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DATA: A COLLABORATIVE STRATEGY?

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Abstract

This study examines the interdependence of relational strategies and data management policies of SMEs during product innovation. The type of data management developed by a small firm to support its innovation efforts requires it to engage in competitive, vertical cooperative or coopetitive relationships. An empirical study of 109 leaders of French high-tech SMEs provides a descriptive and explanatory analysis of this question. This empirical study combines three theoretical dimensions: the characteristics of a Big Data policy, of an innovation product and of a relational strategy. We enrich the existing knowledge concerning the exploitation of data by SMEs by presenting a typology of their data strategies. We also find that Big data and Smart data policies are deployed by SMEs to support product innovation. Finally, we show that SMEs implement data management individually to support radical product innovation but will collaborate to support incremental product innovation. The nature of the data innovation guides the relational context of the SME. This study deepens the interdependence of data management and relational strategies among SMEs.

Keywords

Data management, product innovation, competition, vertical cooperation, coopetition, SMEs.

1. Introduction

Big Data is presented as one of the main drivers of innovation in small and medium-sized enterprises (SMEs) (Johnson *et al*., 2017; Sen *et al*., 2016). Defined by consulting firm Gartner (Laney, 2001) as a high-velocity operation of unprecedented volume and variety of data (the “3Vs” model), Big Data allows small businesses to improve their understanding of the market in order to be more effective in creating or transforming their products (Donnelly *et al*., 2015; Soroka *et al*., 2017). Big Data increases the firm’s ability to meet the needs of its customers by capturing transactional or behavioural data that were previously inaccessible (Vajjhala and Ramollari, 2016; Xie *et al*., 2016). The transformation of Big Data into information and then organizational knowledge has the potential to stimulate both incremental and radical product innovation (Erevelles *et al*., 2016; Sen *et al*., 2016; Zhan *et al*., 2017). As a result, many SMEs are investing in this technology to gain competitive advantage based on innovation (Donnelly *et al*., 2015; Goes, 2014). Information and communication technologies (ICT) influence the innovation output (Hall *et al*., 2013). Thus, Manyika *et al.* (2011) even present Big Data as the main support for innovation and competition.

Nevertheless, the potential offered by Big Data cannot come from the organizational tools and computing devices used until recently in classical information systems (McAfee *et al*., 2012). The deployment of such a data policy requires, on the one hand, significant investments in resources (Caputo *et al*., 2019), which can be a significant obstacle for SMEs (Donnelly *et al*., 2015); and, on the other, the facilitation of an open information system to collect and process, in real time, the multiple data that are needed for large-scale analysis (Chen *et al*., 2015). As a result, Big Data is leading some SMEs to collaborate so that they can access the sources, data and analytical capabilities that will support their innovation efforts (Sen *et al*., 2016; Zeng and Glaister, 2018). New digital technologies are increasing the horizontal and vertical flows of intelligence inside and outside companies (Barlatier, 2016). This finding led

Günther *et al.* (2017) to affirm that Big Data is currently the main driver of innovation support, assisted by the emergence of new cooperative ecosystems.

Researchers and managers have noted the need to better understand the impact of Big Data on product innovation but many questions remain regarding the relational strategies that companies are developing in order to innovate in data-rich environments (Johnson *et al*., 2017; Shamim *et al*., 2018; Xie *et al*., 2016). In this paper, we ask the following question: in the context of its participation in the product innovation of an SME, does Big Data modulate the inter-organizational exchanges of the company? In particular, is an SME more competitive or more cooperative when it mobilizes Big Data to improve or create a product? To date, no research has directly addressed the issue of the link between data management and relational strategy with regard to their support for innovation in small organizations.

To answer this question, this empirical study considers three theoretical dimensions that have not previously been addressed in the literature: the characteristics of a Big Data policy (via the 3Vs model), the characteristics of an innovation product (using the incremental and the radical approach), and the characteristics of a relational strategy (through competitive dynamics and collective strategies). To this end, we considered the responses of 109 leaders of French high-tech SMEs to our questionnaire.

The results of the study are used to propose a theoretical framework addressing the interdependence of data management and the relational strategies of innovative SMEs. Our contribution to the literature is fourfold. First, three types of data management pursued by SMEs are identified: No data, Big data and Smart data. No data is characterized by a lack of interest in data, whereas Big data and Smart data are actively engaged with data but differ in the way the SME apprehends and applies their use. This new typology enriches our current knowledge of data management; it would also help guide managers in their choice of a digital policy that is in accordance with their means and objectives. Second, this study explores the link between product innovation and data management by revealing the types of data management that are best suited to the radical or the incremental product innovation of SMEs. Thus, Big data is revealed as an explorative policy that supports the creation of the SME’s new products. Conversely, Smart data is an operating policy that supports the evolution of an SME’s existing products. Third, the study reveals the relational dimension of data usage by highlighting the need for SMEs to adapt their relational strategy in order to best support their data management. Big data is a necessarily collaborative policy that enables SMEs to access the various external resources and expertise they need in order to collect and process their Big Data. In contrast, Smart data is a resolutely competitive policy because of its sophistication. At this stage of maturity, in exploiting data that are now "smarter", the SME relies more on internal resources and specialist skills. Fourth, this modeling evolves in accordance with the nature of the product innovation supported by the data management of the SME. As a result, the product-driven innovation of data-driven SMEs is systematically accompanied by competitive relationships. Conversely, an incremental product innovation supported by data encourages, on the one hand, cooperation between an SME and non-competing firms and, on the other, coopetitive relations with some of its rivals.

