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Drivers of exploitative and explorative innovation in a collaborative public-sector context

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Abstract

This paper studies multilevel networks, in which municipalities collaborate with higher tiers of government (upward collaboration), with peers (outward) and with local stakeholders (inward) to discover innovative ways to create public value. A set of hypotheses was developed on the effects of three forms of collaboration (i.e. inward, outward, and upward) on two types of innovation (i.e. exploitative and explorative innovation). A range of network and municipality characteristics was also considered. The model was tested by capturing the perceptions of 656 municipal representatives. The research findings provide evidence of complex links between forms of collaboration and types of innovation.

Keywords: inward collaboration, outward collaboration, upward collaboration, exploitative innovation, explorative innovation.

INTRODUCTION

This research focuses on collaborative public-sector innovation. Innovation is broadly understood as the implementation of significant change in the way an organisation operates or in the services it provides (Hartley 2005; Osborne and Brown 2011; Bloch and Bugge 2013). The term 'collaborative' highlights the idea that innovation is approached through relationships between partners involving transformational purposes that require high levels of interaction (Wood and Gray 1991; Innes and Booher 2010). In our research context, innovation occurs within governance networks, which are understood as negotiated structures that involve different levels of government and other stakeholders, and are addressed to facilitate collaborative exchanges and resource integration (Osborne 2006; Keast, Mandell, and Agranoff 2014).

Torfing (2018) suggests that multi-actor collaboration is a superior driver of innovation. It is not surprising, therefore, that collaborative public-sector innovation is growing (Hartley 2005; Hartley and Benington 2006; Bommert 2010; Sørensen and Torfing 2011; Borins 2012; Osborne and Strokosch 2013; Crosby, Hart, and Torfing 2017). However, our knowledge of collaborative public-sector innovation remains limited (De Vries, Bekkers, and Tummers 2016; Lewis, Ricard, and Klijn 2017). In particular, cross-sectional research on collaborative public-sector innovation contexts is scarce and the need for more studies in this area has recently been claimed from diverse research traditions (Arundel, Casali, and Hollanders 2015; Ostrom et al. 2015; De Vries, Bekkers, and Tummers 2016; Lewis, Ricard, and Klijn 2017).

We take a step forward towards covering this gap by studying networks of municipalities and higher tiers of government (hereinafter, HTG, involving provincial, regional and, to a lesser extent, national governments), and analysing the link between

three forms of collaboration and two types of innovation. Specifically, the three forms of collaboration considered are: inward or municipality-to-local stakeholders, outward or municipality-to-municipality, and upward or municipality-to-higher tiers of government (Agranoff 2014); and the two types of innovation are: exploitative innovation, which involves small departures from the existing knowledge base and practices of the municipality, and explorative innovation, which involves significant departures (Jansen, Van Den Bosch, and Volberda 2006).

Some prior cross-sectional research on public-sector innovation has found an overall positive effect from the use of external knowledge sources on innovation outcomes (Pärna and von Tunzelmann 2007; Arundel et al. 2105). However, the specific contribution of the various external knowledge sources has not been analysed. Another limitation of prior cross-sectional studies is that they have not been contextualised within networks. Based on prior networking literature, we argue that networks matter as they may be embedded with some crucial benefits (in our case, shared resources, trust and voice) that affect both the degree of collaboration and innovation outcomes (Kickert, Klijn, and Koppenjan 1997; Ansell and Gash 2008; Keast, Mandell, and Agranoff 2014).

More specifically, this research is aimed at responding to two research questions: (1) What forms of collaboration (i.e. inward, outward and upward) contribute to two fundamental types of innovation (i.e. exploitative and explorative innovation)? and (2) What contribution do three network properties (i.e. shared resources, trust and voice) and a crucial feature of municipalities (i.e. eco-leadership) make to the three forms of collaboration and two types of innovation?

The response to these questions could provide some guidance to both scholars and practitioners. Most prior research tends to implicitly assume a virtuous chain by

which networks lead to more collaboration, which, in turn, leads to more innovation outcomes (Batterink et al. 2010; Dhanaraj and Pakhe 2006; Keast, Mandell, and Agranoff 2014). While this view appears plausible, it also contains many nuances that have not been quantitatively researched. Thus, a municipality could collaborate with various partners that differ in terms of type of knowledge possessed and the easiness, costs and reliability with which this knowledge may be transferred (Damanpour 1991; Kwon and Feiock 2010; Hofstad and Torfing 2015). In addition, municipalities could pursue different degrees of originality in their innovation and, therefore, may require distinct partner types (Nieto and Santamaría 2007; Frenz and Ietto-Gillies 2009). As municipalities have limited resources, they cannot pursue all forms of collaboration with the same intensity and need some guidance in making decisions. Network promoters also need some guidance to choose what forms of collaboration to prioritise within networks. While case studies have improved our knowledge on the role of different collaborators (e.g. Homsy and Warner 2013; Hofstad and Torfing 2015), there is far from a consensus in this area, and qualitative research needs to be supplemented with quantitative research to combine the strengths of both approaches.

The remainder of the paper is structured as follows. The next section describes the specific context of this research. The third section clarifies the innovation concepts considered. The fourth section develops the model and hypotheses, and the fifth section examines the methodological issues. The sixth section refers to the results of the empirical test, and the final sections present discussion and offer avenues for further research.

RESEARCH SETTING

We study innovation processes within collaborative governance networks aimed at promoting local sustainable development in Spain. Hofstad and Torfing (2015)

suggest that collaborative public-sector innovation may be particularly needed to face wicked (i.e. cognitively ambiguous) and unruly (i.e. difficult to ascribe to a specific actor) problems. Sustainable development is one of these problems, as the capacities and powers to face sustainability challenges are ambiguously distributed between multiple actors, including different levels of government, companies and citizens (Ostrom 2010; Bulkeley and Betsill 2005, 2013).

This view underlies the multilevel governance model for sustainable development that was adopted at the United Nations summit in Rio in 1992 (Bulkeley and Betsill 2005), and has been maintained and reinforced in later summits (Jänicke 2017). Recent developments focus on the systemic, collaborative efforts of governments, businesses and civil society (e.g. the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals, including Goal 11, which refers to cities, and the Paris Agreement on climate change).

The Rio summit focused on making the concept of sustainable development operative and attached a crucial role to municipalities as the level of government closest to citizens and companies. It was proposed that municipalities should involve local stakeholders to develop action plans, the so-called Local Agenda 21 (Echebarria et al. 2018). Due to poor baseline conditions (i.e. small municipalities with limited resources and scarce sustainability tradition) the response of Spanish municipalities to Local Agenda 21 took a long time. However, local sustainability processes grew significantly in Spain in the mid-2000s; their spread was associated with the promotion of governance networks that involved a constellation of actors, including various tiers of governments, consultants, and local stakeholders (Barrutia and Echebarria 2015).

Networks were promoted by intermediate level governments (regional and provincial), and supported to a lesser extent by central government. As suggested in

networking literature, the promoters played a key role in both promoting the network, and nurturing and managing the shared resources of the network (Agranoff 2003; Voets 2014). This role was due to the promoters' uniqueness in terms of size, resources and legitimacy (Agranoff 2003; Dhamanaraj and Parkhe 2006). While regional and provincial networks formally involved the municipalities and HTG, each municipality was also encouraged to innovate by involving its local stakeholders. Therefore, upward, outward, and inward collaboration took place (Agranoff 2014). These forms of collaboration led to diverse innovation outcomes. Spanish networks are a suitable research environment; networks and sustainability-led activities proliferated very quickly, which was surprising. Therefore, the factors underlying this process are an interesting object of inquiry.

