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Does strategy formalization foster innovation? Evidence from a French sample of small to medium-sized enterprises

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Abstract. Despite abundant research, the relationship between strategy formalization and innovation remains unclear. Some acknowledge a positive impact of strategy formalization on innovation while others consider it an impediment to novelty and creation. Going beyond the conflicting views over the influence of formalization, we combine open innovation and socio-material perspectives. This study aims to contribute to the debate by considering the possibility that formalization is a means of benefiting from openness with respect to innovation. Therefore, we predict that formalization might positively moderate the impact of openness on innovation. Relying on a unique sample of 555 SMEs, we investigate the effects of strategy formalization and openness—according to their various facets and interactions—on new product innovation. We find a positive influence of formalization (whether it is approached as a process or as a strategic tool) on product innovation. Our findings also support the idea that formalization increases the effectiveness of openness on innovation performance. Implications are discussed, and future research directions are outlined at the end.

Keywords: innovation, open innovation, SMEs, strategy formalization

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INTRODUCTION

To what extent is innovation compatible with strategy formalization in small firms? Researchers have led an indecisive debate over the merits and drawbacks of formalization pertaining to innovation strategy. On the one hand, formalization seems to hamper creativity and improvisation capabilities that are crucial to innovation (e.g., Chua, Roth & Lemoine, 2015; Miner, Bassoff & Moorman, 2001). On the other hand, strategy formalization may be central to innovation as it involves a general clarification of the firm's objectives, a better analysis of competitors, and a general contribution to organizational learning (e.g., Sirén & Kohtamäki, 2016; Vlaar, Van Den Bosch & Volberda, 2006). Recent studies have increasingly demonstrated that, despite criticism, strategy formalization in the form of strategic planning (or business plans) could have a generally positive impact on firm performance, including in small firms (Burke, Fraser & Greene, 2010; Delmar & Shane, 2003). However, innovation is still propitious to confront the advantages and disadvantages of strategy formalization (Song, Im, Van Der Bij & Song, 2011). Furthermore, SMEs' frailty maintains doubt over the possible implementation and impact of strategy formalization, even though some recent studies have contended

the possibility for such firms to take advantage of formalization as well (Dibrell, Craig & Neubaum, 2014; Song & Chen, 2014).

The purpose of this study is to enrich our understanding of strategy formalization in the innovation process. Our central assumption is that the debate over the advantages of formalization may have been misleading in that we do not know the conditions under which strategy formalization may be beneficial to innovation. In this research, we draw primarily on open innovation literature and argue that formalization is a means of benefiting from openness. Innovation scholars have demonstrated the importance for firms of capturing knowledge and resources beyond their organizational boundaries to nurture their own innovation process (Chesbrough, 2003; Cousins, Lawson, Petersen & Handfield, 2011). This openness implies that external stakeholders are progressively involved in a network of relationships that the firm has to manage (Salter, Criscuolo & Ter Wal, 2014). In this regard, SMEs are concerned that increased openness will sometimes stretch already limited resources (Bianchi, Campodall'Orto, Frattini & Vercesi, 2010). Moreover, a fundamental consequence of openness is that the influences, exchanges, and decisions involved become increasingly complex for the firm, and firms must deal with this complexity while negotiating with stakeholders who become increasingly involved in the strategy process (Oberoi, Haon & Freitas, 2014).

In order to justify how formalization may help to leverage open innovation strategy, we combined open innovation with a "socio-material" perspective as a secondary theoretical background. This perspective allows us to consider formalization as a technology: Organizational space includes both material and symbolic artifacts that are constitutive of collective action (Clegg & Kornberger, 2006). Plans, matrices, procedures, and reports are not socially inert but are occasions for actors to interact, confront diverging views, and foster collective thinking. In this view, formalization presents an opportunity to leverage the many implications of actors that open innovation entails. It offers a technology to foster collective thinking about strategy and to simultaneously favor gathering. Because formalization is an opportunity to organize information flows, discuss with partners, and legitimate the choices of organization (Fernhaber & Patel, 2012; Sivadas & Dwyer, 2000), we contend that strategy formalization might be of particular importance in the presence of open innovation strategies.

Therefore, this paper explores the leveraging influence of formalization on open innovation strategies. More precisely, we investigate the possible positive interaction between openness and formalization on innovation performance. Using a unique data set of SMEs that were questioned on their strategy process, we explore the influence of formalization in two facets, namely process (referring to the efforts of clarification and articulation of strategy) and tools (which include common matrices, scenarios, methods, or competitive analysis). Our empirical findings support the general contention of a moderating effect of formalization. Consistent with the socio-material approach, the findings mean that even SMEs can take advantage of formalization in open innovation processes. Therefore, our study supports an increased legitimacy of conventional strategic tools to foster innovation.

The remainder of the paper is divided into four parts. The first part is dedicated to theoretical development, in which we develop the rationale for blending open innovation and socio-material perspectives when studying formalization. The second part presents the data set and the descriptive statistics of the variables used. In the third part, we detail the exploration,

modeling strategy, and analysis of potential interactions between the variables of interests, before we draw conclusions from model testing. In the fourth part, we discuss the implications of our work in light of previous studies.

THEORETICAL BACKGROUND

INNOVATION IN SMES

Central to innovation is the search by firms for knowledge, particularly in the context of SMEs (Hervas-Oliver, Sempere-Ripoll & Borona-Moll, 2014). Innovation may be conceived as the outcome of a creation, absorption, and recombination of technological ideas (Katila & Ahuja, 2002). Accordingly, the literature has developed the argument that firms should rely on external knowledge to innovate. In this vein, open innovation is a seductive term, coined by Chesbrough (2003), that enjoys some convergence in recent innovation studies. It refers to "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, Vanhaverbeke & West, 2006: 1). The concept reflects the general idea that innovation is distributed both inside and outside the firms in terms of available ideas, embodied knowledge, and know-how. Indeed, innovation had been viewed initially as an internal process, involving a focus on resource allocation within the boundaries of the firm. However, many studies have emphasized the role of external sources of knowledge to nurture the innovation process (e.g., Beers & Zand, 2014). In fact, firms may make their innovation open by undertaking a large set of activities with external actors. Therefore, the focus on openness reflects a wider trend to consider the importance of relationships between the firm and its environment (Laursen & Salter, 2006). The innovation project follows a funnel that is permeable in that some actors may leave whereas others may join. As such, the innovation process implies a web of complex relationships between stakeholders (Dittrich & Duysters, 2007). To date, studies focusing on innovation openness have been empirically successful, passing the test of replication (e.g., Garriga, Von Krogh & Spaeth, 2013). Firms adopting open innovation strategies have more chance of developing an innovation as well as attaining higher turnover as a result of that innovation.