The article is structured in four parts: after (1) the introduction, we present (2) the literature review of the study, (3) its methodology, (4) its results and, finally, (5) discussion and conclusions for the academic and managerial worlds.

2. Literature review

2.1 The influence of Big Data on SME product innovation

Successful companies constantly generate new knowledge, which fuels their innovation efforts through the improvement or creation of products (Nonaka and Takeuchi, 1997). This conception of product innovation is understood through technological evolution and/or the perception of customers (Atuahene-Gima, 2005). Big data has raised expectations of being particularly beneficial for the firms' innovation: the relation between a firm's use of big data and the likelihood of the firm innovating is contingent on it investment in IT-specific knowledge and skills (Niebel *et al*., 2019; Fosso Wamba and Mishra, 2017). Product innovation is now being fuelled by knowledge gained from the firm's ability to exploit Big Data (Chen *et al*., 2015; Wang *et al*., 2017; Zhan *et al*., 2017). Established by Gartner (Laney, 2001), the founding and consensus model of the 3Vs (data volume, variety and velocity) disrupts conventional statistical methods and transforms how organizations, large or small, approach and use information (McAfee *et al*., 2012). Davenport and Patil (2012) point out that Big Data firms stand out from traditional information analysis environments by focusing on data flows, rather than stock. Thus, the volume of data is considered either in terms of its quantity, as the scale of digital information measurement has rapidly increased in recent years (we are talking now about exabytes), or through the limits of the management capabilities of traditional IT tools (Holden, 2016). The challenge now lies in the treatment of cumulative, continuous, permanent and real-time flows of multiple data (internal/external, private/public, collective/individual, ambient) that can be structured (e.g. from databases and traditional customer relationship management [CRM] systems) and unstructured (e.g. from sensors, web applications and GPS). As a result, the 3Vs reduce the decision cycle and improve the company's knowledge. Big data are at the core of the innovation itself and generate new innovative digital products (Niebel *et al*., 2019).

Given the difficulties of integration and operationalization still encountered by some SMEs (Goes, 2014), Big Data allows them to improve their existing products by supporting their incremental innovation or to create new ones by facilitating radical innovation (Erevelles *et al*., 2016; Sen *et al*., 2016). In the context of a radical product innovation, data help to introduce technological jumps that make existing products obsolete. For example, manufacturers utilize data about how current products are used to enhance the development of the next generation and create new offerings. As part of an incremental innovation, data improve the existing products through minor changes, such as by extending the modularity of the current offering. With an IT infrastructure that is often more agile than that of large enterprises, SMEs can adapt quickly to the growing creation and storage of multiple data sources in order to focus on innovation (Sen *et al*., 2016). According to Sen *et al*. (2016), the collection by SMEs of more detailed and segmented data than previously favors, first, the analysis of the opportunities and risks to come from their market and, second, allows SMEs to simulate different scenarios of the adaptation or creation of their products according to the projected evolution of what will be needed. For example, the large amount of information now available about an SME’s customers and their experiences (provided by social networks, software platforms, online communities, etc.) encourages the creation of new uses or services that can outperform the functionality of the original product (Xie *et al*., 2016). Thus, Johnson *et al.* (Johnson *et al*., 2017) employ the 3Vs model in this context to emphasize that the creation of high-performance products now requires the processing and integration of a large volume of varied information as quickly as the organization can collect the data. This approach is the source of new products that are less expensive, better distributed and more accessible, such as those produced by 23andMe, an SME that is shaking up the pharmaceutical industry by utilizing the data of its customers, offering them genetic testing kits online that can be used by them at home. The technological dimension of the product and the customers' perception of its relevance attest to the impact of data on product innovation (Zhan *et al*, 2017).

In this sense, Big Data is a key technology that helps small businesses acquire the knowledge they need for their innovation policies through previously inaccessible levels of analysis (Vajjhala and Ramollari, 2016; Scuotto *et al*., 2017). We therefore propose the following hypothesis:

Hypothesis 1: Big Data promotes the product innovation of SMEs.

2.2 SME product innovation and its relational modes

According to the resource approach, a firm's competitive advantage is fostered and maintained by its in-house ability to develop unique, non-imitable and non-substitutable resources and skills to serve its innovation. Thus, innovation allows a company to differentiate itself from its rivals and to remain competitive, despite the velocity of material and the technological and consumer behavior evolutions of its environment. The competitive renewal of a company is, therefore, based on its ability individually to develop new products. In addition to traditional research and development (RandD) investments, increasing numbers of SMEs are investing in Big Data as a distinctive technology resource in order to build a source of competitive advantage based on innovation (Donnelly *et al*., 2015; Goes, 2014). The uniqueness of mastering an emerging technology ensures the competitiveness of the small business that can better predict the opportunities of its market and adapt its products accordingly (Sen *et al*., 2016).

