Does board diversity influence innovation? The impact of gender and age diversity on innovation types

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Abstract

Previous research brought evidence of the influence of board composition for bringing strategic resources for innovation, as well as evidence of positive outcomes of board diversity. Only a few studies have investigated the effects of various indicators of board diversity on innovation. In this article, we will explore the relationship between several aspects of board diversity (gender and age) and four types of innovation, *i.e.* product, process, organizational, and marketing, from a sample of 176 French firms based on data from French Community Innovation Survey (CIS) in 2008 and annual reports. Our results show evidence of the influence of board diversity on all types of innovation except process innovation. We find significant evidence of a positive relationship between gender diversity on boards and marketing innovation, and a negative relationship between gender diversity and product innovation. Age diversity shows a positive relationship with product innovation, and a negative impact one on organizational innovation. Findings provide discussions for the impact of board diversity on innovation.

Key words Board of directors – Board composition – diversity – gender – age – innovation.

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1. Introduction

Board diversity

Diversity on boards has been receiving a growing attention for several years, as one of the most significant issue currently in corporate governance (Kang *et al.*, 2007; Mahadeo *et al.*, 2012, Bear *et al.*, 2010). Corporate governance research has shown that the analysis of composition of boards needs to pay more attention to board roles, and board members' background and characteristics, beyond the traditional monitoring and control role (Ruigrok et al., 2007). Beyond its role of ensuring the alignment of interests between shareholders and managers, dominated by agency theory and focusing on the monitoring and controlling role of boards (Daily et al., 2003), research brought evidence that another crucial role of the board of directors is to provide resources to the firm, strategic advice, knowledge, resources and networking for the company (Hillman *et al.*, 2000; Huse, 2007; Pfeffer, 1972; Mizruchi, 1996; Burt 1992).

In this perspective, many studies investigated the role of board heterogeneity and diversity on firm performance, as well as on firm strategy. Beyond the effect on firm performance, which received mixed evidence (Carter *et al.*, 2003; Siciliano 1996; De Andres *et al.*, 2005; Carter *et al.*, 2010), diversity on board has also been associated with positive cognitive effects such as creativity, innovation, new ideas and insights (Goodstein *et al.*, 1994; Ruigrok *et al.*, 2007; Kang *et al.*, 2007; Deutsch, 2005; Miller and Triana, 2009).

As Mahadeo *et al.* (2012) highlight, diversity can be seen first as an *ethical* objective, which involves much symbolism and consequently does not imply a priori a link with organizational outcomes, such as performance. In this article, we refer to a more functional aspect of diversi-

ty, linked to board heterogeneity. Following previous research (Millikens and Martin, 1996; Erhardt *et al.*, 2003; Kang, 2007), *board diversity* can be defined as variety on the composition of the Board of Directors, which can be categorised in directly *observable* aspects (e.g. gender, age, nationality ...) and *less visible* ones (educational, previous work experience, , competencies ...).

According to many studies (Murray, 1989; Carter *et al.*, 2003; Siciliano, 1996; Erhardt *et al.*, 2003) this diversity provides the firm with several advantages such as greater creativity, better understanding of the market, effective problem solving and enhanced capability. Thus, board diversity provides a competitive advantage to the firm, and long term benefits. Resource dependence theorists have argued that the integration of diverse stakeholders into the board helps the organisation to acquire critical resources (Goodstein *et al.*, 1994; Pfeffer, 1972; Pfeffer and Salancik, 1978). The promotion of diverse perspectives can produce a wider range of solutions and criteria for strategic decisions, and reduce narrow-mindedness in board proposals (Kang, 2007 ; Kosnik, 1990 : Eisenhardt and Bourgeois, 1988).

This wider variety of perspectives and issues brought by board diversity make the board more sensitive to corporate social responsibility (CSR) initiatives, and help the company to better respond to its environment and better manage CSR issues (Bear et al., *2010*).

As Huse (2007) recalls, there are also some downsides to diversity: diversity on boards may generate some coordination difficulties, and diverse boards may need more time for discussion, and may lack some cohesion. Potential conflicts and misunderstandings may prevent the board from efficient decision making (Goodstein *et al.*, 1994).

The influence of Board diversity on Innovation

As suggested by Miller and Triana (2009), the positive outcomes of board diversity help to relate board diversity to *innovation*. Board diversity provides the firm with human and social capital resources that help the board to generate ideas, allocate resources and find opportunities, thereby increasing innovation. The board of directors is a crucial factor that supports all

the innovation activities and influences the level of firm innovation (Zahra and Garvis, 2000). Innovation plays a vital role for the company, and is considered as one of the most important predictors of firm performance (Torchia *et al.*, 2011). Innovation is a key element for helping firms to gain competitive advantage (Hitt et al., 1996), expand market share (Franko, 1989) and increase their performance (Morbey, 1988).

Some research investigated the link between governance and innovation strategies, focusing notably on the relationship between board demographic characteristics and firm innovation (Torchia *et al.*, 2011). Several studies have linked board diversity to innovation, as heterogeneity on boards can lead to broader range of ideas, greater creativity, thus higher level and quality of innovation. The heterogeneity of the top management team in terms of demographic characteristics such as age, nationality, gender, racial diversity, promotes innovation and influences the ideas and types of innovation in the firm (Hambrick and Mason, 1984; Torchia *et al.*, 2011; Olson et al., 2006; Østergaard et al., 2011; Talke *et al.*, 2010; Carter *et al.*, 2010). As Torchia *et al.* (2011) highlight, only a few studies investigated the effect of such patterns of board diversity, such as *gender* or *age*, on innovation.