Exactly what constitutes an open innovation practice varies, according to the relevant authors. However, inter-organizational cooperation and involvement of external stakeholders are frequent indicators (e.g., Laursen & Salter, 2014; Oberoi, et al., 2014). Both denote active behaviors to redirect external resources toward the firm's innovation process. Nonetheless, authors stress the differences between small and big firms. For small firms, open innovation strategies are motivated by different rationales than for large firms (Wynarczyk, Piperopoulos & McAdam, 2013). Small firms seldom look for scale economies but rather seek to deal with resource scarcity and uncertainty. The inflow of knowledge is prevalent when SMEs' stakeholders become involved. In this logic, strategic alliances and relationships with external actors are crucial for SMEs. This echoes the general importance of contractual relationships, ties with stakeholders, alliances, and joint ventures (Han, et al., 2012). Furthermore, open innovation strategies exhibit specific challenges for SMEs. Indeed, they require that firms allocate attention that is intrinsically bounded (e.g., Dahlander, O'Mahony & Gann, 2016). Profiting from openness, therefore, entails organizational requisites and constraints that

only some firms can meet. Consistent with this argument, empirical findings tend to demonstrate that small firms are constrained in open innovation strategies, while openness is as important for them as it is for large firms (Spithoven, Vanhaverbeke & Roijakkers, 2013). Van De Vrande, De Jong, Vanhaverbeke, and De Rochemont (2009) show that SMEs have increased their activity in open innovation with inbound open innovation being far more diffused than outbound open innovation.

STRATEGY FORMALIZATION AS TECHNOLOGY

Practitioners and scholars have suggested a variety of tools and methods that the firms had to implement to increase the likelihood of innovation success. However, the role of these tools and procedures remains in question. This relates to the general influence of formalization on organizational performance, which has given rise to a long-lasting debate. At a general level, formalization refers to the use of explicit rules, procedures, and behaviors (Sivadas & Dwyer, 2000; Vlaar, et al., 2006). For decades, researchers have sought to determine whether it improved or impeded organizational performance, including innovation.

A classic, central assumption is that formalization is likely to exhibit benefits as well as drawbacks (Prajogo & McDermott, 2014; Song, et al., 2011). On the one hand, strategy formalization helps to deal with ambiguity in promoting consensus and legitimacy of strategic orientations (Abdallah & Langley, 2014; Grant, 2003). It also helps to make projects explicit and fosters deliberations within the firm (Sivadas & Dwyer, 2000). It thereby clarifies organizational processes (Song, et al., 2011) and acts as an integrative device (Ketokivi & Castañer, 2004). Consistent with this argument, some researchers have found that business plans increased the performance and survival of new ventures (Burke, et al., 2010; Delmar & Shane, 2003). Dibrell, et al. (2014) even found a direct and positive effect of formal strategic planning on firm innovativeness.

On the other hand, following Mintzberg (1994), researchers have underscored the potential negative effects of formalization on innovation. Because innovation induces novelty, it might conflict with a strict compliance to organizational rules and procedures (Avadikyan, Llerena, Matt, Rozan & Wolff, 2001). As such, innovation might impede innovation because it forces teams working on new products to develop convergent thinking (Im, Montoya & Workman, 2013). Consistent with this argument, Song, et al. (2011) find that the number of new product development projects decreases as strategic planning increases, thus claiming a negative relationship between strategy formalization and innovation. Furthermore, strategic planning is believed to develop an illusion of control among top management teams, which is detrimental to risk assessment (Titus, Covin & Slevin, 2011).

To deal with these conflicting views, some scholars proposed to develop new approaches under the umbrella term “socio-materiality.” A central tenet of socio-material approaches is to consider that organizational space includes material and symbolic artifacts that are constitutive of collective action (Clegg & Kornberger, 2006). In this regard, the socio-material perspective aims at providing a better understanding of technologies in organizations (Orlikowski & Scott, 2008). Early studies considered technology in a narrow sense. Progressively, researchers widened the scope to encompass technology as any means “designed by organizations to steer individuals and objects toward assigned goals” (Moisdon, 2006).

Through socio-material lenses, management tools and techniques are seen as technology to promote organizational performance. They include technological substrate in the form of blueprints, strategic matrices, or written procedures. However, their use is continuously reconfigured by actors. Based on that rationale, socio-material scholars insist on the fact that artifacts are not separable from action and discourse to understand practices (Cecez-Kecmanovic, Galliers, Henfridsson, Newell & Vidgen, 2014). Material artifacts and their use are so intertwined that a debate has arisen to determine whether the two are conceptually distinct (Balogun, Jacobs, Jarzabkowski, Mantere & Vaara, 2014). In any case, socio-material approaches advocate that the social and the material are entangled to constitute an assemblage (Orlikowski & Scott, 2008).

One important contribution from the socio-material literature is that it explains how novelty is possible with technology. In the long term, technology and organizational routines transform each other. Sele and Grand (2016) emphasize that procedures generate opportunities by connecting organization members who may try to use and alter them. From this point of view, routines can trigger innovation outcomes and are generative in nature. Technology influences practices, through technical substrate (in the form of material artifacts) and through managerial philosophy. Technical substrate, organizational models, and managerial philosophy are not necessarily distinct but constitute a theoretical "whole" (Labatut, Aggeri & Girard, 2012).

Building on this perspective, we draw two major conclusions. First, we consider strategy formalization as technology, which may be conceived as an entangled assemblage of technological substrate and managerial practice. It thus embodies "strategic tools" in the form of matrices, checklists (Wright, Paroutis & Blettner, 2013), documents, blueprints, and reports. At the same time, it comprises endeavors to submit strategic choices to rules, procedures, and standards to make them explicit and controllable. As such, it includes not only "strategic planning" (Dibrell, et al., 2014) but also "business planning" (Burke, et al., 2010) or "deliberate" strategy (Titus, et al., 2011). Therefore, it is possible to conceive strategy formalization both as a process and a set of artifacts.