However, faced with complex and uncertain environments, firms do not innovate in isolation, at least not effectively (Del Vecchio *et al*., 2018). The weight of expenditure, the need for external resources or the shortened life cycles of products lead firms to cooperate with competitors and non-competitors in order to innovate (Le Roy *et al*., 2013). In their innovation networks, firms are able to follow changes in demand and production methods by virtue of the information they receive from their various partners. Thus, the collaboration between an SME and its competitors, suppliers and customers particularly favors incremental product innovation (Neyens *et al*., 2010). The relationships built among small businesses enable firms to improve existing products through complementary partner resources, the common understanding of their market, and an effective division of labor (Song and Montoya-Weiss, 1998). Collaboration between competitors would, therefore, be facilitated during an incremental innovation process because, in comparison with a radical innovation process, it is less ambiguous and uncertain (Bouncken *et al*., 2016). Vertical and horizontal collaborative arrangements are also conducive to radical product innovation, allowing SMEs to reduce their risk, expenditure and investment in internal resources and skills (Tether, 2002). The spirit of openness and diversity needed to create a new product also fosters the exchange and sharing of resources and knowledge between partners (Laney, 2001). Innovation is stimulated by the association of distant but complementary knowledge that promotes creativity, efficiency and faster project execution. As part of a radical process, cooperation allows small businesses to work with complementary partners to offset their own lack of resources and in-house expertise and to reduce the many risks (financial, etc.) inherent in a small business producing a new product. Thus, we present the following hypotheses:

Hypothesis 2: Product innovation promotes ...
Hypothesis 2a: ... SME competition.
Hypothesis 2b: ... cooperation among SMEs.

2.3 Relational dimension of Big Data in SMEs

According to the theory of competitive dynamics, information processing is an organizational explanation of competitive behavior (Smith *et al*., 1991). Information plays a vital role in an economic landscape that has become "hypercompetitive", characterized by velocity, flexibility and innovation, whereby every competitive movement initiated by a firm (such as the creation of a new product) leads almost systematically to a reaction on the part of rivals engaged in a continuous race towards the next temporary competitive advantage (D’Aveni, 1994). In such a dynamic context, on the one hand, the volume of available environmental information and the variety of its sources allow the SME to better prepare for and respond to attacks across a wide range of competitive options, such as by improving or creating products (Chen and Hambrick, 1995); and, on the other, the velocity of the information and the speed with which it must be processed and transmitted to the decision-makers is likely to help the SME act more quickly than its rivals (Smith *et al*., 1991). In this sense, the advent of Big Data has transformed organizations' modes of operations (Barlatier, 2016). Where innovation becomes a critical issue, harnessing high data volume, variety and velocity (the 3Vs) enables organizations to bear competitive pressure through better understanding and anticipation of environmental change and adapt their offers (Sen *et al*., 2016; Guo *et al*., 2017). The larger SMEs can be more competitive due to their capacity to generate new knowledge and to innovate using Big Data (Vajjhala and Ramollari, 2016; Zeng and Glaister, 2018). For example, Donnelly *et al.* (2015) point out that the use of data consolidates SME marketing planning, which was traditionally based on intuition. SMEs use Big Data to surpass their competitors through a more precise knowledge of consumers, their needs and, therefore, the business opportunities they can seize, which encourages, among other aspects, their product innovation (Goes, 2014; Sen *et al*., 2016). Big Data is, therefore, seen as a source of innovative business opportunities (Davenport and Patil, 2012). In addition, as SMEs manage the growing data related to their operations, they can gather accurate and up-to-date information about their operational and organizational strategies, which enables them, for example, to optimize their innovation processes (McAfee *et al*., 2012; Sen *et al*., 2016). According to Marshall *et al.* (2015), organizations using Big Data in their innovation processes are 36% more likely to outperform their competitors in terms of operational efficiency and revenue growth. In this sense, in today's hypercompetitive markets, Big Data is the new capital to possess (Johnson *et al*., 2017). We therefore propose the following hypothesis:

Hypothesis 3a: Big Data promotes SME competition.