In their study of the relationship between board diversity and firm performance, Miller and Triana (2009) suggest that innovation takes a mediating role, and they found a positive relationship between gender diversity and innovation. Torchia *et al.* (2011) found a positive link between gender diversity and firm organizational innovation, thus focusing on one specific pattern of diversity (gender) and one specific form of innovation (organizational innovation). Consistent with these studies, this article aims at providing a better understanding of the link between board diversity and innovation, by considering *various patterns of diversity* as well as *various types of innovation*.

This paper is structured as follows: the theoretical framework and hypotheses formulation are presented in the next session. The explanation of data and methodology is detailed in the "Methods" section. Presentation of results and discussion follow in "Findings and Discussion" section. We conclude with the outcome of our study's findings and its contribution to the literature.

2. Theoretical framework

Innovation and types of innovation

Among numerous definitions of innovation and multiple concepts, we use in this article four different types of innovation: Product, Process, Organizational and Marketing innovations. This distinction is very useful in order to study the complexity of innovation strategy (OECD, 2005; Mairesse and Mohnen, 2005; Ballot *et al.*, 2012). Innovation strategy cannot be restricted to product innovation. An innovation strategy has to take into account multiple dimensions of the innovation process including R&D, cooperation, market studies, identification of customer needs, production process, organization of work, workers involvement and commercialization of the innovation.

Thus, while most studies are based on traditional measures of innovation (R&D, patents, publications, number of innovative project, percentage of innovative products on sales), we study probability to introduce types of innovation and board composition at the firm level using four types of innovation based on the 2008 CIS database (described below).

Boards need to pay attention to the various types of innovation: research in innovation shows that introducing different types of innovation (*product, process, organisational, marketing*) can provide greater performance (Mairesse and Mohnen, 2005; Mohnen and Roller, 2005; Laursen and Foss, 2003). In their study exploring the effects of governance and ownership on company's innovation and venturing activities, Zahra *et al.* (2000) used a comprehensive measure of innovation including product, process, and organizational innovation. Despite the importance of product innovation, they argue that little attention has been paid in previous studies to other types of innovation, such as process and organizational innovation. In our analysis of the influence of board diversity on innovation, we will take into consideration this *diversity of types* of innovation (Ballot *et al.*, 2012; Ennen and Richter, 2010; Leiponen, 2005).

Types of diversity on Board and types of Innovation: Hypotheses

When considering the effects of diversity in board composition, several kinds of diversity must be taken into account (Huse, 2007): do some kinds of diversity have a more significant impact than other kinds of diversity? In this way, we test the impact of board diversity on innovation by investigating two types of diversity: *gender* and *age*.

Gender diversity on board and innovation

Gender turns out to be probably the most debated diversity issue in board composition (Huse, 2007; Kang, 2007; Mahadeo *et al*., 2012). Various quota systems have appeared in legislation over the last years to promote gender diversity in board composition, first in Norway in 2005, and then in other countries like France, Spain, Italy, Netherlands. Thus the gender diversity issue is especially relevant within the recent movement of increasing selection of women on boards. In France, for example, a new law adopted in January 2011 decreed that the proportion of female directors should not be lower than 40 % in all major companies by 2017 (20% by 2014).

Women on boards bring specific perspectives, experiences and working styles in comparison with their male counterparts, they bring different knowledge and expertise (Daily and Dalton, 2003; Hillman et al., 2002; Huse, 2007). This broader range of ideas and perspectives helps to identify new innovative opportunities (Miller and Triana, 2009). We can thus expect that the presence of women on boards may contribute positively to firm innovation: women directors bring to the board different values (Selby, 2000) and different expertise that may positively influence the level of innovation (Torchia *et al*., 2011). This specific expertise and knowledge may contribute to broaden the range of new products and services. For Millikens and Martins (1996), diversity in characteristics such as gender has cognitive consequences: a broader range of ideas, as well as an increased number of ideas. Gender diversity thus may contribute to *product* innovation, as more diverse ideas, in their number and in their diversity, may increase the likelihood to introduce new products or new services by the company. In their study of the relationship between employee diversity and innovation, Østergaard et al. (2011), found a pos-

itive relationship between gender diversity and the likelihood to introduce a new product or service. This suggests than we can expect gender diversity on boards to be positively related to firm's *product innovation*.

According to Kang *et al.* (2007), women on boards may have a better understanding of consumer behaviour, the customer needs, and opportunities for companies in meeting those needs. Previous research points out that women have an intimate knowledge of consumer markets and customers, and that one main effect of the inclusion of gender diversity on boards was to broaden the spectrum of ideas and perspectives considered to identify opportunities (Hillman et al., 2002; Miller and Triana, 2009). We can then expect that gender diversity on boards would influence innovation, in particular *marketing innovation.*

Other researchers argue that *organizational innovation* is more appropriate to focus on, when dealing with the contribution of female directors to firm innovation, as this form of innovation may be more "people-oriented" and influenced by specific individual characteristics (Torchia *et al.*, 2011). This suggests that gender diversity influences positively firm's *organizational innovation.*

Following these discussions, we can formulate these hypotheses:

H1a: Gender diversity is positively related to firm's product innovation.