INNOVATION TYPES: CHARACTERISATION AND RELEVANCE

Building on Jansen, Van Den Bosch, and Volberda (2006), we focus on two possible innovation approaches for municipalities seeking to adapt their services and operations to the sustainability challenges: (1) exploitative innovation and (2) explorative innovation. Exploitative innovations are those that are close to the existing knowledge base and practices of the municipality, involving little discontinuity and controlled risk. They have usually been tested beforehand in comparable municipalities. By contrast, explorative innovations require significant departure from the existing knowledge base and practices of the municipality, involving more radical changes and high risk. They are usually unique, at least in certain aspects, and uncommon in comparable municipalities.

Both concepts are understood in relative, subjective or contextual terms (Jansen, Van Den Bosch, and Volberda 2006). The same innovation may be perceived as exploitative in one municipality and explorative in another, being path- and context-

dependent perceptions (Gulati 1999). Explorative innovations are not necessarily new to the world. An innovation may have been implemented previously in one context, but, even so, be perceived as experimental and risky (i.e. explorative) in other contexts for various reasons. Maybe they represent a significant departure from previous knowledge/practices, or there is no prior experience in comparable/neighbouring municipalities, or there are unique local circumstances.

We believe that studying exploitative and explorative innovation in a public sector context is interesting for several reasons. Firstly, while public management research has paid scarce attention to these concepts (see Bryson, Boal, and Rainey 2008, and Choi and Chandler 2015, as exceptions), they have the potential to improve our understanding of the behaviour of public managers. As shown by Ji and Darnall (2018), they are powerful for capturing two fundamental behaviour types in municipal managers when facing sustainability and climate change challenges. The first one focuses on introducing sustainability-led improvements in a step-by-step, low-risk way (i.e. exploitative innovation), and the second one is more transformational and less risk-adverse (i.e. explorative innovation). A third possible approach is to do nothing to tackle the sustainability challenge. We have not studied municipalities that have adopted this approach (i.e. those municipalities that are not members of sustainability-led networks).

Secondly, cross-sectional research on collaborative public-sector innovation is scarce. A parsimonious way of improving our knowledge is by considering two innovation categories that have been previously conceptualised and operationalised (Jansen, Van Den Bosch, and Volberda 2006). More categories could be considered in further research.

Thirdly, public management research could help to clarify controversial literature on exploitation and exploration (Rashman, Withers, and Hartley 2009). March (1991) suggested that managers focus on exploitation because it is perceived as proximate, clear and predictable. Conversely, exploration tends to be viewed as distant, diffuse, and uncertain. Furthermore, March suggested that exploitation and exploration are, by their nature, different activities that require specific and sometimes contradictory resources which are difficult to bring together, leading to a controversial result: while exploitation is preferred by managers and drives out exploration, long-term viability requires exploration (i.e. the so-called exploitation-exploration dilemma). Despite a great deal of business literature studying the exploitation-exploration dilemma, it is not entirely clear whether organisations are able to combine exploitation and exploration (i.e. ambidexterity) and how they can do it (Lavie, Stettner, and Tushman 2010). It has been suggested that networks could be a way of approaching ambidexterity (Lavie, Stettner, and Tushman 2010; Stadler, Rajwani, and Karaba 2014). This research provides further insights into the specific contribution of networks to the exploitation-exploration dilemma.

We focus on innovation instead of improvement. Hartley (2005, 2014) and Osborne and Brown (2011) argue that innovation should involve step-change and discontinuity. In our context, both exploitative and explorative innovation involve discontinuity, as they are aimed at reinventing municipal operations and services to respond to a new management paradigm (i.e. sustainable development) (Osborne 1998). There is a management break from sustainability-blind to sustainability-led services and operations. The empirical part of this research, therefore, focuses on step-changes towards sustainability, leaving out simple improvements and innovations that are unrelated to sustainability.

RESEARCH MODEL AND HYPOTHESES

Model structure is based on the resource-based view of the firm (Barney 1991; Wernerfelt 1984). While systematic consideration of the resource-based view in not-for-profit contexts is relatively scarce, adopting it as a theoretical focal point may advance our understanding of public organisations (Bryson, Ackermann, and Eden 2007). Overall, the resource-based view maintains that organisations pursue unique approaches that are explained by the resources they possess and/or have access to. Organisations are viewed as idiosyncratic and heterogeneous bundles of assets and resources that explain their heterogeneity in terms of strategic positions (Wernerfelt 1984). A link between approaches/goals and resources is, therefore, expected.

As explained above, we focus on two possible innovation approaches for municipalities: (1) exploitative innovation and (2) explorative innovation (Jansen, Van Den Bosch, and Volberda 2006). The resource based-view considers two broad types of resources: internal and relational. For choosing the specific internal and relational resources to be considered, we build on social theories of learning/innovation and prior research on networking. In line with social theories of learning (Brown and Duguid 2017), innovation is viewed as a social construction process in this research. This essentially means that knowledge creation: (1) occurs in the context of a community, which determines the conditions under which municipalities innovate, and (2) depends on the specific ties available for each municipality. Consequently, we consider two types of relational resources: (1) common network resources that are linked to all of the network properties and that partners cannot generate independently (Dyer and Singh 1998); and (2) privative relational resources that stem from the focal municipality's network ties, which are heterogeneously distributed among municipalities because their emergence is a context-dependent and path-dependent process (Gulati 1999).

We draw on networking literature to choose the common network resources considered (i.e. shared resources, trust and voice) (Klijn and Koppenjan 2000; Ansell and Gash 2008; Vangen and Huxham 2014) and the three forms of collaboration (i.e. inward, outward and upward) (Agranoff 2014). We assume municipalities behave rationally and expect them to choose their collaborators according to the potential knowledge resources they are expected to contribute and the transaction costs incurred (Feiock 2007; Kwon and Feiock 2010). While this research focuses on relational resources, a crucial internal resource is also considered: sustainability-related leadership of municipalities (hereinafter, eco-leadership) (Kousky and Schneider 2003; Damanpour and Schneider 2009; Ricard et al. 2017). Municipal eco-leadership is understood as the presence in the municipality of highly motivated and influential individuals who enthusiastically promote sustainability (Howell, Shea, and Higgins 2005; Bloch and Bugge 2013).

Our model is complex; it involves 9 variables and 26 links between variables. For simplicity, we present it in two parts. The first part of the model is called the core model and captures the effect on the three forms of collaboration on two types of innovation; we develop formal hypotheses for this part of the model. The core model is broadened to consider the remaining municipal and common network resources that should affect both innovation outcomes and the level of collaboration. While we have not developed formal hypotheses for this part of the model, a concise justification of the proposed links is provided. The whole model, including the core model and the additional inputs, is called the extended model (see figure 1, which includes the specifications of the model).

(INSERT FIGURE 1)

Core model: Hypothesis development

Upward collaboration as an antecedent of exploitative innovation

Building on Agranoff (2014), upward collaboration is understood as the strength of collaboration with the network promoter and other HTG that could support the network. We argue that upward collaboration may be perceived by municipalities as a source of legitimacy, and a relatively safe, uncomplicated, low-cost and effortless way of participating in the network (Reed 2008). It may also provide privileged access to shared resources, usually managed by promoters (e.g. funding, methodologies, indicators, specialised reports, consultants and the like), and a suitable synthesis of the knowledge frontier in the region (O'Leary and Bingham 2009).

