

An exploratory analysis of the board composition in Spanish innovative firms

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ABSTRACT

The main goal of this work is to develop an exploratory analysis of the board composition of Spanish companies that belong to innovative economic sectors. We seek to contribute to the inconclusive literature that analyses the relationship between board composition and innovation, exploring the characteristics of the board in an organisational context of innovative behaviour. To do so, we collected data from 86 Spanish companies belonging to innovative sectors from 2003 to 2011. The results confirm the relevance of medium size boards with a majority of affiliated directors and CEO duality; male directors are predominant, but the proportion of women, despite its minimum level, is significantly growing. There are relevant differences in the board composition of different Spanish innovative sectors. However, its evolution over time is quite stable, with the exception of the proportion of women on the board. This board composition is characteristic in situations in which the innovative behaviour of companies is significantly improving.

KEYWORDS

Board size, gender diversity, typology of directors, CEO duality, innovation, Spain.

1. Introduction

Previous research has established the relevance of innovation for the success and survival of firms (Kor, 2006; Morgan & Berthon, 2008; Stopford & Baden-Fuller, 1994; Torchia *et al.*, 2011). It is frequent that the search for competitiveness makes companies bet on innovative actions to obtain new or improved products and services (O'Brien, 2003), and to enhance their market shares (Ettlie, 1998).

There are different and varied factors that influence companies' innovation strategies, both at an external and internal level (Cassiman & Veugelers, 2006; Tsai & Wang, 2007). Internally, research has emphasised the effects of different aspects of corporate governance on innovation because corporate governance explains how the power for decisionmaking is distributed and exercised in companies, affecting the strategies planned and finally implemented (Lacetera, 2001). Amongst the different mechanisms of corporate governance, management teams and board of directors have a direct responsibility in decision making. In fact, boards are the formal representation of ownership, and exert their influence on managerial decisions and strategies, exercising their main functions as monitors and supervisors of managers (Petrovic, 2008), and as advisors and support agents on strategy formulation (Kemp, 2006; Wu, 2008).

However, boards of directors are not homogenous groups always with the same characteristics, performance and results. Thus their effects and influences on corporate strategies, including innovation, cannot be predicted in a simple way. This explains the interest of research in trying to ascertain what the determinants and characteristics of boards are that might explain their functions and performance, and lastly their influence on strategies like innovation. One of the board elements more frequently analysed by research has been the board composition, considering aspects like the optimal board size (Cheng, 2008; Peasnellet *et al.*, 2005; Zahra & Pearce, 1989), gender diversity (Burke, 1997, 2003; Cassell, 2000; Singhet *et al.*, 2001), typology of directors (Coles *et al.*, 2008; Hillman *et al.*, 2002; Kor, 2006; Markarian & Parbonetti, 2007), CEO duality (Guilletet *et al.*, 2013; Lan & Lee, 2008; Penget *et al.*, 2010), tenure diversity of directors (Galia & Zenou, 2012), etc. However, despite the previous efforts, there is not a high consensus about the real influence of board composition on innovation and what should be the optimal board composition to assure appropriate innovative behaviour of companies (Galia & Zenou, 2012; Hernández *et al.*, 2010; Kor, 2006; Torchia *et al.*, 2011; Zona *et al.*, 2013). This has led researchers to doubt whether or not there is a direct influence of board composition on innovation (Bianchi *et al.*, 2012; Galia & Zenou, 2012).

These results justify the main objective of this study, which is to develop an exploratory analysis of the board composition of Spanish companies that belong to innovative economic sectors. That way, we aim to contribute to the literature not by trying to explain or predict innovation through board composition, but by analysing the main characteristics of the board in companies whose innovative behaviour has been improving, and seeing how these characteristics have been evolving over time, and if there is a characteristic variability profile in the board composition of Spanish firms belonging to innovative sectors.

2. Literature review on the effects of board composition on innovation

There are many studies that suggest and try to demonstrate what the effects of board composition on innovation are, but few conclusive results have been obtained.