Second, we build on the strong assumption that the use of technology may be generative in nature. Strategy formalization does not contradict innovation because it creates opportunities, in the long run, for a cross-transformation of technology and routines. Therefore, the focus shifts to a better depiction of the conditions under which formalization may be beneficial to the firm.

OPENNESS AND FORMALIZATION

Considering formalization as a technology in practice allows looking beyond the apparent tension between formalization and innovation. In particular, it sheds light on the potential reinforcement of open innovation strategies. To this end, we emphasize two "roles" or "functions" that formalization may fulfill with respect to open innovation strategies.

Integrative function. Firms relying on external sources of knowledge need internal capabilities to assimilate and organize incoming flows. To this end, they must align their internal processes to the external environment (Laursen & Salter, 2014). For many SMEs, this proves to be a substantial challenge due to scarcity of resources (Brunswicker & Vanhaverbeke, 2015). SMEs also face cumulative learning difficulties that involve entry barriers in new markets (D'Este, Iammarino, Savona & Von

Tunzelmann, 2012) and, arguably, this combines with the lack of management procedures. Thus, these firms need tools to leverage open innovation. In this situation, formalization may act as a device to bring together disparate strategic visions. Formalization thus "affords" (Jarzabkowski & Pinch, 2013) disciplined collective thinking. Matrices, strategic tools, or business plans do not solely invite one to fill in blank cells in tables; they also indirectly promote debate and discourse about strategy. They provide opportunities for meetings and interaction whereby actors adjudicate different interests (Kaplan, 2011). Put differently, artifacts may be considered as a "boundary object" providing a locus for negotiation (Yakura, 2002). Through this process, an organizational discourse is elaborated inseparably from the technology in use. Undoubtedly, technology also has constraints besides affordances (Faraj & Azad, 2012). However, both affordances and constraints of technology are a relational attribute: Different people will perceive different uses and limitations of formalization. For that reason, firms might develop their own approach to formalization and be creative in an original fashion.

Analytical function. One of the main limitations of open innovation strategy lies in attention shortcomings (Dahlander & Gann, 2010). Open innovation involves a higher number of partners and projects for the firm to organize (Dittrich & Duysters, 2007). Because individuals can only focus on a few tasks at any given moment, greater openness in the form of numerous sources of knowledge becomes harder to assimilate. Moreover, external stakeholders in open innovation come to gain partial influence over organizations' strategy though their involvement (Oberoi, et al., 2014; Salter, et al., 2014). From this viewpoint, formalization represents an opportunity to deal with attention and cognitive limitations in open innovation settings. Documents, charts, meetings, and exchanges over strategy definition represent opportunities to clarify stakeholder expectations and make sense of their participation in the innovation process. Formalization thereby facilitates heterogeneous discourses and viewpoints together, but also fosters reflection that, in turn, results in artifacts and discourse. It may help to relax cognitive bias shortfalls and contribute to sense-making among managers (Vlaar, et al., 2006). As such, the attention of managers is drawn to opportunities that would otherwise have gone unnoticed (Barnett, 2008). Therefore, strategy tools and artifacts provide discursive and cognitive resources that shape strategy work (Balogun, et al., 2014) and, in this way, help to implement practices for the construction of meaning among the participants (Kaplan, 2011). Knowledge produced in this way does not necessarily match the same requirements as that in science fields. However, practices with tools tend to promote legitimate knowledge reflecting stakeholders' views.

RESEARCH QUESTION

In a nutshell, the research question we address could be formulated in these terms: "Can we say that formalization improves the impact of open innovation strategies?" From what we have seen above, it follows that formalization could be particularly suitable for firms that undertake open innovation strategies. In other words, a reasonable hypothesis is that strategy formalization improves the success of open innovation strategies. In modeling terms, formalization may act as a positive moderator of the influence of openness on success. In this research, we propose to investigate this assumption through an explorative protocol. We build a

series of models derived from the general hypothesized model. We justify this choice as follows: Both “openness” and “formalization” can be understood in different ways. Therefore, we find it more relevant to make a main hypothesis a guideline and to explore the various dimensions of the constitutive variables of the model.

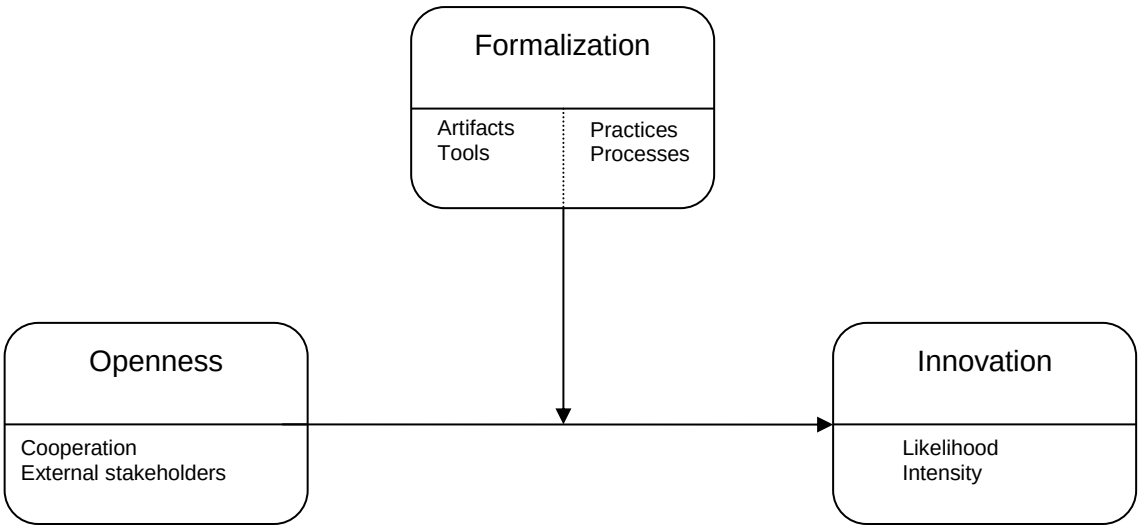

Figure 1—Relationships investigated in the study

Figure 1 (above) depicts this research question, recalling the various facets of the concepts. Formalization is considered both under artifact and organizational practice facets. Openness is noted in its two frequent forms, namely cooperation and external stakeholders’ implication[1]. In the next section, we describe in detail the method used to investigate possible answers.