Although Big Data can support the product innovation of SMEs (Sen *et al*., 2016), this digital potential is still difficult to address and manage for the majority of firms (Barlatier, 2016). The era of Big Data presents unprecedented opportunities but also new complexities for the organization (Wang *et al*., 2017). Despite its potential innovation gains, a data policy requires significant investments in resources, skills and knowledge, which SMEs often fail to achieve (Donnelly *et al*., 2015; McAfee *et al*., 2012). The process of converting Big Data into competitive products is complex: both small and large companies need to understand the drivers of efficient data exploitation and then mobilize the resources (financial, physical, human, etc.) necessary for its success (Erevelles *et al*., 2016). As a result, many SMEs are abandoning this innovative technology, which they consider too complex (Soroka *et al*., 2017). However, other SMEs cooperate with each other in order to reduce the costs, risks and duration of their technological efforts (Ritala and Hurmelinna-Laukkanen, 2013). An agreement can associate the complementary capabilities of firms for exploit a potentially lucrative application of big data (Vonortas and Zirulia, 2015; Zeng and Glaister, 2018). So-called smart ecosystems bring together customers, competitors, suppliers, institutions, etc. to share their infrastructures but also to exchange and combine their data to ensure the effectiveness of their Big Data analysis (Günther *et al*., 2017; Xie *et al*., 2016). To date, industrial production processes present an important division of labor, each step of which generates an increasing amount of information. SMEs often do not have sufficient resources to gather socio-demographic, behavioral, transactional and contextual data collected by CRM systems, databases, sensors, etc. in order to build effective predictive models guiding the evolution of its products or the creation of new ones. As a result, exchanges between stakeholders can enable an SME to improve its offerings through the collection, monitoring and real-time processing of a large volume and variety of data that give it an overview of its data exploitation. Big Data, and its Data-as-a-Service (DAAS) collaborative platforms, has the effect of increasing the horizontal and vertical flows of information within and beyond a company's borders (Xie *et al*., 2016). This open approach also allows SMEs to nurture their creativity by taking advantage in real time of the huge amount of data generated by their various internal and external sources. Nevertheless, the exchange or sharing of data also presents a risk for small firms when their exploitation can be a source of competition and destabilize its position in the market (Günther *et al*., 2017). Horizontal (between competitors) and vertical (between competitors who are also suppliers or customers) coopetition emerge, during which rival firms cooperate, even though they are competitors, to enable them to operate collectively the levers that drive technological change (Le Roy *et al*., 2013). On the one hand, competitors are able to pool their resources (data, infrastructure, expertise, etc.) and, on the other, exploit the collective effort to improve their own market power through, for example, the race for innovation (Bouncken *et al*., 2016). These competitive impulses may, for example, result in the non-sharing or diversion of certain sensitive data in order to destabilize the strategic position of a partner(s) (Van den Broek and Van Veenstra, 2015). Despite these risks, collaborative strategies between competitors and non-competitors play an important role in SME data innovation policies. We therefore propose the following hypothesis:

Hypothesis 3b: Big Data promotes cooperation among SMEs.

Our conceptual model is presented in Figure 1:

-----Insert Figure1-----

3. Methodology

3.1 Sample and data collection

Our quantitative study measures the relationship between data innovation policies and the relational strategies deployed by French high-tech SMEs. The unit of analysis is the firm and the respondents are the CEOs of SMEs. Companies were identified by the intensity of their high-tech activities, measured by the ratio of their value-added R&D expenditure to the technology incorporated in their purchases of intermediate goods and equipment. Our research targeted companies operating in the following fields: pharmaceutical, chemical and automotive; manufacturers of computer, electronic and optical products, electrical equipment, weapons and ammunition, machinery and equipment, transport equipment, and instruments and supplies for medical and dental purposes; and aeronautical and space construction.

Drawn from a sample with an equal probability of being selected, 1,600 executives were contacted in January 2018 and offered our questionnaire, which comprised 79 questions (see Table A). After cleaning the data (removing incomplete questionnaires, late replies, etc.), responses from 109 CEOs were retained. According to the criteria of the European Commission (2003/361/EC), 27% of these respondents managed small enterprises (< 50 employees; annual turnover ≤ EUR 10 million) and 73% medium enterprises (< 250 employees; annual turnover ≤ EUR 50 million).

3.2 Questionnaire, measures and data analysis

First, we used principal component analysis (PCA) and confirmatory factor analysis (CFA) to validate one dependent macro variable and four independent macro variables (KMO and cos2 > 0.5: rule of minimum restitution and rotations; see Table B). The responses in the questionnaire were based on a 4-point Likert scale (from 1 = Strongly disagree to 4 = Strongly agree).

-----Insert Table A.-----

The dependent macro variable concerns the *Relational modes* established between the actors of individual or collective data management and measures the extent of their *Competition*, *Vertical cooperation* (partnership between non-competitors), *Horizontal coopetition* and *Vertical coopetition* through 19 items from Bouncken *et al.* (2016). The *Product innovation* independent macro variable takes 16 items from Subramaniam and Youndt (2005) and Ritala and Hurmelinna-Laukkanen (2013) to measure the influence of data on the

Radical and *Incremental* transformation of SME products (innovations in design, technology, distribution and financing). From Laney's original model (2001) and the work of Johnson *et al.* (2017), the three other independent macro variables measured the 3Vs of data management and grouped companies according to their digital profiles. The *Velocity* macro variable (7 items selected) combines the velocity of obtaining data (continuous/discontinuous) and the associated decision-making (real time/delayed time). Two sub-variables were thus identified: *Low velocity* is characterized by discontinuous flows and delayed decision-making; *High velocity* is characterized by continuous flows and real-time decision-making. The *Volume* (6 items) macro variable evaluates the amount of data collected and produced by the company through three sub-variables (*Low*, *Standard* and *High*). The last macro variable, *Variety* (2 items), measures the diversity of data (texts, figures, images, etc.) and their currency (old or recent data). Finally, four control variables, commonly used in work on innovation and collaborative strategies (e.g. Ritala and Hurmelinna-Laukkanen (2013) were selected to test whether a firm's profile influences the interdependence of its relational and data innovation strategies: *Size*, *Turnover*, *Total assets* and *Age* of the company.