Firstly, promoters usually have higher economic and human resources, which may allow access to technical expertise on sustainability issues, conducting innovation processes, managing stakeholder participation and developing indicators for monitoring and reporting (O'Leary and Bingham 2009; Voets 2014; Bel and Warner 2015; Niemann and Hoppe 2018).

Secondly, promoters develop a virtual service platform that works like an easily-accessible meeting point for all network members (Lusch and Nambisan 2015). To nurture this platform, promoters usually request municipalities to turn their best practices into codified knowledge. The remaining municipalities may access knowledge at low cost.

Thirdly, promoters may organise forums (Agranoff 2003; Crosby, Hart, and Torfing 2017) that bridge ties between unconnected or loosely-connected municipalities (Dhanararaj and Parkhe 2006; Voets 2014). These forums provide an efficient way of knowing who is who within the network and what kind of knowledge they may contribute. Municipalities may be able to find the knowledge they need or the

appropriate partners in these forums, instead of in a trial-and-error one-to-one process (Homsy and Warner 2013).

Fourthly, promoters may also provide funding to municipalities for project development and implementation (McGuire 2002; Mandell and Keast 2007; Collm and Schedler 2014). Access to funding could be easier for projects that fit the goals and priorities defined within the network. Finally, promoters may provide legitimacy for change and innovation, which could prove particularly salient for some local authorities (Rashman, Withers, and Hartley 2009; Agranoff 2003, 2014).

However, upward collaboration has its limits. Firstly, promoters may focus on easy-to-implement, small and low risk changes based on widely shared and consensual knowledge (i.e. exploitative innovation) and use their resources and power to promote these kinds of innovation (March 1991; McNulty and Ferlie 2004; Rashman, Withers, and Hartley 2009). Secondly, while mechanisms such as virtual platforms and forums are useful for acquiring codified knowledge, explorative innovation in the urban space could be based on participatory, bottom-up, grassroots-based knowledge and actions (Moulaert et al. 2007; Homsy and Warner 2013). Therefore, we expect upward collaboration to contribute to exploitative, but not explorative innovation, and propose that:

Hypothesis 1: upward collaboration will have a direct and positive effect on exploitative innovation.

Inward collaboration as an antecedent of exploitative and explorative innovation

Building on Agranoff (2014), inward collaboration is understood as the degree of collaboration with local stakeholders in terms of variety and strength of ties. Inward collaboration involves complexities and high transaction costs. Thus, municipal

managers and local stakeholders are dissimilar in terms of mind-sets and knowledge bases, which could hinder knowledge transferability (Cummings and Teng 2003). In addition, local stakeholders are very dissimilar between themselves (e.g. businesses v. citizens) in terms of values, interests and professional backgrounds, and municipalities could choose the wrong options (Beach, Keast, and Pickernell 2012).

While recognising the above difficulties, prior research indicates that inward collaboration may be fruitful in terms of knowledge specificity, knowledge variety, learning stimulation and increasing successful implementation opportunities. Firstly, the behaviour and needs of local stakeholders are unique to each municipality and inward collaboration may contribute specific knowledge of these needs (Beach, Keast, and Pickernell 2012; Agranoff 2014), which could lead to tailor-made, successful innovations (Moulaert et al. 2007; Homsy and Warner 2013).

Secondly, inward collaboration, when properly managed, can be particularly rich in providing a variety of information, knowledge, skills, values and perspectives originating from a wide range of diverse and heterogeneous groups, such as various segments of citizens (e.g. women, young people or immigrants), local businesses, nearby universities, interest groups and nongovernmental organisations (NGOs) (Beach, Keast, and Pickernell 2012; Agranoff 2014; Torugsa and Arundel 2016). This diversity of contributions may provide rich opportunities for generative learning, leading to explorative innovation (Van de Kerkhof and Wieczorek 2005; Ozer and Zhang 2015).

Thirdly, learning between dissimilar organisations can be stimulating (Downe et al. 2004). Fourthly, inward collaboration increases the opportunities for successful implementation and reduces the perception of risk by municipalities (Reed 2008; Homsy and Warner 2013). Innovations (particularly explorative innovations) may break with the usual routines and, hence, be perceived as inconvenient by local stakeholders.

However, when stakeholders participate in decision making, they may feel themselves to be the owners of innovation, thus increasing acceptability (Conroy and Berke, 2004; Alam 2006; Hofstad and Torfing 2015). Furthermore, stakeholders can be trained to use a new service or process while participating in deliberative processes and may act as ambassadors of innovation in their own networks (Reed 2008; Krogh and Torfing 2015). A specific characteristic of non-profit contexts is that of stakeholders acting as co-producers out of altruism or social prestige.

Taken together, the above observations indicate that inward collaboration is a high-cost and high-learning form of collaboration that seems to be particularly appropriate to explorative innovation. However, it could be productive for both exploitative and explorative innovation, as the adoption of any idea needs a certain degree of adaptation to the context, even if it has been widely applied in other contexts. As suggested by Sørensen and Torfing (2011), when a new concept is applied to a new context, it is transformed to fit the context, which leads to the modification of the context and the original concept. Context adaptation requires a certain level of inward collaboration, even for exploitative innovation. Therefore, we tentatively propose the following:

Hypothesis 2 (a, b): inward collaboration will have a direct and positive effect on exploitative (H2a) and explorative (H2b) innovation.

Outward collaboration as an antecedent of explorative innovation

Building on Agranoff (2014), outward collaboration is understood as the variety and strength of ties with peer municipalities. In the absence of networks, outward collaboration may be the only way to access the dispersed knowledge base of other municipalities. This trial-and-error, dyadic mode of accessing knowledge may be less

efficient than the one provided by the network, which is one of the sources of the rationality underlying the creation of a network (Feiock 2007; Kwon and Feiock 2010).

Once the network has been created and spread over the region, municipalities are required to transfer their knowledge to the network in the form of codified good practices, presentations in forums that may be recorded, participation in chats and collaborative work to develop common views, methodologies, and so on. Consequently, dyadic interactions may be more selective and efficient and even unnecessary within networks for relatively simple innovation projects, in which the region has accumulated experience (i.e. exploitative innovations). For instance, a municipality that tries to introduce green procurement criteria may access the shared resources of the network (e.g. illustrative examples from other municipalities or HTG experts) instead of searching for possible partners through a process of trial and error.

However, investing time, money and effort in developing strong, direct ties with selected peer municipalities may be needed when municipalities pursue relatively complex and ambitious innovation projects that are far from their current knowledge base and practices and are perceived as uncertain (i.e. explorative innovations). The kind of knowledge necessary for these innovations is usually unique, sticky and best transferred via one-to-one, face-to-face interactions (Galunic and Rodan 1998). For instance, some municipalities in Spain have been successful in implementing door-to-door waste collection; however, most have failed. While in some municipalities citizens have accepted the effort and discomfort of door-to-door collection for the common good, this practice has been strongly contested in other municipalities. Citizen response seems to have more to do with sticky management practices than with technical knowledge. Therefore, we propose the following:

Hypothesis 3: outward collaboration will have a direct and positive effect on explorative innovation.

Extended model

The extended model includes a focal municipality characteristic and three network properties. We tentatively propose that all of them will have a positive and direct effect on the three forms of collaboration and two types of innovation. The rationale is explained below.