METHOD

Our research process relied on amassing two databases. The first one is the DIANE database, dedicated to financial information about French firms. As such, it presents official accounting data, especially financial statements, that firms are legally bound to declare every year. The second is the “Plan-PME” database, specifically created to conduct studies on SMEs’ management practices. It was not built for the study, but it contains precise data on how firms undertake their strategy process. Likewise, the database embodies data on innovation that were calibrated on Community Innovation Survey studies to ensure comparability. The data were collected through a questionnaire survey that was completed by SMEs in the Rhône-Alpes region of France in 2012. At the time of writing, we have gathered a sample of 555 observations. The region had publicly asked firms to participate in a study and it would provide them, in turn, with feedback on the results. The aim of the feedback was to serve as a

1. At this stage, the different proxies for innovation have not been presented because they were not central to theoretical development. They are detailed in the methodological part of the paper.

a benchmarking device to help SMEs determine areas in which they might improve. Thus, there were strong incentives to give sincere and non-biased responses. The only caveat was in relation to potential for bias through self-selection; completing the questionnaire was a precondition for accessing support from regional administration, in particular gaining access to the results of the survey. Therefore, there was a risk that respondents differed in their motivation and organizational attributes from those who chose not to respond to the questionnaire. To assess the possibility of a selection bias, we drew 7000 SMEs randomly from the same region and performed mean tests on equity, income, and turnover. None of those tested led us to reject the null hypothesis, with no detectable difference in means between respondents and non- respondents. This suggested that self-selection bias was not an issue in our study.

VARIABLES

Innovation (new product). Our first dependent variable is the existence of a product innovation that can be considered as new to the market. If a new product or service was developed during the three previous years, it takes the value 1; if not, it takes the value 0. New product introduction is, indeed, one of the most acknowledged measures of innovation (Spithoven, et al., 2013); it is the same as in CIS studies, which take products new to market as the core proxy for radical innovation activities. As noted above, we focus here on this kind of innovation because it is the one for which the problem of multiple sources of knowledge arises (Laursen & Salter, 2006).

Turnover derived from innovation. Our second alternative dependent variable is the amount of turnover that derives primarily from innovative activities, and is another widely acknowledged measure of innovation performance (Laursen & Salter, 2006). Early works have used the percentage of turnover as the dependent variable. However, Klingebiel and Rammer (2014) note that this variable may not reflect new product success but rather substitutive strategies in the firm. For that reason, we use the log of the raw turnover derived from new product launches or product improvements made by the firm during the last year. As we shall see, the fact that we cannot precisely distinguish between the effects of new products and the effects of product improvements led to specific treatment of our data as well as a degree of caution in our analysis.

Formalization. As formalization encompasses both artifacts and procedures, we measured it in the following two ways:

Formalization process. This was measured through three five-point Likert scales (“We plan the developments of our firm”; “We check if objectives are achieved”; and “We have a clear and consistent view of what we want to undertake”). Factor analysis indicates a one-dimensional construct whereas reliability appears acceptable (Cronbach’s alpha = 0.69). It corresponds to the organization’s “managerial philosophy” pertaining to formalization efforts.

Formalization tools. In parallel, we measured formalization through the number of strategic tools and documents that the firm used, including: (a) general information notes; (b) strategic planning; (c) strategic scoreboards; (d) scenario development and analysis; and (e) decomposition and

analysis according to strategic business units. As a summative measure, it ranges from 0 to 5. These are part of the most commonly used tools in strategic management (Wright, et al., 2013).

Openness represents the extent to which an organization seeks to integrate external knowledge in its own innovation process. This connection phenomenon with external actors, resources, and knowledge is, by nature, multifaceted (Michelino, Lamberti, Cammarano & Caputo, 2015). In this study, we focus on two of the most agreed proxies for openness, namely inter-organizational relationships and external influences on decision making.

Inter-organizational relationships (IORs). IORs are a central feature of open innovation. Openness is enacted through contracts with partners and involvement in communities, including SMEs (Lee, Park, Yoon & Park, 2010). We measured IORs with the sum of different types of relationships formed during the three previous years, namely: (a) joint ventures or alliance contracts; (b) franchising partnership; (c) integration in a cluster; (d) becoming a member of a "pôle de competitivité"; and (e) vertical agreement with a supplier. The variable takes values between 0 and 5. As such, our measure is akin to what Laursen and Salter (2006, 2014) call the "external search breath," which reflects the number of separate channels of knowledge inflow.

External influences on decision making. The influence of external stakeholders on strategy is one distinctive feature of open innovation (Oberoi, et al., 2014). It was assessed by the number of outside sources of influence on strategic decision processes. The firms were asked if they were involved in strategic decisions involving: (a) banks; (b) consultants; (c) chartered accountants; (d) public organizations or associations; (e) suppliers or clients; and (f) top managers from other firms. The variable has values between 0 and 6.

Control variables. In our analysis, we added the following control variables. **Industrial dummies** take account of sector differences. **Employees (log)** and **turnover (log)** represent the natural logarithm of employees and turnover and aim at controlling size effect, which is believed to matter in formalization studies (e.g., Song, et al., 2011). **Innovation expenses** correspond to the percentage of turnover dedicated to innovation activities, as shown in company statements. We also introduced control variables related to openness. A firm may involve external stakeholders in knowledge searching or decision making. When it does so, it is important to see that internal stakeholders are also involved. If external connections increase in parallel to internal ones, then perhaps they do not denote openness but rather a classic development of the stakeholders' network. In other words, without control of internal participation and monitoring, the measure of openness can be spurious. Therefore, to reinforce the measure of openness, we introduced two other control variables. First, **internal decisions** is a variable reflecting the breadth of internal participation in decision making that includes: (a) all the members of a steering committee; (b) consultation of employees; and (c) involvement of shareholders. The variable spans from 0 to 3. Second, and following the same logic, **internal monitoring** reflects firms' monitoring of: (a) internal resources; and (b) internal processes. This control variable is an integer from 0 to 2.