In fact, past researchers do not consider the same theoretical framework to describe this relationship. Their theories propose different, and at some point, contradictory assumptions. One of the most popular theoretical frameworks to analyse the relationship between board of directors and innovation is the agency theory (Galia&Zenou, 2012; Zona, 2012). It states that the separation of ownership and control causes agency costs, due to the different interests and objectives of owners and managers (Fama& Jensen, 1983; Jensen, 1989). According to this theory, there could be an opportunistic behaviour in managers (Lee & O'Neill, 2003), and the board should monitor the management team to reduce agency costs. Minority shareholders are likely to be risk-neutral because they usually have diversified portfolios (Wiseman & Gómez-Mejia, 1998). Managers and large shareholders, on the other hand, might have a negative attitude towards innovation (Franks & Mayer, 2001) because they normally assume greater risks with their employment and investments concentrated in a single or few companies (Daily *et al.*, 2003; Letzaet *al.*, 2004).

However, agency theory is not the only theoretical framework used by research to explain the relationship between board of directors and innovation. Another relevant theory on this topic is the stewardship theory (Fox & Hamilton, 1994). According to this perspective, managers are trustworthy individuals who act in the best interest of the company, thus managers' and owners' interests are aligned (Davis *et al.*, 1997). From this point of view, the relevance of the board would not be related to the monitoring function but to the strategic one, and the most valued directors would be those with expertise, information and knowledge on management and business (Petrovic, 2008).

Following these different theoretical assumptions, it is not strange that research has stated different propositions and lastly has arrived at contradictory results on the effects of board composition on innovation. The following table (Table 1) shows some of the main findings on this relationship.

Variable	Authors and year	Sample	Main findings
Board size	Cheng, 2008	1252 US firms (1996-2004)	Board size exerts a negative impact on innovation
	Ocasio, 1994	114 US firms (1960-1990)	Big boards positively affect innovation
	Zonaet al., 2013	225 Italian firms (2004)	Firm size moderates positively the negative relationship between board size and innovation
Gender diversity	Miller & Triana, 2009	326 US firms (2002-2005)	Women positively affect innovation
	Østergaard et al., 2011	1600 Danish firms (2003-2005)	
	Galia&Zenou, 2012	176 French firms (2006-2008)	A high percentage of women on boards positively influences innovation in marketing
	Hillman et al., 2002	275 US firms (1993-1997)	
	Torchiaet al., 2011	317 Norwegian firms (2005-2006)	
	Galia&Zenou, 2012	176 French firms (2006-2008)	Women on boards influence product innovation in a negative way, although there is no effect with organisational innovation
	Bianchi et al., 2012	69 Italian firms (2006-2010)	There is no relationship between gender diversity and innovation
Executive directors	Baysinger et al., 1991	176 companies (1981-1983)	High percentage of executive directors has a positive influence on R&D
	Dalzielet al., 2011	221 US firms (2001-2003)	Expertise and knowledge of executive directors are beneficial to R&D
	Hernández et al., 2010	86 Spanish firms (2003-2005)	Executive directors exert a negative influence on R&D
	Malatesta& Walkling, 1988	132 US firms (1982-1986)	Executives without ownership are expected to take short-term actions to increase their personal wealth
Affiliate directors	Jones et al., 2008	403 US firms (1994-2001)	Affiliated directors exert a positive effect on the proliferation of products
External independent directors	Bianchi et al., 2012	69 Italian firms (2006-2010)	High percentage of outside directors has a positive influence on innovation
	Dalzielet al., 2011	221 US firms (2001-2003)	Technical expertise and knowledge of external directors are beneficial to R&D
	Zonaet al., 2013	225 Italian firms (2004)	External directors positively affect innovation, especially in big firms
	Zahra, 1996	127 Fortune 500 companies	External directors negatively influence innovation
	Zahra et al., 2000	239 US firms (1991-1997)	
	Dalzielet al., 2011	221 US firms (2001-2003)	Outsider entrepreneurial, finance experience, and advanced education were shown to be negatively related to R&D spending
	Zonaet al., 2013	225 Italian firms (2004)	There is a negative effect of independent directors on innovation even worst in small firms
	Hoskisson et al., 2002	234 US firms (1985-1991)	There is no association between independent directors and innovation
	Kor, 2006	77 US firms (1990-1995)	
CEO duality	Kor, 2006	77 US firms (1990-1995)	Board independence is positively associated with innovation
	Van Essen et al., 2012	86 studies covering nine Asian countries	CEO duality is positive for innovation
	Chen & Hsu, 2009	369 Taiwan firms (2002-2007)	Non-duality moderates the negative relationship between family ownership and R&D
	Zona, 2013	2000 Italian firms (2004)	The choice of board structures should be contingent upon CEO tenure, with duality structures more effective early in CEO tenure, and non-duality structures more effective later on