-----Insert Table B.-----

4. Results

4.1 Three groups of SMEs and two discriminating functions were identified

Typological analysis was carried out of the data resulting from responses regarding the *Volume*, *Velocity* and *Variety* macro variables in order to classify the respondents according to their data strategies (the indicators, G, of the centers of gravity are presented in parentheses below). The group identified as *No data* (19.2% of the companies examined) is defined by no data volume, variety or velocity (G<0). The *Big data* group (48.6%) uses data that are very large, varied and have a high operating velocity (G>0). Finally, the *Smart data* group (32.2%)

manages data that are small (G>0), not very varied (G<0) and whose operating velocity is low and high (G>0).

This classification has a discriminating power of 97.43%. According to Fisher’s and Wilks' lambda tests, the *Variety* and *Volume* of the data variables best discriminate between firms. Two discriminant functions appear: the *Extended data exploitation* function refers to the transition of a firm into the Big data group, in which the variety and volume of data are high; and the *Reduced data exploitation* function characterizes transition into the Smart data group, in which data volume is limited.

4.2 Characteristics of data management and inter-organizational relations

The analysis of centroids, analysis of variance (ANOVA) and Multiple comparison tests (MCT: T-tests, Tukey where n is unequal, Scheffé, Least Significant Difference and Bonferroni) focus on the particularities of dependent and independent macro variables in order to identify, for each group of SMEs, the link between a firm's data policy and the relational strategies it deploys.

With regard to the relational macro variable, Relational modes, which significantly differentiates SMEs (Fisher's F, where $p<0.01$), the Smart data group develops particularly competitive relations (G>0), unlike the other groups (G<0). The MCT confirms that point ($p<0.05$). As one would expect, vertical cooperation between non-competitors (partnership) is associated with the Big data group (G>0). In terms of coopetitive trade, the Smart data group (G>0) is distinguished by vertical coopetition, whereas horizontal coopetition is exhibited by No data firms and, to a lesser extent, Big data firms (G>0). The MCTs did not provide any additional differentiation for these three cooperative modes. Thus, hypothesis H3a is rejected and hypothesis H3b is validated. Nevertheless, our results indicate that although Big Data promotes cooperation between non-rival SMEs, managing a smaller set of data (Smart Data) stimulates competition and vertical coopetition.

Moreover, the Product innovation macro variable also differentiates between groups (Fisher's F, where $p<0.01$). MCTs highlighted that radical and incremental product innovation is exclusively supported by SMEs that manage their data: The Big data and Smart data groups are differentiated from the No data group ($p<0.05$). However, only the Big data group stands out from the others in terms of support for the SMEs’ radical product innovation (G>0) and incremental product innovation remains the exclusive feature of the Smart data group (G>0). Thus, hypothesis H1 is partially validated.

4.3 Determinants of the inter-organizational relations of SMEs according to their data management

We used a stepwise regression model to examine the Relational mode dependent variable for each group to examine what form of product innovation determines their inter-organizational exchanges (see Tables C and D). The results highlight that radical product innovation promotes competition, regardless of the data management policy. Thus, hypothesis H2a is partially validated. In contrast, incremental product innovation supports both forms of cooperation (vertical cooperation, vertical coopetition and vertical coopetition) regardless of the data management policy. Thus, hypothesis H2b is partially validated. In particular, No data and Big data policies favor horizontal coopetition between SMEs, whereas a Smart data policy privileges relations involving vertical cooperation, vertical coopetition and horizontal coopetition.

Finally, we note that the control variables (Size, Turnover, Total assets and Age of the SME) do not have any causal links with the Relational modes dependent macro variable.

As a result, our study shows that data management (Big data or Smart data) is associated with a relational strategy the nature of which varies according to whether the innovation produced is radical or incremental.

-----Insert Table C.-----

-----Insert Table D.-----

5. Discussion and conclusion

Does Big Data modulate the inter-organizational exchanges of SMEs through its participation in their product innovation? Our research answers this question in the affirmative by partly validating the five hypotheses of our theoretical framework. More specifically, our results reveal the existence of several types of data management associated with the implementation of a specific relational strategy, the nature of which varies according to whether the innovation produced (supported by the data) is radical or incremental. The interdependence between the innovative digital dynamics and relational dynamics of small business is thus confirmed.

5.1 Theorical contributions

The first theoretical contribution is that the SMEs studied can be differentiated through their deployment of different data strategies in relation to the volume, variety and velocity of the management of their data. Thus, we confirm the work of Donnelly *et al.* (2015) and Scuotto *et al*. (2017) in stating that small organizations are investing in this form of technology in order to be innovative. We also enrich the existing knowledge concerning the exploitation of data by SMEs by presenting a typology of their data strategies. According to the three-dimensional model of the 3Vs (Laney, 2001), three groups of firms stand out: No data SMEs, which do not manage their data at all; Big data SMEs, which operate a high volume and variety of data at high velocity; and Smart data SMEs, which mobilize a limited volume and variety of data but with a management velocity that is both low and high. Thus, Smart Data is presented as an approach that mobilizes reduced data but is specific to a particular problem (Davenport and Patil, 2012); in contrast, Big Data is characterized by a more global, generalist approach. Smart data SMEs are also differentiated by an ability to keep abreast of information punctually and to make both instant and delayed decisions. This management method places the organization in a variable temporality depending on the nature and context of the decision to be made. Smart Data is subject to a "slow management" that promotes caution and progressiveness to ensure better efficiency in data processing. It is no longer necessary to exploit a large volume and variety of data quickly. The challenge now lies in an organization's ability to manage data in the most effective way to meet a pre-designated goal (Goes, 2014).

