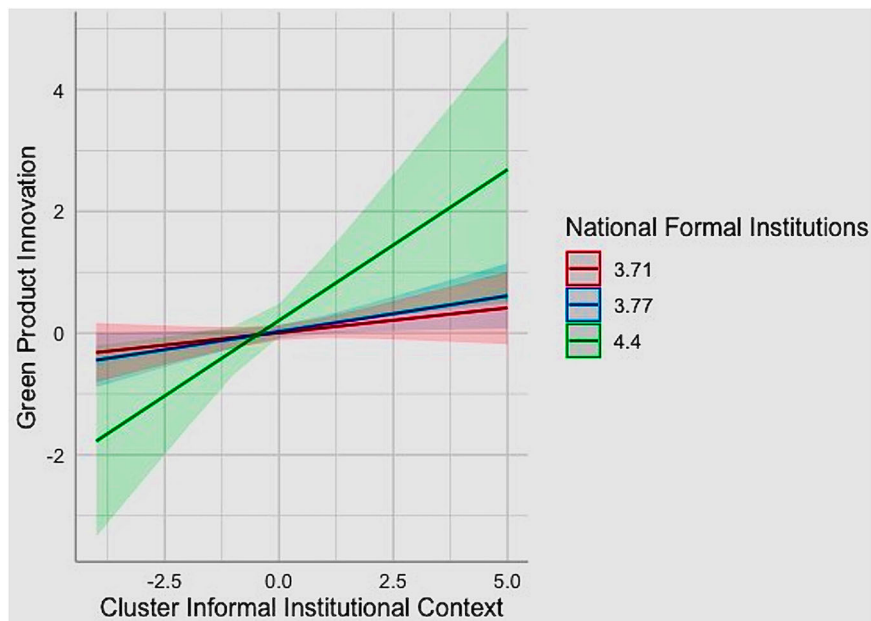


Figure 1. Predicted values of green product innovation.

environmental practices. The correlations of *LATAM country* with cluster ($r = -0.163$; p -value < 0.05) and *Local open innovation* ($r = -0.156$; p -value < 0.05) reveals the weaker territorial involvement and the increasing institutional pressure of Colombian and Brazilian firms. Detailed analysis of the correlation matrix discards potential multicollinearity concerns, as correlations between explanatory variables did not exceed (0.70). Even so, variance inflation factors (VIF) obtained in the regression model were lower than 2.6, far below the cut-off level to require attention (see Table A1 online).

Model 1 evaluates the effect of the cluster institutional context on green innovation – Hypotheses 1 (Table 2). As expected, interactions at the local level exert an effective role in fostering knowledge access to develop a new sustainable product (*Local open innovation*: $\beta = 0.434$; p -value < 0.01). Geographical vicinity together with the sense of belonging, along with a shared vision of firms, the role of institutions or the know-how circulating among companies in the cluster significantly explain green product innovation (*Cluster institutional context*: $\beta = 0.129$; p -value < 0.05). In addition, structured and complex environmental managerial systems induce an accumulation of knowledge and capabilities leading to higher green product innovation. The more a firm invests in the environmental sphere, the more it becomes capable of creating novel knowledge and solutions (*Environmental HRM*: $\beta = 0.270$; p -value < 0.01). Probably linked to the fragmentation of manufacturing activities and the traditional supplier-driven innovation dynamics, despite their distance to final markets, input manufacturers are more innovative (*Suppliers*: $\beta = 0.357$; p -value < 0.05).

Model 2 contains all the previous variables along with our moderation variable. The interaction term *Cluster institutional context***Formal institutions* is significant ($\beta = 0.010$; p -value < 0.1), thus supporting Hypothesis

2. Stronger environmental regulations at the national level make cluster firms more likely to develop green product innovations. The relevance of local interactions is reinforced by the increasingly positive main effect of *Local open innovation* ($\beta = 0.469$; p -value < 0.01). Knowledge exchanges thanks to spatial closeness strongly matter for green product innovation regardless of the evolution of the national formal institutional framework. Our findings are consistent with double-checks (see Table A3 in Appendix A in the supplemental data online).

To better illustrate the two-way interaction effects on firms' green product innovation, we provide the predicted marginal effect plots using the three values of each moderator. In Figure 1, the three cut-offs of the term formal institutions are plotted on an x -axis of cluster informal context and a y -axis of firms' green product innovation. The plot indicates that the positive impact of cluster informal institutions on firms' innovation is magnified when national formal institutions are more relevant. For a weak informal context, there is an unnoticeable influence of national policies on innovation. Medium and overall high scores on the moderator are related to an increasing prevalence of an informal context for innovation. This suggests the complementarities between more consistent national environmental policies and a solid local clustered informal context.