H1b: Gender diversity is positively related to firm's organizational innovation.

H1c: Gender diversity is positively related to firm's marketing innovation.

Age diversity on board and innovation

Traditionally, most members of corporate boards are mature, experienced, and by default senior directors (Kang et al., 2007). This can be explained by the inherent nature of company management and career evolution, which results in considering retired executives or executives which had a significant work experience in other companies in the same industry as ideal non-executive board members (Gilpatrick, 2000). Still, age diversity on boards helps the company to benefit from the different perspectives of different age groups, and the value of having

the perspectives of younger directors on boards is emerging as an aspect of diversity worthy of attention (Walt and Ingley, 2003). Age diversity on boards encourages board development and learning, which may foster creative and innovative ideas. Mahadeo *et al.* (2012) found a significant positive relationship between age diversity on board and firm's corporate performance. They suggest that with age diversity, a board can consider the various strategic and operational aspects in a more effective way. Kang *et al.* (2007) argue that diversity in age of directors helps the board to bring different perspectives, and for example to target firm's customers in different age groups with a variety of products and services. Then, the best way to represent the interest of customers, and increase the customer-board interaction (Huse and Rindova, 2001), would be to have directors from different age groups. We can thus expect that age diversity on board have a positive effect on *product innovation* and *marketing innovation*. Kang et al. (2007) found that companies in the consumer services and products industry are more likely to appoint directors in a more diverse age range. They conclude that in order to deal with a wide range of customers' needs and interests, boards have an advantage when their directors reflect this age range.

Still an age-diverse board needs a division of labour at board level: the older group provides experience, network, financial resources, the middle-aged group is in charge of the main executive responsibilities, and a younger group develops its knowledge of the business (Mahadeo *et al.*, 2012). Therefore this wider range on business may generate conflicts between generations, and make age differences more visible and difficult to coexist. There is an expectation that most directors are mainly former managers from various companies who are now in the position to sit on other corporations and enjoy their retirement (Kang, 2007), whereas younger people have the energy and the drive to succeed, and plan ahead for the future (Ibid., p. 196). As recalled by Huse (2007), this might reveal what the author calls the 'downsides' of diversity: difficulties for maintaining cohesion, for coordination, for building a common understanding. These potential generational conflicts or misunderstandings between different interests or expectations might be especially dangerous for organizational change. Thus *organizational innovation*, which is more 'people-oriented', is impacted by the confrontation of mental and cognitive processes (Torchia *et al.*, 2011). The greater diversity in interests and

expectations, the greater potential for conflicts and diverging definitions of organizational goals and policies (Goodstein *et al.*, 1994).

As regards age diversity and innovation, we can then formulate these hypotheses:

H2a: Age diversity is positively related to firm's product innovation.

H2b: Age diversity is negatively related to firm's organizational innovation

H2c: Age diversity is positively related to firm's marketing innovation.

3. Methods

Data collection and sample

For this study, we use information on innovation from the 6th Community Innovation Survey (CIS 6) in 2008 for France. CIS data is based on firm-level surveys that ask organizations to report information on their individual level and form of innovative efforts. Although definitions of innovation and examples are provided to respondents, all the information relies on self-reported information by managers within these organizations and therefore it has a strong subjective element (OECD, 2005). Despite this subjectivity, the perception of firm's respondents on innovation highlights the involvement of individuals in the innovation process (Torchia *et al.*, 2011).

The data has the advantage of being *comprehensive*, as it covers all sectors of the private economy and *detailed*, as it captures information on many different aspects of firm's innovative efforts. Over time, it has become a central tool for researchers working on understanding the innovation process, and there have been over 100 published papers in academic journals using these data, including leading economic and management journals (see Smith, 2005). The 6th Community Innovation Survey in France was carried out by SESSI (Ministry of Economics, Finances and Industry) in 2008, covering the 2006-2008 period.

In order to complement these data on innovation with governance data, we had to find disclosed information about board composition and directors, on age, gender as well as infor-

mation about independence of board members. Information on board diversity was collected from the company's annual report under the "Board of Directors" and/or "Corporate Governance Report" sections. Companies were excluded from the sample if the relevant information on age, gender, and independence of their directors was unavailable either in the annual report or on their corporate website. All sample companies disclosed how they defined director independence and whether these definitions are consistent with the recommendations and definitions provided by the MEDEF reports and recommendations, as well as "Bouton report", on the date of annual reports publications. These two reports are references for French companies, and have often been used in research involving French governance data for independence of directors (Piot, 2006; Chouchane, 2010; Godard and Schatt, 2005).

In order to take into account the impact of board composition on innovation, we collected board data from 2005 reports, which means board composition at the beginning of 2006. As Mairesse and Mohnen (2005) argue, innovation decisions need some time to be implemented and put into action. We can thus expect that board composition at the beginning of 2006 impacted innovation implementation between 2006 and 2008. In their study of the relationship between employee diversity and innovation probability, Østergaard *et al.* (2011) used end of 2002 data for gender and age diversity and a survey covering 2003 to 2005 for innovation probability.