Table 1. Results of previous research on the relationship between board composition and innovation

2.1. Board size

There is not a clear consensus about the optimal size of the board (Cheng, 2008; Galia&Zenou, 2012; Torchia *et al.*, 2011). In spite of this, literature states that the efficient functioning of the board depends on its size (Zahra & Pearce, 1989).

Some studies highlight a negative association of board size on innovation (Cheng, 2008; Mezghanni, 2011; Zahra & Pearce, 1989), arguing that small boards are more efficient to monitor and control the management team and also more easily reach the consensus needed to adopt risky strategies.

On the other hand, some authors suggest that there can be a positive relationship between board size and innovation (Coles *et al.*, 2008; Linck *et al.*, 2008; Ocasio, 1994), in this case, emphasising the strategic and advisory function of the board and the empowerment of big boards against top management teams.

Recent research usually proposes contingent explanations, trying to reconcile both positions (Raheja, 2005; Zona *et al.*, 2013), and underscores that not always is a big board or a small one better. Also, the association between board size and innovation could be moderated by other variables, like the size of the company (Zona *et al.*, 2013).

2.2. Gender diversity

Gender diversity is a relevant recent topic in studies on board composition (Kang *et al.*, 2007; Mahadeo *et al.*, 2012). Although there are many arguments in favour of a greater number of women on boards (Burke, 1997, 2003; Cassell, 2000; Singhet *et al.*, 2001), in most of the companies, their presence continues to be purely symbolic (Daily & Dalton, 2003; Singh *et al.*, 2001; Terjesen *et al.*, 2009).

Some of the arguments that highlight the benefits of counting with a relevant percentage of women on board are focused on improvements in board behaviour and functions (Bilimoria, 2000). These benefits include a better working environment (Bilimoria&Huse, 1997), a valuable experience in public relations and relational capital (Hillman *et al.*, 2002), a better comprehension of consumers behaviour and needs (Kang *et al.*, 2007), and more diligence than their male counterparts (Huse& Solberg, 2006).

However, few studies have tried to explain how gender diversity might influence innovation (Galia&Zenou, 2012; Miller & Triana, 2009; Torchia *et al.*, 2011). Some exceptions are the studies of Miller & Triana (2009) or Galia&Zenou (2012) that state gender diversity has a positive effect on R&D due to women's better knowledge of consumers and markets, which might positively affect innovation, especially innovation

in marketing. In addition, Hillman *et al.* (2002) and Østergaard *et al.* (2011) suggest that women bring new perspectives, different experiences and knowledge useful for innovation. Torchia *et al.* (2011) state that the number of women needs to be enhanced to reach a critical mass that could exert a relevant positive influence on innovation.

In contrast to these arguments, Galia & Zenou (2012) find that gender diversity could benefit some kinds of innovation, but not others, and highlight the negative influence of gender diversity, for example, on product innovation. Other studies, on the other hand, do not find any kind of relationship between gender diversity on boards and innovation (Bianchi *et al.*, 2012; Galia & Zenou, 2012).

2.3. Typology of directors

Directors can be classified into different categories. One of these groups is formed by executive directors, members of the board who are current or past managers of the organisation (Judge & Zeithaml, 1992; Pearce & Zahra, 1992). Some previous research has indicated a positive relationship between the proportion of executive directors and innovation (Baysinger *et al.*, 1991; Dalzie *et al.*, 2011), especially in R&D intensive firms (Coles *et al.*, 2008; Markarian & Parbonetti, 2007) and in the case of internal innovation. On the contrary, some other authors argue that executives are expected to take short-term actions to not assume risks and increase their wealth, provoking a negative effect on innovation (Hernández *et al.*, 2010; Malatesta & Walkling, 1988).