5. DISCUSSION AND CONCLUSIONS

We postulate that green innovation is not only pursued from a firm's green innovation capabilities and activities but also institutional factors. Both formal, at the macro-level, and informal, at the cluster level, exert an influence on a firm's green innovation process. Thus, our research question is: How do national formal institutions and cluster informal institutions individually and jointly influence

a clustered firm's green innovation performance? Evidence using mix methods confirms that both levels exert an individual and a joint effect on firms' green innovation, expanding our knowledge on the topic (Díez-Vial et al., 2022; Martínez-del-Río & Céspedes-Lorente, 2014). Overall, the results point out that clusters exert a relevant role on green innovations.

In terms of findings, first, we highlight the fact that not all clusters influence green innovation equally but will depend on their specific institutional quality. The national regulatory system per se is not significant except when the informal institutional context of the cluster plays a role of diffusion amplifying its effect: when the national institutions in each country are green-oriented, then the clusters leverage that effect on firms' green innovation. This insight introduces the necessity to go beyond a single institutional level. According to the results, therefore, the cluster effect *per se* is not enough: the national level needs to be considered. Evidence revealed that firms in the European subsample (Portugal) are incentivised to introduce green innovation from a multi-scalar institutional setting: national norms and the local *right thing to be done*, vis-à-vis clusters in the LATAM area.

Second, results show the leveraging role of stronger national environmental regulations on clustered firms being more likely to develop green product innovations. As discussed in the quantile regression, for a weak cluster informal context, there is an unnoticeable influence of national policies on firm's green innovation. Nevertheless, medium and overall high scores on the moderator are related to an increasing prevalence of a cluster informal context for green innovation. In practical terms, we highlight the relevant complementarities between more consistent national formal environmental policies and a solid local clustered informal context for developing green innovations.

All in all, this research goes a step beyond in the understanding of why companies belonging to clusters go green. We develop a novelty multi-level analysis, cross-fertilising micro-, meso- and macro-level effects on a firm's green innovation. Thus, results confirm the two stated hypotheses and contribute to Institutional Theory (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; Devarakonda et al., 2018) by adding the meso-level (informal) setting. In addition, we intersect the cluster and the national level of analysis on understanding firms' green innovation, contributing also to the scant cluster literature and environmental sustainability (Díez-Vial et al., 2022).

Findings on formal and informal institutions in this study are connected to literature where context, that is, knowledge endowments of the region within which the firm is located, influences interactions and innovation (Fitjar & Rodríguez-Pose, 2015; Hervás-Oliver et al., 2021; Hervás-Oliver & Albors-Garrigos, 2009; Hervás-Oliver et al., 2018a). Put differently, institutional conditions and resource endowments of the region within which the firm is located influence innovation (Rodríguez-Pose & Fitjar, 2013), a central tenet in IDs and regional innovation systems (e.g., Becattini, 1990). Our results expand

understanding of the necessity to couple different multi-scalar institutional systems for stimulating eco-innovation, confirming regional greening path studies (e.g., Trippel et al., 2020) and mainstream cluster literature (e.g., Espósito & Rigby, 2019; Morrison et al., 2013).

In a practical application approach and picturing a clearer understanding and relevance of our empirical results, scholars need to pay attention to the *quality of clusters' institutions*, such as those factors related to existent social capital, shared goals and understanding, collective efforts, etc., because of their powerful impact on fostering green innovation. On the contrary, a poor and thin institutional setting would not encourage green innovation. As observed, the LATAM clusters (Brazil and Colombia) do not capitalise on their informal institutional settings for green innovation. Despite the existing agglomeration forces, green innovation is not facilitated in these LATAM clustered firms largely due to the poor macro-institutions.

From the perspective of regional policymakers, a main implication is derived: the development of green practices inside clusters should be prioritised, in line with a recent report from the European Expert Group on Clusters (2021) that encourages clusters to boost green and digital transitions. As long as green innovations become locally institutionalised, becoming part of the 'rules of the game', more and more firms will undertake green practices. Nevertheless, these cluster initiatives should not work independently of the macro-level regulatory framework. As has been observed, a proper formal institutional context makes the cluster effect on green innovations even more positive. In this sense, results indicate that regulation per se is not significant unless it is channelled through the cluster. In designing and implementing effective sustainable policy frameworks, policymakers should consider the interactive effects at the two levels: proactive sustainability from national institutions and their interactions with informal cluster institutions.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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NOTES

1. Using the expression of North (1990).
2. For more, see Daddi et al. (2017).

3. All study participants provided informed consent for their data to be used here, following the UPV Ethics Committee.
4. Many product innovations rely on the creation and development of new designs and inputs (insoles, buttresses, cuirasses, heels and soles) by recycling of waste and surplus from previous collections without generating new 'leftovers' in the process (see companies such as Belcinto in Portugal or the Brazilian Ramarin). More examples are available in the three business associations mentioned.

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