After data collection, our dataset consists of 176 French firms. Descriptive analysis is provided in the Findings section.

Measures

Appendix A provides a summary description of our variables, and summarized descriptive statistics.

Innovation variables:

Product innovation was taken from a question on CIS survey to whether the firm had developed a product that was new for their market. The question defined product innovation as the

market introduction of a new good or service or significantly improved good or service respective to functionalities. Following this definition, we defined *Product innovation* as dummy variable, equal to 1 if the firm introduces any new or significantly improved goods and/or services, and 0 otherwise. Similarly, following CIS survey, we defined *Process innovation* as a dummy variable equal to 1 if the firm introduces any new or significantly improved processes for producing or supplying products (goods or services), and 0 otherwise. In CIS survey, an *Organizational innovation* is defined as one of the following: new or significant improved organizational or management processes (e.g. knowledge management, quality management …), important modifications of work organization within the firm (e.g. teamwork organization, power delegation, training system …), or organizational methods for external relations with suppliers or partners (e.g. first time setting of alliances, partnerships, subcontracting …). *Organizational innovation* has been defined as a dummy variable equal to 1 if at least one of the previous actions was implemented. *Marketing innovation* is a dummy variable equal to 1 if the firm implements any changes in marketing concepts or strategies over the data period (e.g. significant change in positioning, design, packaging, new techniques for promotion, selling, pricing …).

These variables are all dependent variables, binary variables (1 when a firm introduced the associated innovation over the study period, 0 otherwise), that have been tested in our statistical models.

Board diversity variables:

These variables are independent variables in our models.

Women is the percentage of female directors on the board of firms of our sample. This estimation of gender diversity as a proportion of board size reflects the extent of female directors appointments to the board, and the extent of board homogeneity (0%) or heterogeneity (100%), as suggested by Mahadeo *et al.* (2012).

The age range of directors is an important indicator of board diversity. Following several studies testing age diversity on board (Kang et al., 2007; Mahadeo et al., 2012), we have categorized age diversity at board level by the number of age bands present in firm's board, ranging from one band (no diversity at all) to having all 5 age bands (very diverse). *Age Range* variable counts the number of age bands in firm's board (from 1 to 5).

Control variables:

We control for several variables influencing the probability to innovate in each of the previous innovation type. First, as *size* is a critical variable in determining innovative outcomes (Cohen, 1995), we have controlled for firm size by using the share of full time equivalent staff. Second, since investments in R&D are often a precursor to innovative outcomes and they help firms more successful to absorb knowledge from outside their firm, we have included a measure of R&D expenditures per FTE employee for each firm (Cohen and Levinthal, 1990), called *R&D*. Third, investing in training is a signal that firms invest resources in improving the quality of their employees and therefore we have introduced a dummy variable *training* indicating if the firm invested in training for innovation. Fourth, research has shown that firms that cooperate with external organizations are more likely to innovate and, given this, we have included a dummy variable *cooperation* to measure if the firm had a formal collaborative arrangement with an external organization (Ahuja, 2000; Tether, 2002). Fifth, as past research has found that firms open to external ideas were more likely to innovate and this openness variable also appears to explain management innovation, we have included a measure of openness (Laursen and Salter, 2006; Mol and Birkinshaw, 2009). To construct this measure, we have used the same approach as Laursen and Salter (2006), simply counting up the number of times a firms indicates it drew knowledge from ten possible sources of external knowledge, giving us a variable *openness* that has a value of between 0-10. Finally, as patterns of innovation may differ according to whether the firm operates in an industrial sector, we have included a dummy *Manufacturing* for whether the firm belongs or not to the manufacturing sector.

We also controlled for several board characteristics most often investigated in relation to the influence of board diversity (Kang *et al.*, 2007; Mahadeo *et al.*, 2012) and in particular in

studying the relationship between board diversity an innovation (Miller and Triana, 2009; Torchia *et al.*, 2011): *Board size* was measured as the total number of members with voting rights at the board, and *Independent* is the percentage of independent board members on the board. As previously mentioned, independence of each director was assessed according to the reference definitions provided by the MEDEF reports and recommendations, as well as "Bouton report", at the date of annual reports publications.

Analysis

Tables 1 and 2 respectively provide descriptive statistics on gender diversity and age diversity on board from our data. We use probit regression models to examine the relationship between board diversity indicators (age and gender) and the probability to innovate in four types of innovation. Appendix B presents descriptive statistics on Pearson correlations between our variables.

In order to test hypotheses, we use 4 regression models for each type of innovation we identified. Model 1 tests the relationship between board diversity and *product innovation*, Model 2 relates to *process innovation*, Model 3 relates to *organizational innovation* and Model 4 to *marketing innovation*. Table 3 shows the result of our regression models. We discuss the findings in the following section.

4. Findings and discussion

Descriptive analysis

Appendix A shows descriptive results about firms' types of innovation. Among the 176 firms included in our sample, 114 (65%) implemented *product innovation*, thus introduced at least one new or significantly improved good or service from 2006 to 2008. Product innovation is therefore the most often implemented type of innovation, by firms of our sample. By decreasing rank, 111 firms implemented *process* innovation (63% of our sample), 109 firms (32%) implemented *organizational* innovation, and finally 83 (47%) *marketing* innovation. We also

checked the number of firms which did not implement any innovation at all: 142 firms introduced at least on type of innovation among 4 (80.7%), thus 34 firms (19,3%) did not introduce any innovation of any kind.