A second theoretical contribution reinforces the literature by demonstrating the link between product innovation and SME data policy (Erevelles *et al.*, 2016; Goes, 2014; Sen *et al.*, 2016). The data management of a small company appears to provide targeted support for its innovation efforts compared to organizations that do not implement any data policy. We complement this knowledge by identifying the data policies that are most suited to incremental or radical product innovation. Our results underline the finding that Big Data particularly favors the radical product innovation of SMEs, whereas Smart Data stimulates incremental product innovation. The role of Big Data in the creation of new products can be explained by the need for SMEs to explore a broad spectrum of new information that was, traditionally, distant from the firm's field of expertise in order to better capture current or future market developments in order to disrupt the market and make existing products obsolete. In comparison, a Smart data policy supports the development of an SME's existing products. We can explain this through the need to mobilize more specific and, therefore, more limited data quickly, which, when extracted, for example, from each function of the SME's value chain, enable the steady refining of an existing product via minor changes. Thus, Smart data is an operating policy, whereas Big data is a policy of exploration for an SME.

Incremental product innovation is, therefore, inherently less data intensive than radical product innovation. Consequently, these varying approaches to the mobilization of data lead high-tech SMEs to modify their inter-organizational exchanges in the service of their data policy. First and foremost, irrespective of the product innovation context, our third theoretical contribution confirms that a Big data policy favors cooperation (Günther *et al.*, 2017). The SME associates itself particularly with non-competing partners because of the difficulty a single SME has in managing by itself the resources (technological, material, human, etc.) necessary for its exploitation of Big Data. In addition, access to a large and continuous flow of heterogeneous data (financial, commercial, marketing, etc.) requires only a small structure to multiply its sources of supply. These collaborative strategies bring SMEs that are complementary and non-competitive together to optimize their investments in Big Data. Our results reveal that Smart Data SMEs favor competitive relations. In a Smart data policy, the data mobilized remain unique because of their contextualization (due to the organizational, economic, technical, historical, etc. characteristics of the firm). This seems to reduce the interest in SMEs drawing on partners' data, which are considered unusable because they are unsuited to the other firms' contextualized objectives. In addition, firms use their own data experience to select, evaluate and exploit a small amount of data targeting a predefined research theme (Davenport and Patil, 2012). As a result, a Smart data policy relies on SME-specific expertise, which makes the company less dependent on external resources and expertise. Thus, Smart data is a competitive policy because of its sophistication, whereas a Big data policy involves a more cooperative approach.

Nevertheless, our fourth theoretical contribution finds that the above model is modified according to the nature of the product innovation supported by the data (see Table C). Thus, when data contribute to radical product innovation, the relational strategy deployed by the SME to mobilize them is systematically competitive. Regardless of how the data policy is driven (No data, Big data, Smart data), the issues related to the nature of a breakthrough innovation place the firm solely in a competitive relationship. Here, data seem to be considered a distinctive resource that should not be shared with other companies so that the data can exclusively support the competitive innovation of their owner. Conversely, an incremental product innovation supported by data favors vertical cooperation between non-competitors and coopetitive relations between competitors. Mutualizing the management of its data with its customers, suppliers and rivals allows an organization to transform its existing products effectively through the analysis of multiple pieces of information regarding its environment. Incremental product innovation supported by data is, therefore, cooperative. More specifically, in the context of incremental product innovation, our results underline the finding that a Big data policy favors horizontal coopetition, whereas a Smart data policy favors partnership and horizontal and vertical coopetition between SMEs. The simultaneity of competition and cooperation responds to the need for an SME to combine its technological resources, while exploiting them in order to reinforce its own product in a market shared with its partners (Le Roy *et al*., 2013). Several explanations can justify this observation. First, in the context of this type of innovation, the data are considered less critical than in a radical innovation and this facilitates their sharing. Although the competition is ubiquitous between partners, their cooperation allows access to multiple resources and data flows in order to anticipate or detect opportunities for the development of their offers that meet the same demand as those offered by their peers. Second, incremental product innovation is fueled less by complementary information from distant partners (from other markets) than by local actors who share the same environment. Similarities in their value chains, experiences, qualifications and resource constraints are likely to bring together competitors, customers and suppliers whose familiarity to each other will reduce the costs and risks of their cooperation. Last, it should be noted that a Smart data policy particularly encourages SMEs to rely on all forms of cooperation. We conclude that mobilizing targeted and useful data for the predefined transformation of a product requires small businesses to integrate a complex network of many sources of information into both competitive and cooperative relationships. In this sense, the data and relational strategies of SMEs are highly interdependent as part of their support for product innovation. Although collaboration between competitors or non-competitors favors the sharing of information and knowledge for their incremental and radical product innovation (Bouncken *et al*., 2016; Le Roy *et al*., 2013), our work emphasizes that it is also beneficial upstream of the creation and management process because, as data are processed they become information, which is then transformed into knowledge and placed in the service of decision-making.