More research has been conducted on external, independent or outside directors, including affiliated directors who are those representing large shareholders (De Andrés *et al.*, 2005). Their relevance in research might be motivated because they are usually a large percentage of the board (Coles *et al.*, 2008; Peasnel *et al.*, 2005) and good governance codes recommend a high proportion of this kind of director to protect shareholders' interests (Fama, 1980). However, despite the relevance of this kind of director in research, few conclusive results have been obtained regarding their effects on innovation. Some arguments in favour of a positive relationship between the proportion of external directors and innovation are their potential for monitoring and controlling managerial actions, their freedom of thought and cognitive diversity for decisionmaking (Bianchi *et al.*, 2012; Dalzie *et al.*, 2011). Besides, this positive association between external directors and innovation can be even stronger in certain cases, for example, in big companies (Zona *et al.*, 2013). Other studies, on the other hand, emphasise a negative relationship (Zahra, 1996; Zahra *et al.*, 2000), which could be motivated by the low

operating knowledge and background on the company, low cohesiveness provoked by diversity and conflict (Gibson & Earley, 2007). Zona *et al.* (2013) also suggest that this negative relationship between the proportion of external directors and innovation is stronger in small firms. Finally, there are also several studies that do not find any kind of relationship between external directors and innovation (Hoskisson *et al.*, 2002; Kor, 2006).

2.4. CEO duality

Duality describes a situation where the CEO also serves as the chairman of the board. Agency theory advocates for the separation of functions to reduce managerial discretion (Guillet *et al.*, 2013; Lan & Lee, 2008; Penget *et al.*, 2010). However, there is little research to support the positive association of the separation of the CEO and the chairman of the board, and the firm performance (Boyd *et al.*, 2011). On the other hand, stewardship theory states a positive influence of duality on firm performance (Donaldson & Davis, 1989; Van Essen *et al.*, 2012).

Regarding innovation, arguments supporting the benefits of non-duality for innovation underscore that independent boards, with separated functions, might better control and monitor managers and incentive innovative actions of companies, which could be key for their success and survival (Kor, 2006). In addition, duality can exert a moderator role in certain companies, like family firms, where family ownership might exert a negative impact on R&D investment, but attenuated when there are separated functions of the CEO and the board chairman (Chen & Hsu, 2009). On the contrary, some research findings highlight that sometimes duality favors R&D investments (Van Essen *et al.*, 2012), when the CEO supports risky strategies and also concentrates a high power as manager and chairman of the board. Finally, some authors claim no better board structure, because it should be contingent upon CEO tenure, with duality best working when CEO tenure is low.

After reviewing these different assumptions and inconclusive findings of previous research, we don't seek to establish a predictive model of the innovative behaviour of companies depending on board composition. Especially, in the Spanish context, where innovation intensity in companies is below the average of EU and OECD countries (COTEC, 2012), we think that it would be very complicated to construct an effective model to explain this complex process of innovation through few board composition characteristics. On the other hand, we aim to develop an exploratory data analysis to

contribute to the existing literature in three ways. First, we describe the main characteristics of the board composition in terms of its size, directors' gender, typology of directors, and CEO duality; and determine, if any, the differences of board composition amongst economic sectors. Second, we study the evolution of these main characteristics of board composition over time. And finally, we analyse the variability profile of board composition in Spanish companies belonging to innovative sectors.

3. Methodology

3.1. Data collection

The data for this study came from Spanish companies listed on the Spanish stock exchange between 2003 and 2011. We select these nine years because we were interested in analysing the effects of the good governance practices proposed by corporate governance codes in Spain. We initiated the data collection in 2003 coinciding with the publication of the Aldama report (2003). There had been some years since the appearance of the first Olivencia code of 1998, and companies have had time to be used to good governance practices. On the other hand, 2011 was the last year with available information.