Product innovation seems higher in our sample than in some other studies. In their study involving 3 types of innovation (product, process, organizational), Ballot *et al.* (2012) found that 52% of French firms in their sample implemented product innovation from 2002 to 2004, 75% did process innovation and 66% organizational innovation. With only one type of innovation studied, Østergaard et al. (2011) found that 55% of firms of their sample implemented product innovation from 2003 to 2005.

The average *board size* of our sample is slightly higher than 15, which is quite high in comparison to other studies. These differences can be strong according to the country studied: Kang (2007) found an average board size of 8 in Australian companies, Torchia *et al.* (2011) found an average board size of 7 in Norwegian companies, and Godard and Schatt (2005) also noticed a higher average board size on French firms of their sample (more than 11) in 2002. 46% of directors on average were *independent* board members, which is line with results for France of Godard and Schatt (2005).

Gender diversity is displayed especially on Table 1, which shows that overall there are quite few female directors in our firms' board: on average, 64 firms (36%) had no female director at all, thus 112 firms (about 64%) had gender diversity represented on board. A main proportion had only one female director (47%). Only 10% had 2 women on board, and 10 firms (around 6%) 3 or more. The average percentage of female directors on boards is slightly less than 6%. This low level is consistent with previous studies: Kang *et al.* (2007) had a percentage of 10% on Australian firms, Torchia et al. (2011) found 7% with Norwegian firms, and Mahadeo et al. (2012) only 3% on Mauritanian firms. Carter et al. (2010) had an average number of 1.3 women in boards on a sample of US companies. We find an average number of less than 1 (0.87) female director in board. This great proportion of companies having less than 2 female directors in board is consistent with previous research on the "tokenism" approach with women participation on boards (Adams and Ferrara, 2009; Torchia *et al*., 2011).

Table 1 Gender diversity and gender representation across boards

Gender	*Frequency (Nb. of firms)*
No Female directors	36.4% *(64)*
One Female director	47.7% *(84)*
Two Female director	10.2% *(18)*
Three Female director	3.4% *(6)*
Four Female director	2.3% *(4)*
Total	100% *(176)*
At least one Female director	63.6% (112)
Women (%):Female director proportion	Average 5.76% (Std 6.08) Min=0; Max=28.57%

Sources: French CIS2008 and Annual Report.

Table 2 Age range and age diversity across boards

Age	*Frequency (Nb. of firms)*
Age range: number of age bands in the board	
Board includes one age band	0% (0)
two age bands	11.4% (20)
three age bands	36.4% (64)
four age bands	35.2% (62)
five age bands	17.1% (30)
Total	100% *(176)*
AgeRange: Nb of age bands present in company's board	Average 3.56 (Std 0.90) Min = 2; Max = 5
Age diversity	
At least one Director under 41 in the board	34.1% *(60)*
At least one Director between 41 and 50	59.7% *(105)*
At least one Director between 51 and 60	96.6% *(170)*
At least one Director between 61 and 70	100% *(176)*
At least one Director over 71	67.6% *(119)*

Sources: French CIS2008 and Annual Report.

Age diversity is also an important indicator of board diversity, and our Table 2 shows that directors between 61 and 70 are the most represented on boards: all companies (100%) have this age band represented on their board. This is closely followed by directors between 51 and 60 (96% of companies). Only 34% of firms have at least on director under 41, but the last age band (directors over 71) is still quite highly represented (67% of companies have at least one director over 71 in their board). The average *AgeRange* variable is 3.56, which means that on average companies of our sample cover 3.56 age bands. No company had only one age band on board (which would mean no age diversity at all), and only 17% of firms have a full age diversity (5 age bands on board). These findings are consistent other similar studies (Kang et al., 2007: Mahadeo *et al*., 2012).

The effect of board diversity on innovation

Appendix B shows Pearson correlations between our variables, and the results of probit regression models are shown in Table 3.

As suggested in the literature review, we find significant evidence that *Board characteristics influence innovation*. All types of innovation have significant relationships with board diversity variables, except *process* innovation. Models 1, 3 and 4 show significant correlations with board variables, which shows the crucial influence of board and board composition on innovation (Miller and Triana, 2009; Zahra and Garvis, 2000; Huse, 2007).

Our study contributes to literature by differentiating between the various types of innovation: process innovation seems to be less impacted by board diversity and composition than other types. *Process* innovation was defined as the use of new or significantly improved methods for the production or supply of goods or services, which involves mainly technical and operational dimensions, and excludes most organizational or managerial changes (Ballot *et al.*, 2012). We can conclude that board influence is weaker on these aspects, which might be more operational and less impacted by strategic changes than other types of innovation.

Model 4 gives *significant support to our first hypothesis H1c*: *gender diversity plays positively on marketing innovation*. This brings evidence to the positive output of gender diversity regarding the understanding of consumer behaviour, customer needs, as well as means and opportunities for firms to meet those needs (Kang, 2007; Mahadeo *et al.*, 2012). This supports the argument that female directors bring specific perspectives and experiences, different knowledge and expertise (Daily and Dalton, 2003; Hillman et al., 2002), that result in a positive influence of board's ability to generate relevant innovations for targeting customers' needs and markets.