5.2 Managerial implications

The managerial implications of our work are related to the awareness required of decision-makers that there are several ways of managing their data to support product innovation and that this management requires the mobilization of adequate relational strategies. Therefore, a capacity to vary between competitive and/or cooperative exchanges, as well as to be able to choose appropriate partners as sources of data and digital expertise, remains necessary for SMEs who wish to transform their offers, either radically or incrementally, in response to their digital strategy.

5.3 Limitations and future research areas

Our results should be understood only in relation to the limits of the study. Thus, the results are only related to French high-tech SMEs and product innovation. For example, other business profiles from medium- and low-technology industries (or markets) that use data to support their product and organizational innovation should be tested. We also provided a static, rather than a dynamic, approach to the phenomenon because of our quantitative method. However, it would be interesting to analyze whether data management has its beginnings in No Data, then moves to recognizing a need for Big Data, which ultimately leads to a Smart Data policy. Studying this cycle in detail through interviews (in a qualitative study) could be a matter for future research. In addition, the literature now appears to have evolved towards a "6Vs" model to define firms' data management (volume, variety, velocity, variability, veracity and data value). This new model could soon, therefore, be used to deepen our understanding of the relationship between data strategies and relational strategies in an innovative context. Finally, our research assumes that the equilibrium of competitive and cooperative exchanges of SMEs is fixed. The influence of data strategies on the different degrees of coopetition could also be addressed in future research.

5.4 Conclusion

This research concluded by demonstrating the interdependence between the types of data management employed by an SME and its relational strategies. Competing or cooperating is a choice that a small organization must make in order to better manipulate the data it uses in the service of its product innovation. Thus, Big Data is a collaborative form of data management because of the extent of the technological, material, human, etc. resource requirements that an SME cannot manage alone. However, the narrower set of resource requirements in the context of a Smart Data policy could direct the SME to exclusively competitive relationships.

Nevertheless, the nature of product innovation supported by the exploitation of data reorients the relationship identified between data management and relational strategy. The critical nature of radical product innovation systematically leads SMEs to manage their data alone in order to support the creation of new disruptive products. However, the approach of SMEs is cooperative or coopetitive when their data are intended to improve their existing products. Through its new theoretical framework, our empirical study offers important insights into the understanding that, on the one hand, small businesses manage their data to enhance their innovation efforts and, on the other, support this approach through the implementation of appropriate relational strategies.