Municipal eco-leadership. The presence in the municipality of highly motivated and influential individuals who enthusiastically promote sustainability ensures the effective involvement of municipal resources in collaborative innovation processes (Kousky and Schneider 2003; Sullivan, Williams, and Jeffares 2012; Fattore, Iacovone, and Steccolini 2017), and is a key determinant of the extent of knowledge transfer (Hamel 1991; Simonin 2004) and the successful integration of internal and external knowledge for innovation purposes (Pärna and von Tunzelmann 2007).

Shared resources. Shared resources are understood in this research as those resources that are jointly created and accessible by all network members (Tschirhart, Amezcua, and Anker 2009). Accessibility to shared resources may lead municipalities to the belief that the time and effort devoted to collaboration may be productive, which may increase collaborative efforts (Wood and Gray 1991; Tschirhart, Amezcua, and Anker 2009). When devising and implementing innovative solutions, municipalities integrate the shared resources available within the network with their own resources (Ashworth et al. 2013; Vargo and Lusch 2016; Osborne 2018). Accordingly, shared resources may constitute a crucial ingredient of innovation.

Trust. Building on Zaheer, McEvily, and Perrone (1998), we define trust as the expectation of an actor that others: (1) can be relied on to fulfil promises, (2) will behave in a consistent and predictable manner, and (3) will act and negotiate fairly when the possibility for opportunism is present. Collaboration is fostered in two ways when high levels of trust exist. Firstly, trust reduces the cost, effort, and conflict of collaboration (Nahapiet and Ghoshal 1998; Dhamanaraj and Parkhe 2006; Kwon and Feiock 2010). Secondly, trust increases the expectation of positive reciprocity (Adger 2003; Adger, Arnell, and Tompkins 2005; Dhamanaraj and Parkhe 2006). Finally, trust facilitates the transfer of sticky knowledge, leading to greater innovation outcomes (Levin and Cross 2004).

Voice. In accordance with Carson, Tesluk, and Marrone (2007), we define voice as the degree to which network participants have an input into how decisions are made. Much research on collaborative governance processes suggests that voice affects the involvement of municipalities in collaborative processes (Adger 2003; Mandell and Steelman 2003; Reed, 2008; Emerson, Nabatchi, and Balogh 2012; Crosby, Hart, and Torfing 2017). Municipalities may use their voices to promote the alignment of network support to their innovation goals, leading to higher innovation outcomes (Mohr and Spekman 1994).

METHOD

Survey administration

Our research object consisted of the provincial and regional sustainability-led networks of municipalities in Spain. To identify these networks we relied on the Spanish 'network of networks,' which was created in 2005 to bring together all the networks existing in Spain. It was composed of 18 networks and 2,706 municipalities. Each municipality had one representative manager in its network and these managers

constituted our sample frame. They were selected as information sources because they were the most knowledgeable people in the municipality regarding sustainability-related issues. Our questions referred only to activities developed under the sustainability framework.

Data were collected through a self-report survey, using computer-aided telephone interviewing (CATI). Confidentiality was guaranteed. Ultimately, 656 municipal representatives participated in the study; 273 respondents were high-level civil servants and 383 were politicians (response rate = 24.24%). We did not force a higher number of responses as 656 responses reflect the target population with a confidence level higher than 99% and a margin of error below 5%, figures which are usually considered acceptable for scientific research.

In terms of size, our sample includes municipalities of all segment sizes that are relevant for the purposes of this research (different powers are assigned to each of the four size-segments included in table 1). Overall, the smallest municipalities are underrepresented. This is usual in studies of Spanish municipalities, as 84% of municipalities in Spain belong to the lower segment size (i.e. less than 5,000 inhabitants) (e.g. Zafra-Gómez, Lopez-Hernandez, and Hernández-Bastida 2009 and Bel, Fageda, and Mur 2012 only consider municipalities with more than 1,000 inhabitants). Also, 4,173 municipalities with less than 5,000 inhabitants (out of 6,825) are in a region that has no sustainability networks (Castilla-La Mancha).

(INSERT TABLE 1)

In terms of geography, the NUTS1 regions of Madrid and Canarias had no established sustainability-led networks and the network in the North West was only created recently. They were not considered in this research. Our sample includes municipalities from the remaining NUTS1 regions. The East, which includes Catalonia,

is the most represented, as this region has a longer tradition of local sustainability and has very active and dense networks (375 municipalities). The North East region is represented by 150 municipalities, the South by 79 and the Centre by 51.

Control for potential biases

We assessed potential non-response bias by looking for differences between early and late respondents (Kanuk and Berenson 1975); they did not differ significantly in their responses to the study variables, suggesting that concern regarding non-response bias is minimal. The average experience of local authorities with sustainability processes was 5.03 years. The expertise of local authorities that were interviewed, the representativeness of the sample and the guarantee of confidentiality contributed to the validity of this research as a whole (Hair et al. 2010).

We implemented two procedures to account for the potential effect of common method variance (CMV) in our results. Firstly, we used the marker-variable technique proposed by Lindell and Whitney (2001) and extended by Malhotra, Kim and Patil (2006). We incorporated a special item (i.e. we prefer to wait and observe before making decisions) into our study that was theoretically unrelated to at least one variable in the study. We then computed a CMV-adjusted correlation between our variables by partialling out the second-lowest correlation of the marker-item from the uncorrected correlation and re-estimated the model. As the second-lowest correlation of the marker-item was low (.009), the CMV-adjusted structural relationships were close to the original estimates. Secondly, we obtained responses from two local representatives in 236 municipalities. The second informant was only questioned about innovation performance (i.e. exploitation, exploration and value). The complete model was tested for both samples (n = 236 and n = 656) and the results proved to be similar. Therefore, both tests indicated that CMV was not a concern.

Measurements

The model was verified based on the perceptions of local authorities. Likert-type scales with scores between 0 (completely disagree) and 10 (completely agree) were used. Questions referred to perceptions, activities and innovation outcomes within the sustainability-led provincial or regional networks. Table 2 summarises the measurements used and their sources for all of the study constructs. The measurements for the study constructs respond to the concepts provided in the previous sections of this paper and were adapted from existing scales. As most of the measurements were generated for use in a private sector context, we had to adapt them to a public sector environment. A pre-test of the questionnaire was performed using 7 municipal managers to assess its logical consistencies, ease of understanding, uniqueness, sequence of items, and contextual relevance (Hair et al. 2010). The comments gathered from these experts led to several minor modifications in the wording and the elimination of some items that were perceived as being redundant or confusing. Furthermore, an online pilot study was conducted involving another 20 managers. We requested suggestions on the item content and structure.

(INSERT TABLE 2)

The metrics used to assess inward, outward and upward collaboration were adapted from Ordanini and Parasuraman (2011). Exploitative and explorative innovation was measured using three-item metrics adapted from Jansen, Van Den Bosch, and Volberda (2006). Our questions referred to step-changes towards sustainability (sample item for explorative innovation: we are well-known for experimenting with new services and operations; sample item for exploitative innovation: we frequently refine the provision of existing services). We deleted some items that were difficult to transfer to a public sector context without modifying their

meaning (e.g. our unit regularly uses new distribution channels). Measures for municipal eco-leadership, trust, voice and shared resources were adapted to our context from Howell, Shea, and Higgins (2005), Chiu, Hsu, and Wang (2006), Carson, Tesluk, and Marrone (2007), and Frels, Shervani, and Srivastava (2003), respectively.