Using information from the Spanish Institute of Statistics, we selected firms from sectors that showed significantly high innovation indicators, such as the percentage of innovative firms (above 50%), innovation intensity (above 1.5%), and the percentage of income generated by new or improved products (above 10%). Considering the first two digits of the National Classification of Economic Activity (NACE 2009) in Spain (INE, 2009), 78 sectors were chosen because they accomplish at least one of the innovation indicators explained above. In order to simplify comparisons, we consider not the divisions, which refer to the first two digits of the code, but the sections because they allow us to aggregate economic activities related to the same section. Finally, five sections or sectors were included: energy and water supply, extractives, construction, industry and services. The final sample comprised 86 Spanish-listed companies from the chosen sectors, with data covering nine years, so we could construct an imbalanced data panel of 706 observations (69 observations belong to the construction sector, 33 to the energy and water supply sector, 22 to extractives companies, 308 to industry firms and 274 to companies in the service sector).

We conduct this study using secondary sources of information. The database of the CNMV (Spanish Security Exchange Commission) was the main resource used to gather information on corporate governance. We were also interested in determining the innovative behavior of companies in the period considered. Data related to innovation was obtained from the European network of patent databases for gathering the number of patents registered by the companies.

3.2. Measurement of variables

Board size is measured by the number of directors on the board (Coleset *al.*, 2008).

The proportions of male and female directors were obtained by dividing the number of men and women respectively by the board size (Nekhili&Gatfaoui, 2013).

The proportion of inside or executive directors is determined by dividing the number of insiders by the total number of directors (Judge &Zeithaml, 1992). The proportion of affiliate directors is determined by dividing the number of affiliates by the total number of directors (Unified Code on Good Corporate Governance, 2006). The same occurs with the proportion of independent and other external directors. The proportion of independent directors is computed by dividing the number of independent directors by the total size of the board, and the proportion of other external directors is calculated by dividing the number of external directors by the board size (Unified Code on Good Corporate Governance, 2006).

CEO duality is a board characteristic frequently related to the independence of the board. Duality is considered as a dichotomous variable, coded “0” when the CEO also serves as chairman of the company’s board and “1” when the CEO and the chairman of the board are two different individuals (Daily & Dalton, 1997).

This study also includes a measure of innovation, just to analyse if the innovative behaviour of the companies considered has been improved or not during the studied period. There are different indicators of innovation directly related to innovative activity (Alegreet *al.*, 2004; Flor&Oltra, 2004). In our case, we decided to use the number of registered patents because, as a legal mechanism for protecting inventions, patents have served as a basis for developing innovation indicators in many studies and can be easily accessible (Flor & Oltra, 2004).

4. Results

The statistical analyses of this work were carried out using R, version 3.0.2 (R Core Team, 2013). We developed three different analyses to address each of the three research propositions.

The first question is analysed in Tables 2 and 3. Table 2 shows descriptive statistics of the main characteristics of the board composition in terms of size, typology of directors, gender and duality. In order to relate board composition with innovation, we consider also data on patents of the companies in the sample.

Variables	Min	Max	Mean	Sd
Board size	1	24	10.4	4.11
Proportion of men	0.25	1	0.93	0.10
Proportion of women	0	0.75	0.07	0.10
Proportion of insiders	0	1	0.21	0.16
Proportion of affiliated directors	0	1	0.46	0.25
Proportion of independent directors	0	0.88	0.29	0.20
Proportion of external directors	0	0.67	0.05	0.11
Duality	'0'=294 (0.42)	'1'=391 (0.55)		
Patents	0	29	1.04	3.06

N=706

Table 2. Board composition and innovation

As Table 2 shows, the mean values of board characteristics indicate that boards of directors of Spanish companies in innovative sectors have around 10 members and are basically composed of men. Most of the directors are affiliated ones, meaning they represent great shareholders. We can see that duality exists in the majority of the boards analysed. Finally, we observe great differences between the minimum and maximum value in the number of registered patents, although the mean value is quite low, around 1.04.