DESCRIPTIVE STATISTICS

Table 1 (below) presents an overview of the firm's sample by size and industry, while Table 2 displays the descriptive statistics. Product innovation (NwPdt) appears reasonably correlated with formalization variables as well as openness proxies. These observations are consistent with a large body of literature about innovation. The signs being positive for formalization, we anticipate that our findings will resolve the dilemma of formalization influence in the direction of a positive effect. In parallel, we observe a strong correlation between formalization measured as a process (FormalPcs) and as an output in the form of tools (FormalTool). It suggests that the two variables may be two facets of the same construct. Our purpose is not to aggregate them, however. We managed to test our models using formalization variables separately, assessing solely their final consistence. Likewise, openness variables (IORs, ExtDecis) exhibit highly significant correlations between them, corroborating a convergence in underlying phenomena. As for formalization, we do not need to aggregate them as far as we use them separately in different models. Finally, we observe that product innovation appears at a rate of 61%; a percentage that, in CISs, tends to be associated with big firms, whereas small firms usually exhibit an approximate rate closer to 50% (e.g., Spithoven, et al., 2013). Our sample, therefore, could be slightly biased toward higher rates of innovation. The order of magnitude of product innovation likelihood, however, remains the same.

Industry	**Size**			**Total**
	< 10	10 to < 50	50 +	
Food industry	8 (3.83%)	18 (6.59%)	3 (4.11%)	29 (5.23%)
Clothing, leather	5 (2.39%)	10 (3.66%)	1 (1.37%)	16 (2.88%)
Wood, paper	5 (2.39%)	18 (6.59%)	3 (4.11%)	26 (4.68%)
Metal products	24 (11.48%)	45 (16.48%)	20 (27.40%)	89 (16.04%)
Computer, electronic, optical, electric equipment	4 (1.91%)	10 (3.66%)	5 (6.85%)	19 (3.42%)
Machinery	12 (11.48%)	20 (16.48%)	10 (27.40%)	42 (7.57%)
Furniture, jewelry, repair	15 (7.18%)	23 (8.42%)	4 (5.48%)	42 (7.57%)
Electricity, gas, water	37 (17.70%)	24 (8.79%)	6 (8.22%)	67 (12.07%)
Waste	2 (0.96%)	3 (1.10%)	1 (1.37%)	6 (1.08%)
Construction, electricity, plumbing	7 (3.35%)	14 (5.13%)	3 (4.11%)	24 (4.32%)
Retail wholesale, repair	10 (4.78%)	5 (1.83%)	1 (1.37%)	16 (2.88%)
Transport	0	1 (0.37%)	1 (1.37%)	1 (0.36%)
Accommodation, food	0	1 (0.37%)	1 (1.37%)	1 (0.36%)
Publishing, motion picture, broadcasting	4 (1.91%)	9 (3.30%)	2 (2.74%)	15 (2.70%)
Telecommunication, programming, information	14 (6.70%)	16 (5.86%)	4 (5.48%)	34 (6.13%)
Real estate, scientific activities, management	39 (18.66%)	36 (13.19%)	3 (4.11%)	78 (14.05%)
Administrative activities, renting, employment	23 (11.00%)	21 (7.69%)	5 (6.85%)	49 (8.83%)
Total	208(100%)	273(100%)	73(100%)	555(100%)

Table 1—Frequencies of firms by sector and size in sample

	Mean	s.d.	NwPdt	InnoTurn	FormalPcs	FormalTool	IORs	ExtDecis	LNemp	LNturn	InnoExp	IntMonit
NwPdt	.618	.480										
Turnover	7.82	77.38	0.626***									
FormalPcs	3.688	.827	.159***	0.215***								
FormalTool	1.356	1.198	.137***	0.207***	.489***							
IORs	1.486	.993	.181***	0.249***	.186***	.256***						
ExtDecis	4.337	1.537	.104*	0.107*	.111**	.138***	.400**					
Emp(ln)	2,651	1.09	.023	0.006	.173***	.158***	.136**	.0286				
Turn(ln)	7.56	1.489	.040	0.005	.217***	.096*	.151**	.076	.556***			
InnoExp	4.550	5.387	.267***	0.379***	.091*	.138***	.188**	.036	.059	.114**		
IntMonit	1.755	.457	.065	0.021	.294***	.256***	.115***	.190***	.060	.114**	.060	
IntDecis	1.988	1.080	.064	0.129**	.261***	.200***	.323***	.391***	.289***	.302***	.082*	.184***

Table 2—Descriptive statistics and bivariate correlations

MODELING STRATEGY AND RESULTS

We built our models following two waves of analysis. In the first wave, we took the likelihood of innovation as a dependent variable. In the second wave, we considered the amount of turnover that directly stems from innovation. The two variables are potential and alternative measures of innovation performance and are, arguably, convergent. The use of turnover seems more widespread in the literature. In our case, however, some shortcomings in data availability—which we develop later—led us to conduct analyses with the two dependent variables.

INNOVATION LIKELIHOOD

This analysis was decomposed into two subsets. First, we basically assessed the influence of formalization and openness on innovation products new to market (NwPdt). In Table 3 (below), Model 1 is a logit model on product innovation with formalization process and formalization tools as explanatory variables. It may be considered as the base model. To this model, we independently added openness variables. It exhibits a positive influence of formalization on NwPdt ($\beta=0.29$, $p<0.05$). However, the influence of formal tools appears to be non-significant. In particular, the influence of formalization tools seems to decrease when we integrate openness variables. In parallel, we observe a general but marginal influence of IORs on innovation ($\beta=0.23$, $p<0.05$). This is consistent with theory in so far as IORs are considered one of the most important tools to develop innovation in open innovation settings (Chesbrough, 2003). In contrast, external involvement in decision making seemingly has no influence on innovation.