FINDINGS

Measurement Model

The measurement model showed a reasonable fit to the data, with Chi-square = 362.53 (d.f. = 239), comparative fit index (CFI) = .988, Tucker-Lewis index (TLI) = .985, and root mean square error of approximation (RMSEA) = .028. Table 2 presents the results of the convergent validity and reliability analyses for the extended model. Wording on scales, composite reliability and average variance extracted (AVE) are shown. All items loaded significantly on their respective dimensions, ranging from .696 to .958. The AVE values obtained were between .687 and .918 (all above .50), indicating convergent validity between items for each latent construct (Gerbing and Anderson 1988; Hair et al. 2010). All variables showed good internal consistency, with construct reliabilities ranging from .842 to .971. Discriminant validity was tested using the most demanding form of verification. This form required the squared correlation between two factors to be lower than the AVE for each variable (Hair et al. 2010).

Table 3 shows the results for the assessment of discriminant validity. All comparisons between construct pairs met the requirements of the criteria. Correlation between exploitation and exploration proved to be positive and significant (.323), which means that municipalities are able to combine exploitation and exploration, at least at a certain level.

(INSERT TABLE 3)

Structural Model

Table 4 shows the results of the structural model, together with the fit indices. Most of the proposed hypotheses were supported. As expected, upward collaboration affected exploitative innovation (β = .208). The effect of inward collaboration on explorative innovation was confirmed (β = .549). However, inward collaboration seems not to be productive for exploitation. This result could be explained by the costs of inward collaboration and the relative ease of implementing previously tested improvements that have achieved certain consensus within the public-sector sphere. Outward collaboration had a significant direct effect on explorative innovation (β = .248).

(INSERT TABLE 4)

The contribution of the variables considered in the extended model (i.e. trust, voice, shared resources, and eco-leadership) was mostly as expected. The three network properties (i.e. trust, voice and shared resources) were shown to have significant direct and indirect effects on exploitative innovation (being the total effects β = .189, β = .296, and β =.324, respectively). In terms of explorative innovation, the results were disparate. While trust was shown to have significant direct and indirect effects on explorative innovation (β = .256), the contribution of voice was fully mediated by inward collaboration (β =.101). The most surprising result was the non-significant total effect of shared resources on explorative innovation, which could indicate that, in practice, explorative innovation is approached by each municipality primarily in isolation. Only a weak indirect significant effect of shared resources on explorative innovation, mediated by outward collaboration, was found (β = .054), which could be interpreted in the sense that shared resources (e.g. best practices) could help to find the appropriate partners for specific explorative innovation projects. Finally, eco-leadership

was shown to have significant direct and indirect effects on exploitative innovation (β = .142). Its contribution to explorative innovation was found to be fully mediated by inward (β = .142) and outward (β = .037) collaboration.

As Table 4 shows, the estimated model appears to satisfactorily explain the data variance. A substantial proportion of variance in exploitative and explorative innovation was explained (58.7%, and 55.8%, respectively). Fit indices were around the recommended limits (Chi-square = 394.28, d.f. = 244, CFI = .986, TLI = .982, RMSEA = .031) (Hair et al. 2010).

Controls and post hoc analyses

We included a control for the possible effect of the type of respondent (i.e. politician v. technician) on exploitative and explorative innovation (Walker and Boyne 2006; Korac, Saliterer, and Walker 2017). We found that being a politician has a positive significant effect on exploitative innovation (β = .312, p = .002). We interpret this result as indicative of the fact that politicians may tend to exaggerate their exploitative innovation outcomes, as exploitative innovation seems to be favoured by network promoters (i.e. HTG).

To further explore the links between the model constructs, we examined all of the possible quadratic and interaction effects of inward, outward and upward collaboration on exploitative and explorative innovation. As suggested (Aiken and West 1991), we considered all possible quadratic and interaction effects jointly. To estimate these effects, we used LMS (latent moderated structural equations; Klein and Moosbrugger 2000). One of the advantages of this method is that it is not based on the creation of two groups (e.g. high and low upward collaboration), so information is not lost.

A negative interaction effect of inward and outward collaboration on explorative innovation was found (i.e. the positive effect of inward collaboration on explorative innovation was shown to be weaker as outward collaboration increased and vice versa). It seems that, when municipalities collaborate with both local stakeholders and other municipalities, some pieces of the new knowledge gained may be redundant or inconsistent, leading to diminishing returns (Laursen and Salter 2006; De Marchi 2012). Results are provided in Table 4 and represented in figures 2 and 3.

(INSERT FIGURE 2 AND FIGURE 3)

DISCUSSION

This research is aimed at advancing our knowledge on collaborative public-sector innovation. We focus on the link between three forms of collaboration and two types of innovation within networks (i.e. the core model). It is recognised that these variables are affected by other municipality- and network-related characteristics (i.e. the extended model).

Our findings show that the various forms of collaboration have different effects on the two types of innovation. Within networks, exploitative innovation is linked to upward collaboration. Our interpretation of this result is that, within networks, municipalities may be able to substitute cost- and time-intensive municipality-to-municipality, dyadic interactions with more efficient access to forums, group work, virtual platforms and other knowledge instruments (e.g. a hotline to ask questions), which are managed by the network promoter. However, the kind of knowledge that may be captured through this kind of collaboration tends to be well-tested, low-risk, easy-to-implement and relatively consensual knowledge. This finding confirms prior research that suggests that collaborative public-sector networks, promoted by HTG, tend to focus on exploitative innovation (e.g. Rashman, Withers, and Hartley 2009).

Our context includes examples of exploitative innovation, in which several forms of upward collaboration occurred. For instance, inspired by the recommendations of network promoters, many municipalities reduced their investments in new roads to develop bike paths and introduce bike sharing services. Others abandoned their old monitoring systems to introduce new sustainability-led ones, which were developed within the networks and sponsored by the network promoters. Green procuring criteria were also introduced in some municipalities by taking advantage of the expertise developed within the networks and made accessible by the network promoters.

By contrast, it is shown that, for explorative innovation purposes, municipalities need to rely on cost- and time-intensive interactions with their local stakeholders and peers. Our interpretation of these findings is that explorative innovations are unique by nature and respond to specific and idiosyncratic needs, objectives and wishes, which can be learned by intense face-to-face interactions with local stakeholders and/or require high levels of involvement by local stakeholders, which has been previously suggested (e.g., Moulaert et al. 2007; Homsy and Warner 2013). As these innovations involve new ways of thinking and doing and deeply affect the existing practices in the municipality, face-to-face and intense interactions are also needed with selected municipalities that possess the specific knowledge required.

Our context includes examples of explorative innovations, in which several forms of inward and outward collaboration took place. One example of this was the development and implementation of a Solar Thermal Ordinance in Barcelona, making it compulsory to use solar energy to supply 60 percent of running hot water in all new buildings, renovated buildings, or buildings changing their use. Inward collaboration was essential, both as an enabler and as a multiplier of the impact of the Ordinance. A working group was formed, including professional associations for architecture and

engineering, promoters, residential building administrators, consumer associations and solar industry associations. Outward collaboration also occurred. Guided by the experience of Barcelona, over 70 Spanish municipalities implemented similar ordinances. Managers from Barcelona have held intense face-to-face interactions with peers.

While Barcelona is a very big city (1.6 million inhabitants), explorative innovation has also taken place in small- and medium-sized municipalities. In 2015, Santiago de Compostela (95,966 inhabitants) implemented the 'rewarding recycling' initiative. Using a game-based web platform, citizens can win recycling vouchers and exchange them for rewards from the City Council and local retailers. Inward collaboration is crucial. The project is supported by local stakeholders, from hotels to beauty treatment establishments. Knowledge has been transferred to other municipalities and similar initiatives are active in, at least, six different municipalities (outward collaboration).