We were also interested in analysing the differences in board composition and innovation considering different sectors (Table 3). We included also on Table 3 one-way ANOVA analyses to determine the existence of significant differences in the mean values of the variables considered amongst sectors.

Variables	Mean					F
	Energy and	Extractives	Construction	Industry	Services	

	water supply					
Board size	13.20	6.70	12.63	9.22	11.17	131.5***
Proportion of men	0.91	0.97	0.98	0.94	0.91	5.04**
Proportion of women	0.09	0.03	0.02	0.06	0.09	5.04**
Proportion of insiders	0.11	0.31	0.16	0.25	0.17	25.85***
Proportion of affiliated directors	0.51	0.33	0.58	0.44	0.44	30.6***
Proportion of independent directors	0.23	0.12	0.22	0.27	0.34	22.31***
Proportion of external directors	0.15	0.24	0.03	0.04	0.04	66.64***
Duality (proportion of 'yes')	0.27	0.59	0.46	0.59	0.56	372.04***
Patents	0.37	0	1.40	0.98	1.21	2.63*

***p<0.001; **p<0.01; *p<0.05; +p<0.1

Table 3. Board composition and innovation by sectors

As Table 3 shows, the activity with the biggest boards is energy and water supply, and with the smallest ones is the extractive industry. The proportion of men is much higher than the proportion of women in all sectors, but the activity with more men on the board is construction and the activities with more women (although the number is still very low) are energy and water supply, and services (around 9%). Relating to the typology of directors, we can observe in Table 3 that the proportion of affiliated directors is the highest in all sectors, followed by the proportion of independent directors, with the exception of the extractive industry where the proportion of executives on the board is higher. The economic activity with the highest proportion of executive directors or insiders (31%) is the extractive industry, while construction has more affiliated directors (58%), services has more independent directors (34%), and the extractive industry has more other external directors (24%). This kind of other external director is the less common type of director in our sample of Spanish companies. Duality is especially high in two different economic activities, extractives and industry, where, in 59% of companies, the CEO and the chairman of the board is the same person. The number of registered patents is the highest in construction (1.40), followed by the service sector (1.21). We can also conclude that there are significant differences amongst economic sectors in all the variables taken into account.

The second question of this work is focused on the evolution of the characteristics of board composition and innovation over time. To this end, we develop graphical analyses

of how the mean values of the variables considered have been evolving over time, and also by sectors.