Table 3: Explaining four types of innovation (Product, Process, Organizational and Marketing) using Probit Models.

	Model 1		*Model 2*		*Model 3*		*Model 4*	
	Product innovation		*Process innovation*		*Organizational innovation*		*Marketing Innovation*	
	Coef.	z	Coef.	z	Coef.	z	Coef.	Z
Board diversity								
Women (%)	-8.871***	3.50	1.853	5.48	2.231	4.23	6.175*	3.33
Age range	0.700*	0.36	0.170	0.36	-0.610*	0.34	-0.210	0.19
Innovation control variables								
R&D (log)	-0.378*	0.21	0.355	0.25	-0.011	0.26	-0.037	0.18
Training	1.201**	0.68	0.810*	0.49	1.191**	0.48	0.930**	0.37
Cooperation	-1.724*	1.02	1.705***	0.45	1.327**	0.63	0.212	0.38
Openness	0.227**	0.11	0.123	0.08	0.175**	0.07	0.034	0.06
Other control variables								
Board size	-0.157*	0.08	0.019	0.08	0.038	0.06	0.077	0.05
Independent (%)	-3.839***	1.52	-0.017	1.06	-0.157	0.75	1.064	0.73
Size	-0.124	0.39	0.093	0.41	0.185	0.32	0.240	0.22
Manufacturing sector	1.266***	0.51	-1.812*	0.73	-1.994**	0.78	-0.459	0.45
Constant	4.846**	2.35	-2.474	1.78	0.586	1.47	-2.627**	1.32
Pseudo R2	0.409		0.397		0.387		0.158	

Sources: French CIS2008 and Annual Report.

Significance levels at *** 1%, ** 5% and * 10%.

Model 3 *does not give support to hypothesis H1b*. Contrary to our expectations, *gender diversity does not play significantly positively on organizational innovation*. The positive but not significant coefficient prevents us from giving support to the finding of Torchia *et al.* (2011), about the influence of female directors on this specific type of innovation.

Torchia et al. argued that the impact of female directors on organizational innovation should be positive because of the 'people oriented' focus and the higher relation to cognitive processes of this particular type of innovation, in comparison to process innovation for example. They found a positive relationship studying the only organizational type of innovation. We can postulate that *marketing innovation* might partly include some cognitive or 'people-oriented' dimensions related to organizational innovation. As suggested by Ballot et al. (2012), some overlapping effects might exist between those 2 types of innovation. The authors suggest that much greater progress and attention will need to be placed on the measurement and conceptualization of this organizational form of innovation, if a greater understanding of its sources and impacts on performance are to be realized in the future. For example, in the UK version of Community Innovation Survey (CIS), a term 'wider innovation' is used and combines both organizational and more 'marketing' dimensions, contrary to the French CIS survey.

Model 1 shows that *gender diversity plays negatively and significantly on product innovation*. Thus this model *does not give support to our hypothesis H1a*. This is in contrast with previous findings, such as Østergaard *et al.* (2011), which find a positive relationship on a sample of Danish firms between gender diversity and innovation, defined as "the introduction of a new product or service" (Ibid., p 504) by the company, thus very close to CIS *product innovation* definition. These contrasted results from hypotheses H1a to H1c contribute to enrich the analysis of the contribution and impact of board gender diversity to innovation: our results tend to highlight that women on boards bring more impact in terms of understanding and targeting consumers' needs and markets, than on introduction itself of new products or new services.

Model 1 also brings significant evidence of a *positive relationship between age diversity and product innovation, which supports our hypothesis H2a*. This result is consistent with suggestions from Walt and Ingley (2003) about the positive influence on board of a wider range of perspectives brought by an age-diverse board. Diversity in age of directors helps the board for innovating on a wider variety of products and services (Kang, 2007).

Contrary to our expectations and previous findings, Model 4 does not show a *significant relationship between age diversity and marketing innovation*, which *does not support our hypothesis H2c*. Previous research suggested that an age-diverse board is more able to target firm's customers in different age groups with a variety of products and services, and to represent the interest of customers (Kang, 2007), which would and increase the customer-board interaction (Huse and Rindova, 2001).

The downsides of age diversity on organizational innovation suggested by previous research are shown by Model 3, which brings evidence of a *significant negative association between age diversity and organizational innovation*. This gives *support to our hypothesis H2b*. The difficulties for cohesion and common understanding suggested by previous research about age diversity and potential conflicts of interests between different age groups play negatively of firm's probability to implement *organizational innovation*. This finding is in line with Zajac et al. (1991), who argue that age diversity generates disagreements that lead to lower innovative performance.

Our study thus contributes to the literature by showing evidence that age diversity on boards is more suitable for promoting product innovation than organizational innovation. By taking different types of innovation into account, our research allows to *differentiate the benefits of board diversity* on innovation.