Riudecanyes (750 inhabitants all year and 1,500 in summer) started a door-to-door collection of waste with an intense process of citizen participation (inward collaboration). The locals collect their waste individually in small containers. People get immediate feedback if their waste was not collected properly. In addition to this, many municipalities of all sizes have broken the municipal boundaries for the first time to find new ways of collaborating with their local stakeholders to face the sustainability challenges (e.g. joint waste management between municipalities and local companies).

Beyond collaborative forms (i.e. privative relational resources), it has been proven that some common relational resources may prompt both types of innovation. In particular, two network properties (i.e. trust and voice) have been shown to have strong effects on both exploitative and explorative innovation. These findings are consistent

with those of private (e.g. Dhamanaraj and Parkhe 2006) and public networking literature (e.g. Ansell and Gash 2008; O'Leary and Bingham 2009), which stress the role of network promoters as drivers of trust and voice. Shared resources have a strong effect on exploitative innovation but contribute only weakly to explorative innovation, which seems to confirm the risk aversion of network promoters. Finally, an internal resource of municipalities (i.e. municipal eco-leadership) is crucial to explaining the involvement of municipalities in inward and outward collaboration for exploitative innovation, and particularly, explorative innovation.

Overall, these findings provide interesting insights to improve our knowledge on the way in which network promoters and municipalities approach innovation within networks and on the role of networks in fostering sustainability.

It has been shown that network promoters tend to be risk-adverse and foster exploitative innovation, which is in line with March's (1991) view. Risk-aversion could be particularly salient in the public-sector due to the asymmetries between rewards for success and punishments for failure, which discourage risk-taking and learning from failure (Feller and Feller 1981). Therefore, focusing on low-risk improvements could be perceived as an appropriate strategy by network promoters, which could gain legitimacy and attract more municipalities to the network by adopting risk adverse behaviour.

However, when we observe the behaviour of municipalities, we can appreciate that some of them focus on explorative innovation and others show a certain level of ambidexterity, as indicated by the positive and significant correlation between exploitative and explorative innovation. This finding does not fit March's predictions, but could be explained by the presence of networks. Within networks, exploitative innovation is easier and less resource-intensive for municipalities, which frees up resources that could be used for explorative innovation purposes. Thus, networks could

provide municipalities with the opportunity to combine exploitation and exploration, which matters, as organisations have significant difficulties in combining both innovation forms (March 1991; Levinthal and March 1993). This finding is consistent with recent proposals that indicate that networks could help organisations to combine exploration and exploitation (Lavie, Stettner, and Tushman 2010; Stadler, Rajwani, and Karaba 2014). Nevertheless, not all municipal managers are prone to fostering explorative innovation. As consistently suggested by prior literature (e.g. Pärna and von Tunzelmann 2007; Damanpour and Schneider 2009; Lewis, Ricard, and Klijn 2017) and supported by our data, taking advantage of this opportunity depends on municipal eco-leadership.

Frameworks for the successful management of networks tend to suggest that the innovation broker or promoter should facilitate interaction between the network members to socialise knowledge (e.g. Ansell and Gash 2008; Dhanaraj and Pakhe 2006; Batterink et al. 2010). Despite socialisation involve costs, no nuances or limits have been clearly established for the socialisation effort. Our findings provide a nuanced perspective of socialisation within networks. They suggest that a suitable strategy for exploitative innovation seekers may be to focus on upward interactions, while reducing cost-intensive, one-to-one, face-to-face, outward interactions. However, more socialisation is needed for explorative innovation seekers. They cannot exclusively rely on upward collaboration; inward and outward collaboration (in this order) are also needed.

Our findings have improved our knowledge on the role of public-sector innovation networks in practice. Networks essentially seem to provide an efficient path for exploitative innovation and may indirectly foster explorative innovation in two ways. Firstly, networks may help create an appropriate voice and trust context that

facilitates explorative innovation. Secondly, within networks, exploitative innovation is easier and less resource-intensive for municipalities, which could free up resources that could be used for explorative innovation purposes.

FURTHER RESEARCH

Our findings are tempered by a number of limitations. Firstly, this research focused on local managers' perceptions for verifying our hypotheses. Perceptions are relatively robust as they require little or no interpretation or translation of the measurements produced (Hair et al. 2010, Thamhain 2003). However, one limitation of this approach is that managers' perceptions of exploitative and explorative innovation may be biased and not be in line with real innovation outcomes. Unfortunately, there are no robust objective indicators of innovation outcomes available in Spain. The secondary sources available only provide partial measures that do not fit our purposes.

Secondly, a simple division between upward, outward and inward collaboration may be problematic, as there are a number of inter-relationships and dependencies (e.g. a municipality assists a forum organised by the network promoter and has further meetings with selected municipalities). However, we believe that the perceptions of managers, although imperfect, may improve our understanding about the link between network properties, forms of collaboration and innovation types. Thirdly, the cross-sectional nature of this research does not allow us to test for causality. Further research could adopt a longitudinal approach to examine causal relationships.

Fourthly, while cross-sectional research is appropriate for proving specific assumptions, qualitative methods may offer in-depth understanding of collaborative public-sector innovation in complex networks with many actors and reciprocal effects (e.g. actor behaviour affects and is affected by the network). Finally, this study only

uses one data source (i.e. municipal managers). The views of HTG and local stakeholders were not considered.

Despite these limitations, we believe that this study reveals the critical relationship between forms of collaboration and types of innovation within a network context and improves our understanding of the role of governance networks in public-sector innovation.