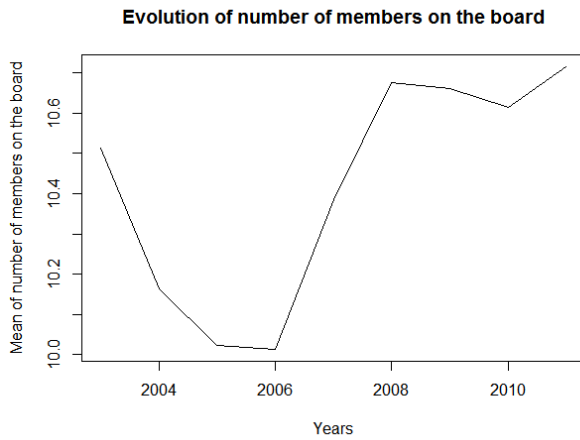


Figure 1. Evolution of board size

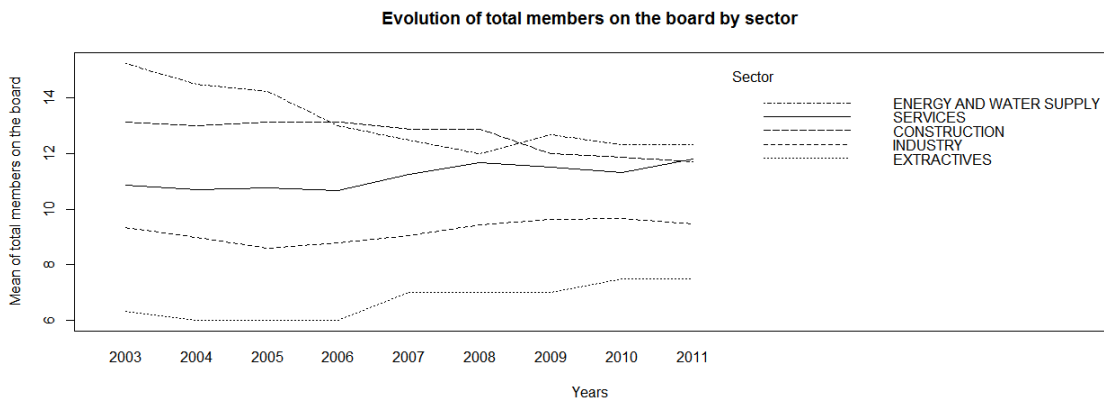


Figure 2. Evolution of board size by sector

Graphs 1 and 2 refer to board size. They show little changes in the number of members on Spanish boards in the firms analysed, moving around 10 members during all the years considered. We can observe few changes in general terms although the tendency of these changes has been quite irregular, decreasing until 2006 and growing afterwards. By sectors, Graph 2 shows that energy and water supply is the sector with biggest boards (around 13 members) whilst the extractive industry has the smallest ones (around 7 or 8 members). We can also observe little oscillations in the board size of the different sectors and the tendency becomes closer over time.

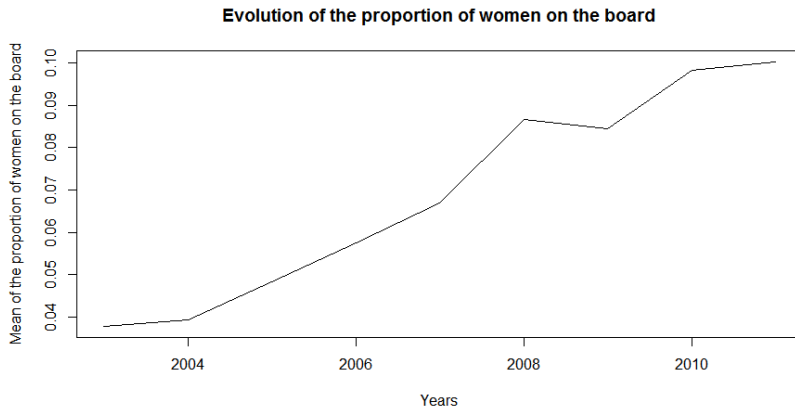


Figure 3. Evolution of the proportion of women

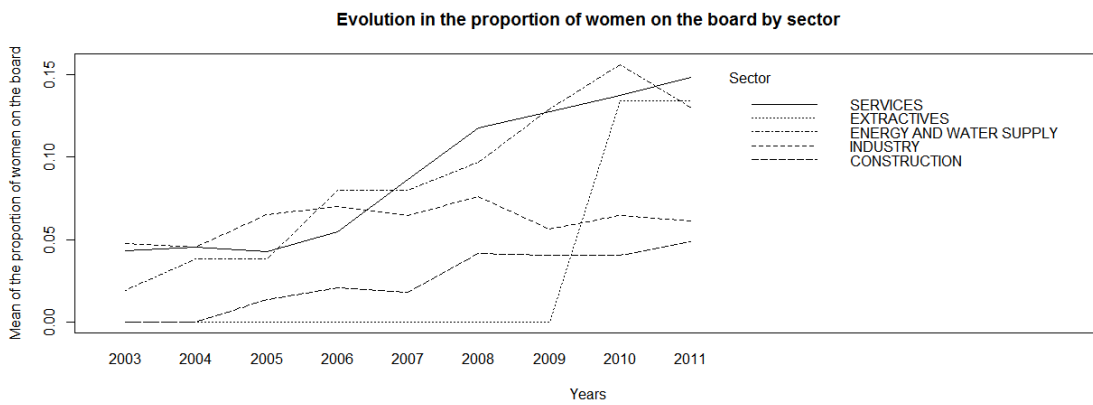


Figure 4. Evolution of the proportion of women by sector

Graphs 3 and 4 are related to the proportion of women on boards. As we can see, the evolution of the percentage of women on Spanish boards is continuously increasing since 2003, however its mean value at the highest moment scarcely arrives at 10%. The evolution is positive also in all sectors, although the sector with the major growth is the extractive industry, followed by services and energy and water supply. On the other hand, the sector with fewer women on its boards is construction.