A second subset of logit models consists of focusing on possible interaction effects between formalization and openness. To this end, interaction terms were added to the regressions. Nonetheless, it is now well documented that the interpretation of interaction coefficients can be misleading in terms of probability (Hoetker, 2007). A researcher should

interpret neither the sign nor the magnitude of an interaction coefficient to infer an interaction effect. In nonlinear models, the strength of interaction effects on probability varies with the level of variables. Interaction effects are marginal effects at various levels of an interaction variable (Wiersema & Bowen, 2009). Therefore, only a general scanning of the interacted variable can display the values for which the interaction effect is significant. To deal with this issue, we adopted the following approach. First, we estimated a logit with interaction term resulting in Models 2 to 5 in Table 3. Then, we computed the marginal effects of the interacted openness variable at different values of formalization variables. Next, we plotted the marginal effects with confidence intervals against interacted variables to get a graphical representation. Wherever it appeared that the confidence interval did not include zero, the interaction effect could be considered significant.

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
FormalPcs	0.29*	0.06	-0.00	0.31*	0.30*
	(0.14)	(0.22)	(0.36)	(0.15)	(0.15)
FormalTool	0.06	0.06	0.06	-0.16	-0.54*
	(0.10)	(0.10)	(0.10)	(0.18)	(0.26)
FormalPcs × IORs		0.17			
		(0.13)			
FormalPcs × ExtDecis			0.07		
			(0.08)		
FormalTool × IORs				0.14	
				(0.09)	
FormalTool × ExtDecis					0.14*
					(0.06)
IORs	0.23†	-0.39	0.23†	0.04	0.22†
	(0.12)	(0.49)	(0.12)	(0.17)	(0.12)
ExtDecis	0.06	0.06	-0.20	0.07	-0.11
	(0.08)	(0.08)	(0.31)	(0.08)	(0.10)
Employees (log)	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Turnover (log)	0.11	0.11	0.11	0.11	0.11
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Innov. expenses	0.86***	0.86***	0.86***	0.86***	0.86***
	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)
Internal decisions	-0.11	-0.11	-0.11	-0.11	-0.10
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Internal supervision	0.00	0.02	0.02	0.01	0.06
	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)
Industrial dummies	Yes	Yes	Yes	Yes	Yes
Intercept	-1.48	-0.72	-0.47	-1.40	-0.83
	(0.97)	(1.13)	(1.50)	(0.97)	(1.00)
AIC	675.00	675.29	676.24	674.68	670.61
BIC	791.95	796.57	797.52	795.96	791.89
Log likelihood	-310.50	-309.64	-310.12	-309.34	-307.30

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\dagger}p < 0.1$

Table 3—Logistic regressions explaining product innovation (N=555)

Following the procedure above, we tested the interaction effects for formalization and IORs through Models 2 and 4 presented in Table 3. Interaction terms do not appear to be significant, which is a poor clue for detecting interactions. To assess potential interaction effects, we must refer to the graph of marginal effects of IORs plotted with 95% confidence intervals for different levels of formalization variables, as presented in Figure 2 (below).

Contrary to interaction terms, plotted marginal effects indicate an interaction effect that is perceptible for higher values of formalization process and for most values of formalization tools. More precisely, the graphs show that interaction effects become positive and significant when the process formalization variable takes values above mean. In other words, for higher values, formalization increases the influence of IORs on product innovation. A similar analysis applies, with sharper results, to the interaction of IORs with formalization tools. A significant interaction effect appears as soon as the firm uses at least one strategy-formalization tool. This supports the existence of a general interaction effect between IORs and formalization tools.

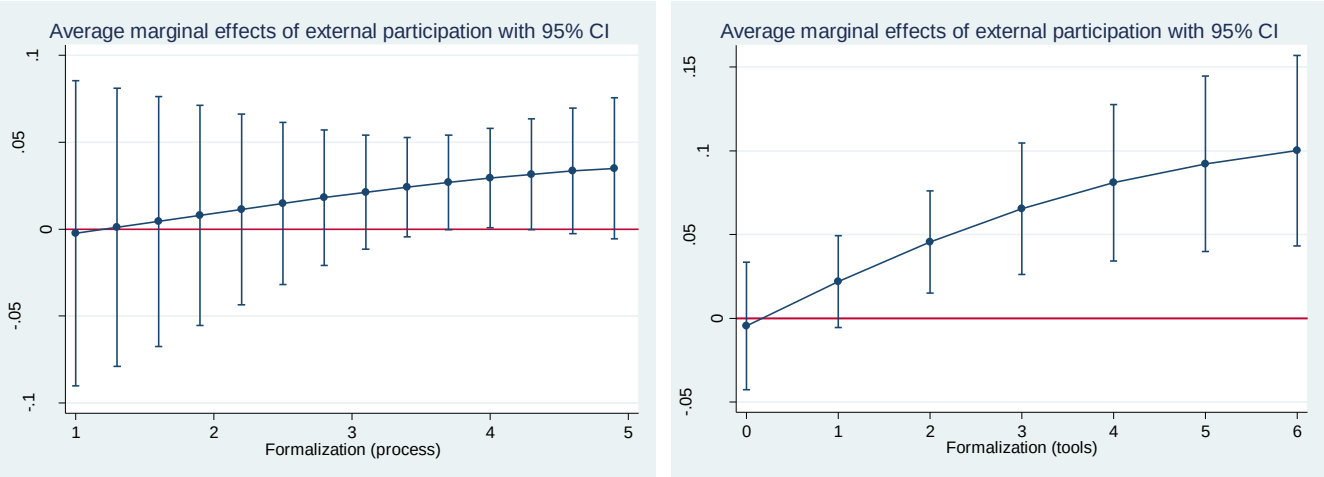

Figure 2—Average marginal effects of IORs at various levels of formalization (process and tools)

Finally, Models 3 and 5 aim to assess the potential interaction between external participation in decision making and formalization (Table 3). Below, Figure 3 exhibits the average marginal effects of the external participation on the probability of innovation. The analysis of marginal effects of external participation provides mixed findings that, nonetheless, identify interaction effects. For lower levels of formalization process, the marginal effects are clearly not significant. However, the interaction effect becomes moderately significant for high values. Conclusions are sharper for the marginal effects of formalization: The interaction effect is clearly observable whenever the number of tools the firm uses is greater than 1.