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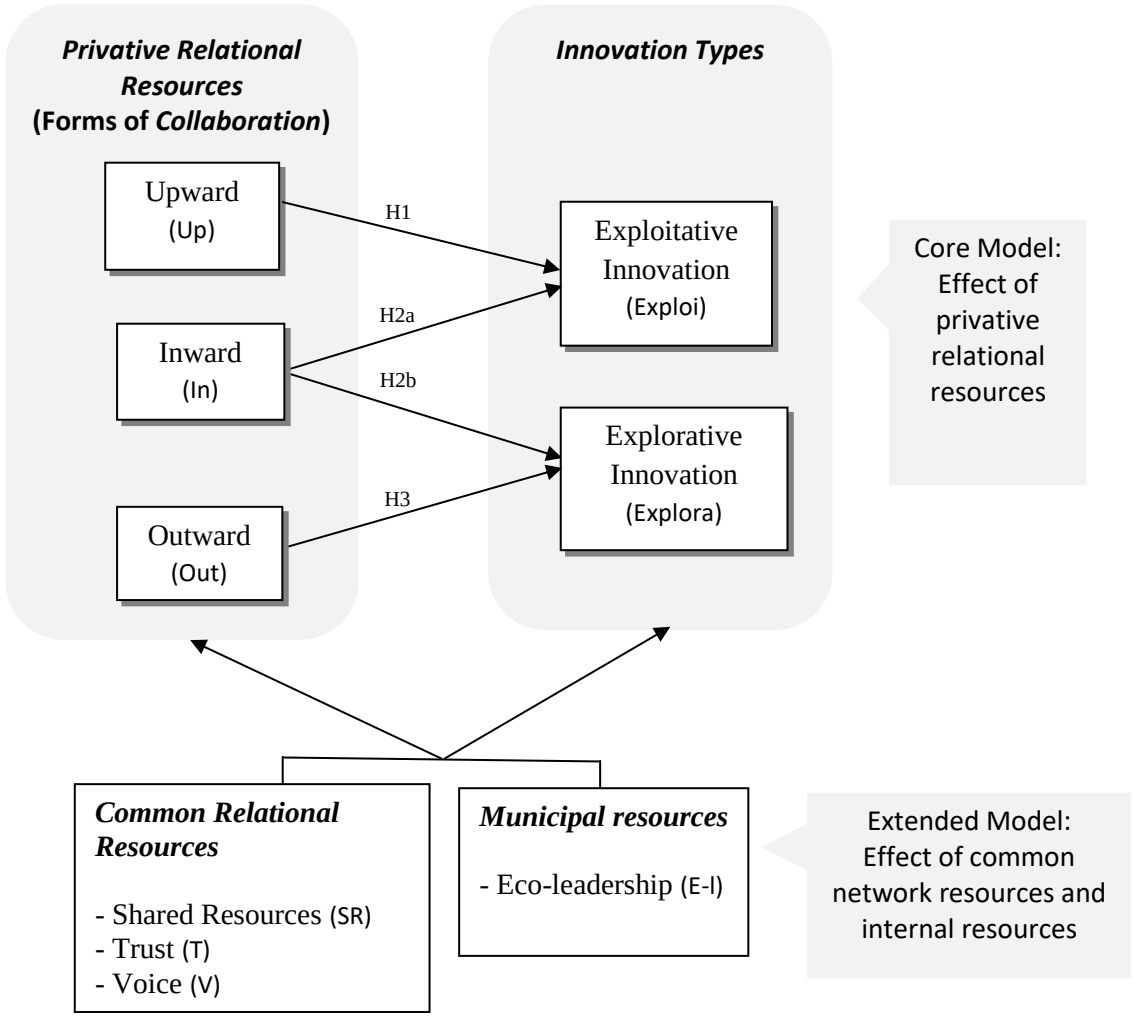
Figure 1. Model and hypotheses: Sources of exploitative and explorative innovation within networks



Note. The model specification is as follows: (1) $\mathbf{Exploi}_i = \alpha_1 + \beta_{11}(Up_i) + \beta_{12}(In_i) + \beta_{13}(Out_i) + \beta_{14}(SR_i) + \beta_{15}(T_i) + \beta_{16}(V_i) + \beta_{17}(E\text{-}I_i) + \varepsilon_{1i}$; (2) $\mathbf{Explora}_i = \alpha_2 + \beta_{21}(Up_i) + \beta_{22}(In_i) + \beta_{23}(Out_i) + \beta_{24}(SR_i) + \beta_{25}(T_i) + \beta_{26}(V_i) + \beta_{27}(E\text{-}I_i) + \varepsilon_{2i}$; (3) $\mathbf{Up}_i = \alpha_3 + \beta_{31}(SR_i) + \beta_{32}(T_i) + \beta_{33}(V_i) + \beta_{34}(E\text{-}I_i) + \varepsilon_{3i}$; (4) $\mathbf{In}_i = \alpha_4 + \beta_{41}(SR_i) + \beta_{42}(T_i) + \beta_{43}(V_i) + \beta_{44}(E\text{-}I_i) + \varepsilon_{4i}$; (5) $\mathbf{Out}_i = \alpha_5 + \beta_{51}(SR_i) + \beta_{52}(T_i) + \beta_{53}(V_i) + \beta_{54}(E\text{-}I_i) + \varepsilon_{5i}$

Table 1. Size of municipalities in the sample *vs.* Spain

Number of Inhabitants	≤ 5,000	5,001-20,000	20,001-50,000	> 50,000	Total
Spain	6,825	897	257	145	8,124
%	84%	11%	3%	2%	100%
Sample	402	167	59	28	656
%	61%	25%	9%	4%	100%

Table 2. Convergent Validity and Reliability Assessment (Spanish municipalities; N=656)

Construct and item (source)	Stand. Loading	CR	AVE
Indicate your degree of agreement about how well these statements describe your sustainability-related innovation activities during the last three years.			
UPWARD COLLABORATION (Ordanini and Parasuraman, 2011)		**.904**	**.759**
The frequency of interaction with HTG is high	.783***		
The intensity of interaction with HTG is high	.937***		
We have a fluid relationship with HTG representatives	.888***		
INWARD COLLABORATION (Ordanini and Parasuraman, 2011)		**.842**	**.727**
The frequency of meetings with local stakeholders is high	.798***		
The variety of local stakeholders with whom we interact is high	.905***		
We have a fluid relationship with local stakeholders		*Deleted*	
OUTWARD COLLABORATION (Ordanini and Parasuraman, 2011)		**.956**	**.846**
The frequency of meetings with other municipality representatives is high	.867***		
The number of municipalities with whom we interact is high	.916***		
The intensity of our interaction with other municipalities is high	.965***		
We have a fluid relationship with other municipality representatives	.929***		
Indicate your degree of agreement about how well these statements describe your sustainability-related innovation outcomes during the last three years.			
EXPLOITATIVE INNOVATION (Jansen, Van Den Bosch, and Volberda 2006)		**.867**	**.687**
We regularly implement small adaptations to our existing services	.893***		
We frequently refine the provision of existing services	.884***		
We are well-known for regularly improving the provision's efficiency of our existing services	.696***		
EXPLORATIVE INNOVATION (Jansen, Van Den Bosch, and Volberda 2006)		**.971**	**.918**
We are well-known for experimenting with new services and operations	.953***		
We lead the way in introducing innovations that require brand new competences	.985***		
We constantly consider introducing innovations that go beyond what is usual in a municipality	.937***		
Indicate your degree of agreement about how well these statements describe your municipality during the last three years.			
MUNICIPAL ECO-LEADERSHIP (Howell, Shea, and Higgins 2005)		**.914**	**.842**
Relevant people in this municipality have expressed strong conviction about sustainability	.941***		
People with influence in this municipality have enthusiastically promoted sustainability	.894***		
Indicate your degree of agreement about how well these statements describe (network name) during the last three years.			
TRUST (Chiu, Hsu, and Wang 2006)		**.940**	**.838**
Members of this network usually meet their promises	.923***		
Behaviour of members is consistent	.958***		
Precaution is not necessary when addressing others	.864***		
VOICE (Carson, Tesluk, and Marrone 2007)		**.918**	**.849**
Participation in decision-making is encouraged	.915***		
Everyone has a chance to participate in decision making	.928***		
This municipality is highly influential in decision-making		*Deleted*	
SHARED RESOURCES (Frels, Shervani, and Srivastava 2003)		**.926**	**.806**
Many resources are accessible within this network	.855***		
Network resources are easily accessible	.926***		
Network resources are of high quality	.912***		
Model fit indexes (Robust): χ^2= 362,53; d.f.= 239; CFI = .988; TLI = .985; RMSEA = .028; SRMR = .028			

Note: *** p < .01, ** p < .05, * p < .10; CR, composite reliability; AVE, average variance extracted. HTG = Higher Tiers of Government (e.g. Regional Government)

Table 3. Descriptive Statistics and Correlation Matrix for Discriminant Validity Assessment (Spanish municipalities; N=656)