Control variables on boards bring evidence of interactions with *product* innovation. In Model 1, *board size plays negatively on the probability to implement product innovation*, as well as the proportion of *independent members*. This last finding is consistent with previous research, which shown that 'insiders' directors bring a specific background and knowledge that helps innovation. Whereas traditional corporate governance arguments are in favour of independent outside directors rather than inside directors (Fama and Jensen, 1983; Hoskisson *et al.*, 2002), an insider status can support innovation activities, because they have a good knowledge of the business, more attention on internal development, and are more willing to adopt new product development strategies (Hoskisson *et al.*, 2002). Because of innovation activities are long-term and unpredictable, the cost and time for assessing these attributes are high for outside

directors (Holmstrom, 1989). Zahra *et al.* (2000) found a negative association between outsider representation and innovation and venturing activities. They argued that outside directors may not devote sufficient time to understand managerial decisions, and that inside directors are better suited to promote innovation activities. Consistent with our results, the insider status of board members may be thus favourable to innovation activities, by bringing a good knowledge of strategies and operations (Bear *et al.*, 2010). This is supported by the *negative significant association shown in Model 1* between the proportion of independent board members and the firm's probability to implement product innovation. Our result related to *board size*, showing evidence of a *significant negative association with product innovation*, is in line with the negative impacts of board size on the ability to initiate strategic actions, and on board's internal dynamics to face complex environments (Goodstein *et al.*, 1994).

Innovation control variables illustrate some previous results. As shown by our findings, the impact of board diversity on innovation appears weaker on *process* innovation. In addition to our previous suggestion related to the more technical and operational aspects involved by this form of innovation, Model 2 shows that process innovation is significantly explained by *cooperation*. This shows that process innovation is mainly influenced by inter-firm relationships or relationships with different partners (competitors as well as clients, suppliers, and universities). This suggests that process innovation is less influenced by internal strategic orientation given by the board than by external relationships and partnerships. This explanation is coherent with our findings, which show evidence of this weaker impact of board diversity on *process innovation*.

Despite the importance of obtaining external information, cooperation involves sharing knowledge and information about innovation, which might be an obstacle for firms whose innovation needs a degree of protection (Ballot *et al.*, 2012). The degree of protection of firm's innovation is an important theoretical determinant of the effort to innovate. CIS data are interesting in that respect since they distinguish between formal and informal protection. Informal protection through secrecy, complexity of design or lead time on competitors is always a very significant factor which encourages innovation. Formal protection has been shown as definitely important for *product* innovation especially in previous studies (Ballot *et al.*, 2012), which

makes product innovation especially impacted by the ability to ensure this protection. This is consistent with the *negative significant association* shown in Model 1 between *cooperation* and *product innovation*.

In all models, all types of innovation show evidence of a significant positive association with *training*, this is in line with the view that the implementation of these innovations requires adapting human skills in the firm. The significant association with *Openness* is in line with the importance to draw knowledge from external sources of knowledge when a firm wants to implement innovations (Laursen and Salter, 2006). The firm's belonging to *manufacturing* sector generates more product innovation than other sectors, but influences negatively the probability to innovate in process and organizational innovation. These results concerning innovation control variables are in line with traditional results in innovation research (Mairesse and Mohnen, 2005; Mohnen and Roller, 2005). R&D efforts (*R&D* variable in our models) have a significant and negative impact on *product* innovation, which is in contrast with previous studies (Cohen and Levinthal, 1990; Mairesse and Mohnen, 2005).

Conclusion

By looking at the impact of various types of diversity on innovation, and by taking into account various types of innovation, this article brings theoretical and practical insights to board diversity issues.

One main outcome brought by the consideration given to several types of innovation is a deeper understanding of the link between board composition and innovation, which allows to differentiate board's influence according to different types of innovation. As Zahra *et al.* (2000) argue, little attention has been given in literature to other types of innovation than product innovation, such as process and organizational innovation. Our findings bring evidence of significant associations between board diversity and 3 types of innovation: *product innovation, organizational innovation* and *marketing innovation*. Board's influence is weaker on *process* innovation.

As Torchia et al. recall (2011), very few studies focus on the contribution of gender diversity to firm innovation. We contribute to filling this gap by bringing significant results that help to take a deeper look at gender diversity's impact on innovation: in our findings, gender diversity helps the board to generate *marketing innovation*, which supports the promotion of gender diversity by bringing differentiated results according to the type of innovation implemented. As suggested in Carter *et al.* (2003), diversity may often remain a 'loaded' term which involves much symbolism and not enough practical and precise outcomes for performance or innovation. This paper aims at precising these outcomes by studying various impacts of gender diversity on innovation. If the impact of gender diversity on *marketing* innovation has been shown as significant, our results did not show significant impact on *organizational* innovation, and revealed a negative impact on *product* innovation.

Despite the fact that gender diversity is the most often debated issue when dealing with diversity on boards (Huse, 2007), our findings also encourage a broader look at diversity in board composition by showing significant evidence that *age diversity* is worth taking into consideration. Age diversity has been significantly associated to firm's probability to implement *product* innovation in our sample. Our results are consistent with the necessity to take a deeper look at diversity's advantages as well as downsides: we bring evidence that age diversity on board might bring difficulty to firm's ability to implement *organizational* innovation. Beyond our independent variables related to board diversity, we also shown in our results some negative impacts on product innovation of board size and of the proportion of independent members on board. This latter finding enriches the issue of board composition, suggesting that insiders are worth taking into consideration for generating product innovation.