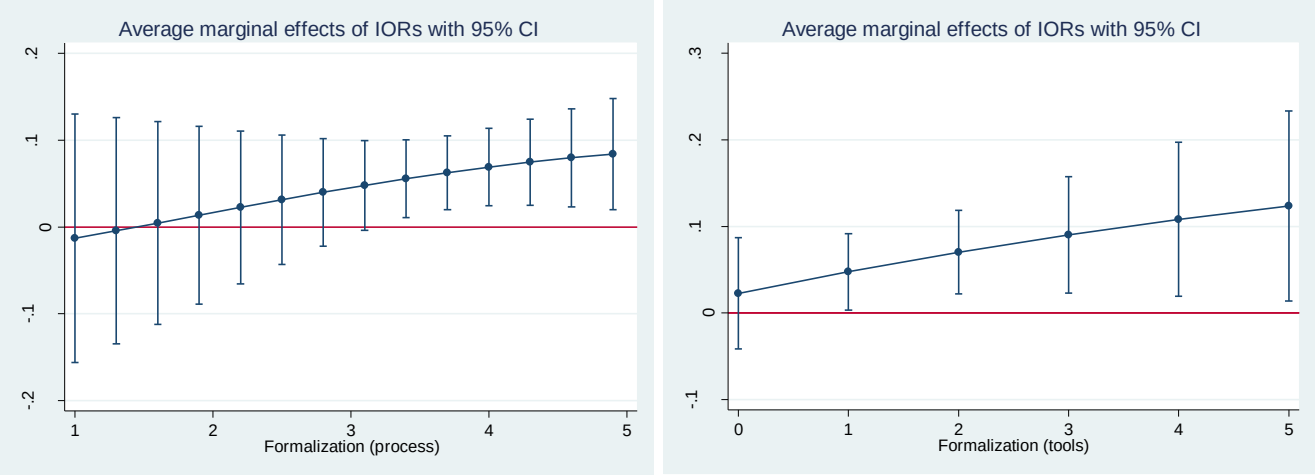

Figure 3—Average marginal effects of external participation at different levels of formalization (process and tools)

INTENSITY OF INNOVATION TURNOVER

The second wave of analysis took innovative turnover as the dependent variable. In our sample, the variable was nonetheless subject to two significant caveats. First, the firms were asked to provide the turnover that resulted from products new to the market, products new to the firm only, and improved products. It is worth noting that the different possibilities are not exclusive. Available turnover is, therefore, an inclusive variable that includes radical but also more incremental innovations. In this research, we focus on the former. However, there is no possibility of distinguishing the relative proportion that relates to each kind of innovation. Consequently, we used one supplementary control variable, namely the presence of a simply implemented product. This variable aims to control the impact of incremental innovation on turnover. Moreover, the sample exhibits substantial missing data of the dependent variable; we observe innovative turnover in only 477 cases of a total of 555 original observations. We found no identifiable pattern to explain why those values are missing, for they include observations of innovating and non-innovating firms simultaneously. In the same vein, t-tests on the variables show there is no significant difference between missing observations and the remaining subsample. This suggests that the missing observations are random.

Our analysis relied on Tobit regressions. The dependent variable is indeed censored. Regardless of the missing data, we can observe the dependent variable only when there is an innovation. The observed zeros in turnover, therefore, mean that the variable is censored and does not reflect the intensity of the turnover. Because Tobit models take the censoring phenomenon into account, they tend to be common in innovation studies. As far as we interpret the model, based on the latent variable that is not always observed, interaction terms may be understood as in classic ordinary least squares regressions. In Table 4 (below), Model 6 reflects the basic model with no interaction term. We observe that formalization process seems to have a significant impact on innovation performance (β=36.90, $p<0.05$) while formalization tools have not. Model 7 presents the interaction term between formalization process and IOR, and proves to be

neatly significant and positive (β=41.28, p<0.01). Model 8 corresponds to interaction between formalization process and external participation. It is also significant and positive (β=17.22, p<0.05). Finally, Models 9 and 10 show interaction effects taking tools with IOR and tools with external participation, respectively. Both interaction terms prove to be positive but only moderately significant (β=18.02 and β=11.93, p<0.05). From the above results, we can conclude that formalization, both as a process and a tool, increases the effectiveness of openness on innovation performance. As such, the findings are consistent with those obtained for the likelihood of innovation.

	Model 6	**Model 7**	**Model 8**	**Model 9**	**Model 10**
FormalPcs	36.90*	-24.49	-34.85	40.59**	39.79**
	(15.28)	(24.34)	(38.07)	(15.32)	(15.29)
FormalTool	13.78	16.08	14.25	-16.90	-38.93
	(9.89)	(9.82)	(9.83)	(17.67)	(26.43)
FormalPcs × IORs		41.28**			
		(13.15)			
FormalPcs × ExtDecis			17.22*		
			(8.46)		
FormalTool × IORs				18.02*	
				(8.63)	
FormalTool × ExtDecis					11.93*
					(5.55)
IORs	27.20*	-132.76*	26.76*	-1.14	25.44*
	(11.76)	(52.33)	(11.69)	(17.91)	(11.74)
ExtDecis	6.36	7.18	-58.56†	7.46	-9.44
	(8.25)	(8.14)	(32.82)	(8.22)	(10.96)
Improved product	90.13***	93.29***	88.39***	91.34***	89.41***
	(25.22)	(24.97)	(25.01)	(25.07)	(25.10)
Employees (log)	0.38	0.37	0.39	0.42	0.45
	(0.36)	(0.35)	(0.35)	(0.35)	(0.35)
Innov. expenses	70.76***	73.44***	70.53***	71.25***	69.45***
	(13.23)	(13.16)	(13.14)	(13.18)	(13.19)
Internal decisions	-4.51	-2.06	-3.70	-4.71	-3.48
	(11.75)	(11.66)	(11.66)	(11.70)	(11.71)
Internal supervision	-7.87	-5.06	-2.36	-7.38	-3.18
	(25.88)	(25.55)	(25.86)	(25.69)	(25.81)
Industrial dummies	Yes	Yes	Yes	Yes	Yes
Intercept	-378.15***	-166.04	-114.31	-365.73***	-322.54***
	(83.63)	(103.61)	(150.91)	(83.09)	(86.21)
AIC	3189.66	3181.71	3187.56	3187.29	3187.02
BIC	3306.35	3302.57	3308.42	3308.15	3307.87
Log likelihood	-1566.83	-1561.85	-1564.78	-1564.64	-1564.51
Left-censored	263	263	263	263	263
Uncensored	214	214	214	214	214