Dimensions	Mean	S.D.	1	2	3	4	5	6	7	8	9
1. Eco-leadership	6.34	2.28	.842	.138	.239	.106	.105	.099	.166	.201	.145
2. Trust	6.56	1.84	.372	.838	.317	.151	.147	.104	.288	.288	.186
3. Voice	6.01	2.11	.489	.563	.849	.198	.132	.114	.311	.377	.175
4. Shared resources	5.53	2.10	.326	.388	.445	.806	.054	.137	.460	.334	.080
5. Inward collaboration	6.51	1.90	.324	.384	.364	.232	.727	.044	.085	.094	.084
6. Outward collaboration	4.48	2.82	.314	.322	.337	.370	.210	.846	.169	.085	.243
7. Upward collaboration	6.59	1.92	.408	.511	.558	.678	.291	.411	.759	.085	.243
8. Exploitative innovation	6.01	1.85	.448	.537	.614	.578	.307	.292	.630	.687	.143
9. Explorative innovation	6.09	2.83	.381	.431	.418	.283	.289	.493	.378	.323	.918

Notes: Likert-type scales with scores between 0 (completely disagree) and 10 (completely agree) were used. S.D. = Standard Deviation. Correlations between construct pairs are shown below the diagonal. Shared variances between each construct and other constructs (correlations squared) in the model are shown above the diagonal (in percentage). The diagonal includes the average variance extracted (AVE) for each construct with respect to its indicators (in percentage). HTG, higher tiers of government

Table 4. Structural Model Estimation. Drivers of exploitative and explorative innovation (Spanish municipalities; N = 656)

Hypothesis and other effects		**MODEL**		
β		Estimate	Est./S.E.	p-Value
	CORE MODEL (DIRECT EFFECTS)			
β_{11}	Upward collaboration→ Exploitative innovation (H1)	.208***	3.101	.002
β_{12}	Inward collaboration→ Exploitative innovation (H2a)	.051	1.257	.209
β_{22}	Inward collaboration→ Explorative innovation (H2b)	.549***	14.305	.000
β_{23}	Outward collaboration→ Explorative innovation (H3)	.248***	7.032	.000
	EXTENDED MODEL (DIRECT EFFECTS)			
	Effects of eco-leadership			
β_{34}	Eco-leadership → Upward collaboration	.098**	2.210	.027
β_{44}	Eco-leadership → Inward collaboration	.262***	5.185	.000
β_{54}	Eco-leadership → Outward collaboration	.157***	3.137	.002
β_{17}	Eco-leadership → Exploitative innovation	.126***	2.810	.005
β_{27}	Eco-leadership → Explorative innovation	.019	0.493	.622
	Effects of trust			
β_{32}	Trust → Upward collaboration	.175***	3.475	.001
β_{42}	Trust → Inward collaboration	.164***	2.715	.007
β_{52}	Trust → Outward collaboration	.175***	3.475	.000
β_{15}	Trust → Exploitative innovation	.162***	3.076	.002
β_{25}	Trust → Explorative innovation	.149***	3.057	.002
	Effects of voice			
β_{33}	Voice → Upward collaboration	.195***	3.752	.000
β_{43}	Voice → Inward collaboration	.180***	2.708	.007
β_{53}	Voice → Outward collaboration	.103**	1.602	.010
β_{16}	Voice → Exploitative innovation	.242***	4.542	.002
β_{26}	Voice → Explorative innovation	.035	0.718	.473
	Effects of shared resources			
β_{31}	Shared resources → Upward collaboration	.492***	11.011	.000
β_{41}	Shared resources → Inward collaboration	-.026	0.049	.594
β_{51}	Shared resources → Outward collaboration	.119*	1.956	.050
β_{14}	Shared resources → Exploitative innovation	.227***	3.487	.000
β_{24}	Shared resources → Explorative innovation	-.002	-0.667	.947
	TOTAL EFFECT (DIRECT + INDIRECT)			
	Eco-leadership → Exploitative innovation	.143***	3.189	.001
	Eco-leadership → Explorative innovation	.200***	3.870	.000
	Trust → Exploitative innovation	.189***	3.647	.000
	Trust → Explorative innovation	.256***	4.419	.000
	Voice → Exploitative innovation	.296***	5.718	.000
	Voice → Explorative innovation	.174***	2.839	.005
	Shared resources → Exploitative innovation	.324***	5.796	.000
	Shared resources → Explorative innovation	.043	.993	.321
Post Hoc: Quadratic (Q) and Interaction (Int) effects		Estimate	Est. / S.E.	p-Value
Int	Inward*Outward → Explorative innovation (The remainder quadratic and interaction effects were probed to be not significant)	-.205***	-3.986	.000
R-square				
	Inward collaboration	.224		
	Outward collaboration	.210		
	Upward collaboration	.573		
	Exploitative innovation	.587		
	Explorative innovation	.558		
Hypothesis confirmation (rejection)		Hypotheses H1, H2b and H3 confirmed. H2a rejected.		
FIT INDEXES		χ^2= 394.28; d.f.= 244 CFI = .986; TLI = .982 RMSEA = .031; SRMR = .045		

Note: *** p < .01, ** p < .05, * p < .10

Figure 2. Explorative innovation as a function of outward collaboration at different levels of inward collaboration, from low (-1SD; standard deviation) to high (+1SD) inward collaboration. (Each series is built by increasing the inward collaboration in +0.1SD)

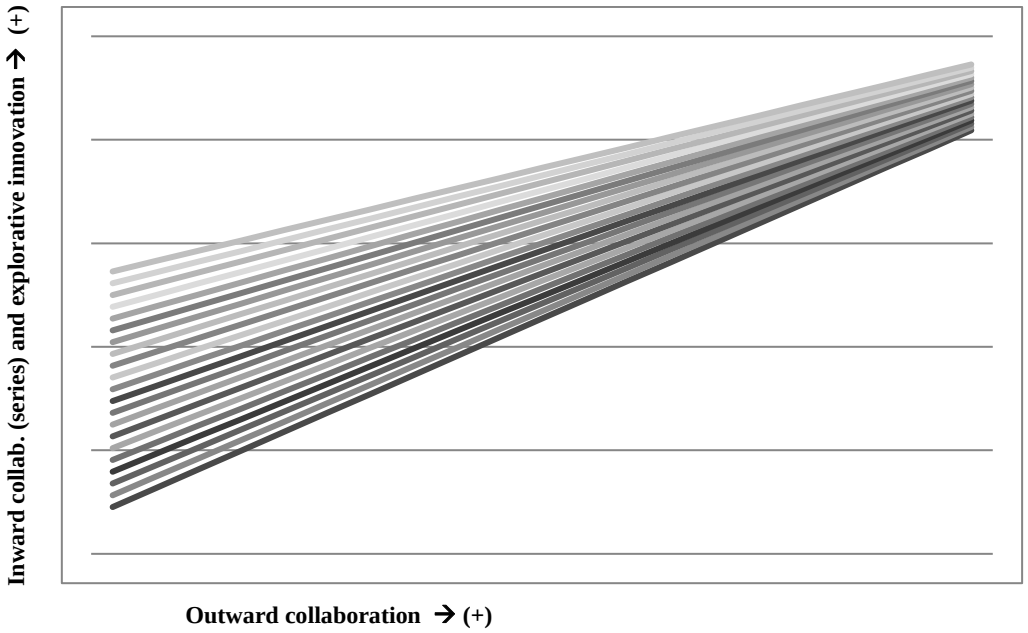


Figure 3. Explorative innovation as a function of inward collaboration at different levels of outward collaboration, from low (-1SD; standard deviation) to high (+1SD) outward collaboration. (Each series is built by increasing outward collaboration in +0.1SD)