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Appendix

Figure 1. Big data and SMES's relational strategies

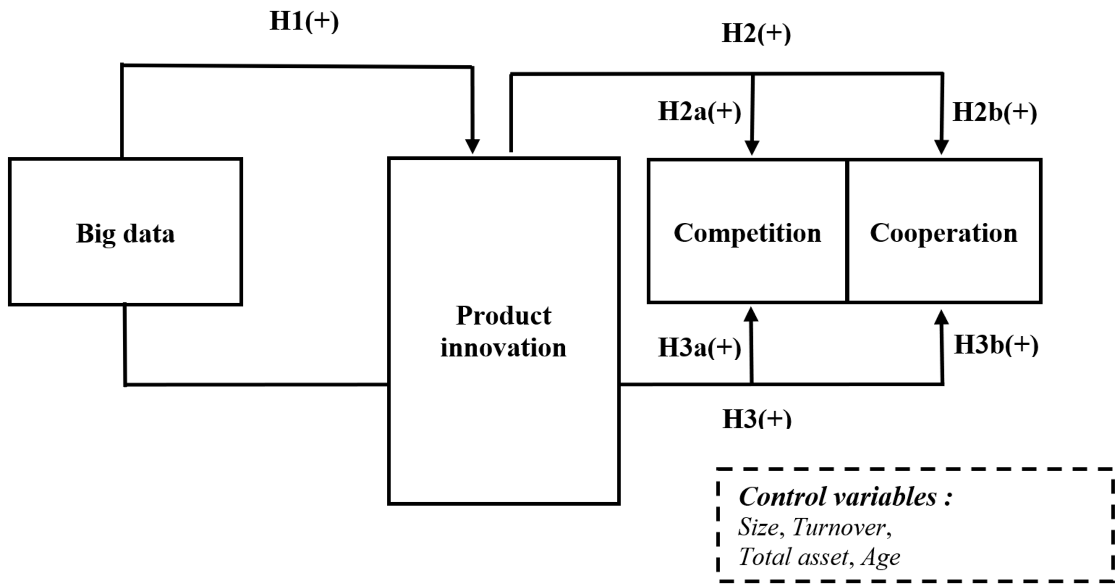

Table A: Questionnaire for data collection

Macro variables	Variables	Items
Relational modes	Competition	**Compared to your main competitors, the data allow you ...** … to improve your knowledge of the market. … to better stimulate demand. … to identify new business opportunities. … to reach your sales objectives. … to increase your sales. … to increase your market share.
	Vertical cooperation	**Your business uses certain data from its suppliers ...** … who sometimes become competitors. **Your business uses some data from its customers ...** … who sometimes become suppliers. … who are regular suppliers.
	Horizontal coopetition	**Your business uses some data from competitors ...** … with whom it has regular relationships (common projects, shared actions, etc.). … with whom it has occasional relationships (meetings, trade shows, joint customers, etc.). … with whom it has a common goal. … with whom it has a relationship of competition and cooperation. … who are its allies on certain projects, themes, etc.
	Vertical coopetition	**Your business uses some data from competitors ...** ... who sometimes become suppliers. **Your company uses certain data from its suppliers ...** … who sometimes become competitors. … who are regular competitors. **Your business uses some data from its customers ...** … who sometimes become competitors. … who are regular competitors.
Volume	Low	**According to you, your firm collects ...** …a low volume of data per year (one or more CD ROMs, USB storage, etc.). **According to you, your company produces…** ... a low volume of data per year.
	Standard	**According to you, your firm collects ...** ... a standard volume of data per year. **According to you, your company produces…** ... a standard volume of data per year.
	High	**According to you, your firm collects ...** ... a significant volume of data per year. **According to you, your company produces…** ... a significant volume of data per year.
Velocity	Low	**Your firm is informed about the topics that interest it (trends, actors, etc.) ...** ... in delayed time (after a certain delay, etc.). **As a result, your data help you make decisions ...** ... in a discontinuous flow (punctually, etc.). ... later (after a certain amount of time, etc.).
	High	**Your company is informed about the topics that interest it (trends, actors, etc.) …** ... in a continuous flow (permanently, etc.). ... in real time (instantly, etc.). **As a result, your data help you make decisions ...**

		... in a continuous flow (permanently, etc.). ... in real time (instantly, etc.).
Variety		**Your firm uses ...** ... many types of data (encrypted, texts, images, videos, etc.). … data on various topics (trends, events, actors, etc.).
Product innovation	Radical	**Data help your business radically transform ...** … its understanding of new markets. … the design of its new products. … the distribution of its new products.
	Incremental	**Data help your business gradually transform ...** … its understanding of the markets. … the design of its products. … the distribution of its products.

Table B: Measurement scales (PCA, CFA and acceptability steps)

Macro-variables	Variables	RM	α (si>0,5)	AI					RI					PI
				χ²	*GFI*	*AGFI*	*RMR*	*RMSEA*	*NFI*	*RFI*	*CFI*	*IFI*	*TLI*	*χ²/ddl*
				Le + ↓	≥0,9		≈0	<0,09	≥0,9					<5
Relational Modes	Competition	PCA	0,915											
	Vertical cooperation	CFA	0,847	34,315	0,941	0,863	0,038	0,086	0,941	0,889	0,972	0,973	0,973	1,806
	Horizontal coopetition	PCA	0,913											
	Vertical coopetition	PCA	0,882											
Volume	Low	CFA	0,862	12,756	0,967	0,885	0,029	0,082	0,957	0,894	0,941	0,977	0,941	2,126
	Standard	CFA	0,736											
	High	CFA	0,880											
Velocity	Low	PCA	0,767											
	High	PCA	0,857											
Variety		PCA	0,672											
Product Innovation	Radical	CFA	0,845	10,57	0,932	0,89	0,041	0,055	0,969	0,917	0,992	0,992	0,979	1,321
	Incremental	CFA	0,86											

Note: RM = Retained method; PCA = principal component analysis; CFA = confirmatory factor analysis; α = Cronbach's alpha; AI = absolute indices; χ2 = Chi2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMR = root mean residual; RMSEA = root mean square error of approximation; RI = relative index; NFI = normed fit index; RFI = relative fit index; CFI = comparative fit index; IFI = incremental fit index; TLI = Tucker-Lewis index; PI = parsimony index; χ2/ddl = Chi2 by degrees of freedom.

Table C. Stepwise regression

	DV: Competition		
IV	***No data***	***Big data***	***Smart data***
Radical product innovation	0.542(***)	0.342(**)	0.490(**)
R/R²/R² adj.	*0.705/0.497/0.935*	*0.342/0.117/0.686*	*0.622/0.387/0.822*
Fisher tests	*8.899(**)*	*6.479(**)*	*9.780(*)*

	DV: Vertical cooperation
IV	***Smart data***
Incremental product innovation	0.545(**)
R/R²/R² adj.	*0.545/0.297/0.854*
Fisher tests	*13.513(**)*

	DV: Vertical coopetition
IV	***Smart data***
Incremental product innovation	0.344(***)
R/R²/R² adj.	*0.344/0.119/0.881*
Fisher tests	*4.305(***)*

	DV: Horizontal coopetition		
IV	***No data***	***Big data***	***Smart data***
Incremental product innovation	0.608(**)	0.286(***)	0.350(***)
R/R²/R² adj.	*0.608/0.369/0.336*	*0.286/0.082/0.063*	*0.350/0.123/0.095*
Fisher tests	*11.127(***)*	*4.447(***)*	*4.479(***)*

DV = dependent variable; IV = independent variable
(*) = p < 0.001; (**) = p < 0.01; (***) = p < 0.05

Table D. Data management and relational strategies

<table>
<tr><th rowspan="2"></th><th colspan="2">Product innovation</th></tr>
<tr><th>Incremental</th><th>Radical</th></tr>
<tr><td>No data</td><td rowspan="2">Horizontal coopetition</td><td rowspan="3">Competition</td></tr>
<tr><td>Big data</td></tr>
<tr><td>Smart data</td><td>Vertical cooperation
Horizontal coopetition
Vertical coopetition</td></tr>
</table>