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\dagger}p < 0.1$

Table 4—Tobit models to explain innovative turnover (N=477)

DISCUSSION

The purpose of this research was to deepen our understanding about the impact of strategy formalization on open innovation strategies. To go beyond the conflicting views over the influence of formalization, we combined open innovation and socio-material perspectives. In doing so, we specifically considered the possibility for formalization to be a means of benefiting from openness in order to innovate. Therefore, we hypothesized that formalization could be a positive moderator of the acknowledged influence of openness on innovation success. Using a unique database of 555 SMEs, we investigated the effects of strategy formalization, open innovation, and their interactions on product innovation. Analyzing the data, we dealt with several models that could be derived from our general hypothesis. This data analysis strategy was motivated, on the one hand, by debates over definition of some variables and, on the other hand, by limitations induced by data availability during our empirical investigations. In a nutshell, the multiple model design was commended by a search for robustness. Next, we considered innovation success alternately as new product likelihood and as turnover derived from new products. Using the same logic, we considered innovation through its process and artifact dimensions. Furthermore, we used two different variables to measure openness: cooperation, and the implications of external stakeholders. Ultimately, the multiple models provided convergent findings. Overall, formalization positively moderates the influence of openness on innovation. While we concede that findings are only moderately significant, they all show that open innovation strategies lead to better outcomes when formalization is greater. The main effect is more obvious for formalization considered in its process dimension than as a tool. However, the interaction effects have no perceivable differences across the facets of formalization. Consequently, our findings contribute to the extant research on four main points.

First, our study underscores the positive influence of formalization in open innovation situations. To the best of our knowledge, this is the first study to investigate how open innovation strategies interact with formalization. Prior research nurtured competing views on this topic; some researchers developed complex models that allowed a negative influence of strategy formalization on innovation development, while having a generally positive role in organization performance (e.g., Song, et al., 2011). In parallel, a growing body of literature argued that formalization, despite its double-edged nature, could bring direct benefits to the organization (e.g., Dibrell, et al., 2014). The socio-material literature invites us to look beyond this debate by considering the generative facet of formalization and its potential role on innovation. Therefore, we contribute by specifying some of the conditions under which formalization benefits the open organization. In our study, we developed the rationale whereby formalization could play a positive role. In open innovation strategies, the number of stakeholders poses specific challenges that formalization helps to cope with. Indeed, formalization may play both an integrative and an analytical function. The need to clarify, organize, negotiate with stakeholders on the project, and legitimate this project to partners' views tends to prove that the literature should now pay more attention to firms' internal capabilities to leverage inbound openness. Our empirical approach confirms implications drawn from this view.

Second, and of particular importance, is that our findings were obtained in an SME setting. Until recently, researchers neglected open

innovation in small firms (Spithoven, et al., 2013). However, open innovation is recognized to be important for SMEs as well (Gassman, Enkel & Chesbrough, 2010; Van De Vrande, et al., 2009). Constraints on SMEs' capabilities explain that open innovation represents an opportunity to develop them. But, at the same time, it raises the question of availability of techniques and finite resources to take advantage from openness. Our study yields interesting insights on this point: As the small firm adopts openness, formalization gains increased importance in innovating as well as increasing turnover from innovation activities. Furthermore, we also note a modest direct effect from the formalization process on innovation performance, whatever the openness of the firm. In this way, we prolong the studies of the impact of strategy formalization in new ventures (Burke, et al., 2010; Delmar & Shane, 2003) and expand them toward innovation. As for the question of whether the tools we teach in business schools are useful to managers (Wright, et al., 2013), we would clearly answer "Yes" in the context of open innovation.

Third, we see our study as providing incidental feedback to the socio-material literature. Our first goal was to build on socio-materiality to enlighten our strategy for data analysis. In doing so, we confirm empirically the strong ties between the technical artifacts and organizational practices pertaining to formalization. Socio-material studies confirm the strong correlation between the two but remain controversial as to whether they are separable constructs. In our study, we provide an example in which the two facets may be distinguished. We identify each variable's proper influence by controlling for the other in the analyses. Therefore, we were able to treat each phenomenon separately during our empirical investigations. Future studies could develop a series of measures and investigate the relationships between them. Hitherto, in-depth case studies have been the exclusive research method used by socio-material approaches. However, our work suggests that quantitative methods may be more suitable to study socio-material variables, but the lack of consensus over the use of the various theoretical models represents a limiting factor for now.

Fourth, our work offers direct managerial implications. It points out the importance of formalization in open innovation contexts. Managers frequently consider business plans, reports, and meetings for plans as mainly time consuming, and often rate more informal methods as superior to formalized procedures. Thus, it is important that formalizing strategy is seen as key for small firms aiming to adopt openness. If managers plan to collaborate with other organizations or involve many actors in decision making, formalization becomes essential. Managers should, therefore, learn to disregard the apparent drawbacks of formalization for innovation. Considering the importance of formalization in bringing together actors and stimulating strategic thinking is a way of acknowledging an assertion that has been counterintuitive.

INTENSITY OF INNOVATION TURNOVER

Besides the usual shortcomings, two limitations are noteworthy. In this research, we deliberately focused on strategy formalization at the general level. However, it is also possible to consider strategy at the specific level of new product development (e.g., Holahan, Sullivan & Markham, 2014). While the literature has explored formalization of processes dedicated to innovation, much remains to be learned about their link with open innovation. Another limitation is that we have not studied the antecedent of formalization. In this regard, our approach was consistent

with the literature that has paid scant attention to the causes of strategic planning (Harris & Ogbonna, 2006). Future research could advance the argument for the open innovation approach by investigating how the need for a network could trigger specific postures in initiating strategy formalization. More generally, we strongly believe that future research will reveal more interesting ideas by focusing on management details and accessing microdata not present in conventional databases, thus avoiding the pitfall of considering concepts as monolithic.

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