Future research may explore further the impacts of board diversity, by taking into account a possible 'critical mass' effect, in order to address to potential 'tokenism' image of board diversity or any minority group on board, as suggested by Torchia *et al.* (2011). Indeed, the effects that different sizes of minority groups could have on board tasks and firm value seem to be under-researched (Terjesen *et al.*, 2009). Minorities can be marginalized if their presence in a larger group is modest, thus their representation on Board can be viewed as a symbol or a to-

ken. This 'critical mass' might affect the influence of board diversity on innovation, for gender as well as for age diversity.

Future studies on board diversity could focus on a *deeper level analysis* within the firm: beyond diversity among board members, heterogeneity relate to various dimensions and levels within the firm, including interactions with employees and executive teams (Harrison *et al.*, 1998). As recalled by Østergaard *et al.* (2011), this would be all the more relevant in studies related to innovation, since the innovation process involves interactions between several employees at different levels in the firm. *Deep-level* analysis of diversity should also involve, even at the sole Board level, a look at broader composition of skills, knowledge, and various backgrounds of board members. The cognitive dimensions of board (Hillman *et al.*, 2000; Huse, 2007; Pfeffer, 1972; Mizruchi, 1996) and their impact on innovation would benefit from the inclusion of diversity variables in knowledge and expertise, even if these are less visible dimensions of diversity (Millikens and Martin, 1996).

As regards methods, longitudinal analysis could analyze if persistent innovative firms include more diversity in their board, or if firms with board diversity become more innovative. This could bring further insights about the relationship between diversity and innovation. Our study does not take into account the likely combination in innovation types: further research could take a look at combination strategies for innovation (Ballot *et al.*, 2012) and their relationship with diversity. In this perspective, interactions may exist also between types of diversity at board level: other studies could test the likeliness of moderating or mediating effects between diversity indicators, as well as between diversity indicators and board involvement in strategy or board tasks, as suggested by Torchia *et al.* (2011). Finally, the influence of board diversity on innovation might be impacted by country-specific dimensions, whether cultural or institutional, which could enrich further analysis of this topic by some international comparisons.

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Appendix A: Definition of variables and descriptive statistics.

Name of variables	*Description*	*All firms (N=176)*
Dependent variables		
Product innovation	If the firm introduces a new or significantly improved goods and/or services (0,1)	64.8 % *(114)*
Process innovation	If the firm introduces any new or significantly improved processes for producing or supplying products (goods or services) (0,1)	63.1 % *(111)*
Organizational innovation	If the firms introduces one of the following item: new or significant improved organizational or management processes, important modifications of work organization within the firm, or organizational methods for external relations with suppliers or partners (0,1)	62.0 % *(109)*
Marketing innovation	If the firm implements any changes in marketing concepts or strategies (0,1)	47.2 % *(83)*
Board diversity		
Women	Percentage of women directors in the board	*5.76% (Std 6.08)* *Min=0; Max=28.57%*
Age Range	Nb of age bands present in company's board	*3.56 (Std 0.90)* *Min = 2; Max = 5*
WomenNb	Number of women in the board	*0.87 (Std 0.89)* *Min = 0; Max = 4*
MenNb	Number of men in the board	*15.05 (Std 0.89)* *Min = 4; Max = 20*
Innovation control variables		
R&D	Amount of internal R&D expenditures per employee (in Euros and logs)	3.68 (Std 1.23)
Training	Dummy for firms investing in training for innovation (0,1)	77.9 % *(102)*
Cooperation	If innovation cooperation arrangements with other firms or institutes (0,1)	80.2 % *(105)*
Openness	Number of 'important' or 'very important' sources of innovation: internal, suppliers, customers, consultants competitors, universities, public research institutes, conferences, scientific and trade publications, and professional and industry associations (0-10)	5.98 (Std 3.23) *Min = 0; Max = 10*
Other control variables		
Board Size	Size of the firm's board (nb of directors)	*15.82 (Std 3.79)* *Min = 5; Max = 21*
Independent	Percentage of independent directors in the board	*0.46 (Std 0.22)* *Min = 0.11; Max = 0.87*
Size	Log of number of FTE employees	4.81(Std 0.12)
Manufacturing	Dummy for firms belonging to Manufacturing sector (0,1)	41.5 % *(73)*

Sources: CIS2008 France and Annual reports. Number of firms in brackets.

Appendix B: Correlation Matrix (176 firms)

	Board size	Women (%)	Age range	Independent (%)	R&D (log)	Training	Cooperation
			Board composition				
Women (%)	-0.16**	-					
Age range	0.29***	0.04	-				
Independent (%)	-0.57***	-0.14**	-0.04	-			
			Innovation variables				
R&D (log)	-0.29**	-0.13	0.22**	0.12	-		
Training	0.09	-0.15*	0.12	-0.01	0.16	-	
Cooperation	-0.21**	-0.07	0.11	0.13	0.22	0.19**	-
Openness	-0.14*	0.10	0.20***	0.10	0.36	0.12	0.25***
			Control variables				
Size	0.12*	-0.02	0.01	-0.21	0.39	0.13	0.14
Manufacturing sector	-0.22***	-0.23***	0.23***	0.20***	0.63***	0.06	0.28***

Sources: French CIS2008 and Annual Report.
Significance levels at *** 1%, ** 5% and * 10%.