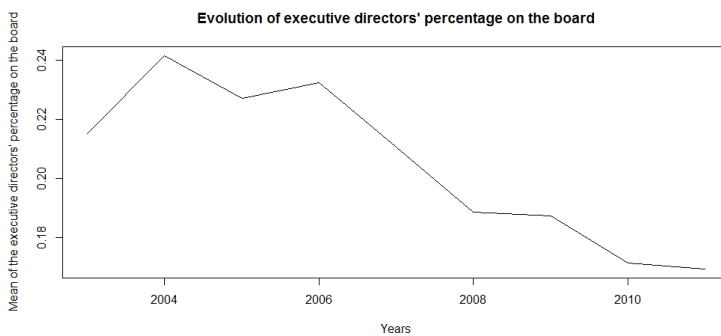


Figure 5. Evolution of the proportion of executive directors

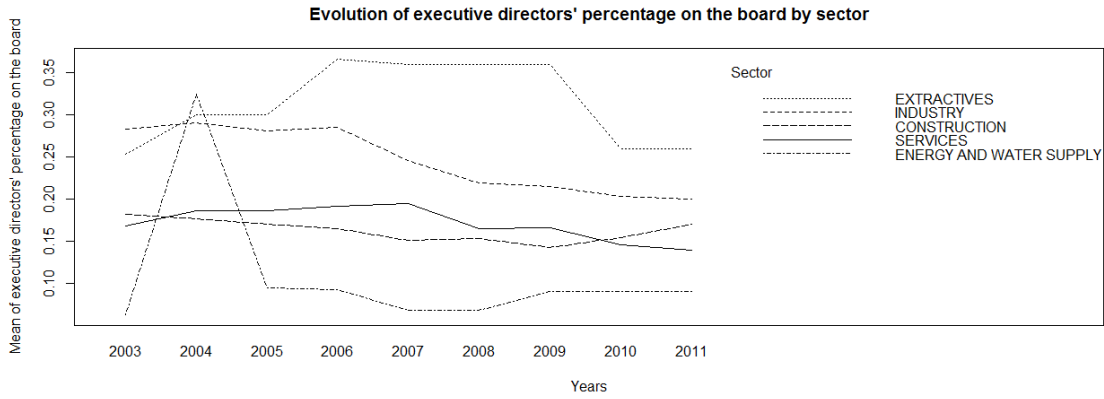


Figure 6. Evolution of the proportion of executive directors by sector

Graphs 5 and 6 refer to the proportion of executive directors on boards. Graph 5 indicates that the percentage of executive directors has not been the majority in the period considered, and even more, it has been descending since 2006. As Graph 6 shows, the sector with more executive directors on its boards is the extractive sector and the one with fewer is energy and water supply, but in none of the economic activities considered is this kind of director predominant.

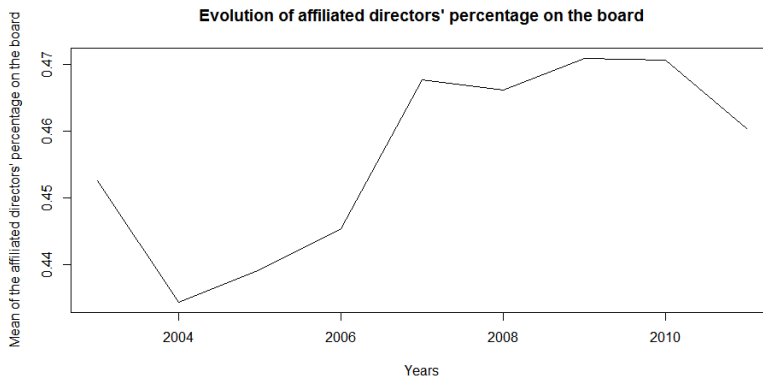


Figure 7. Evolution of the proportion of affiliated directors

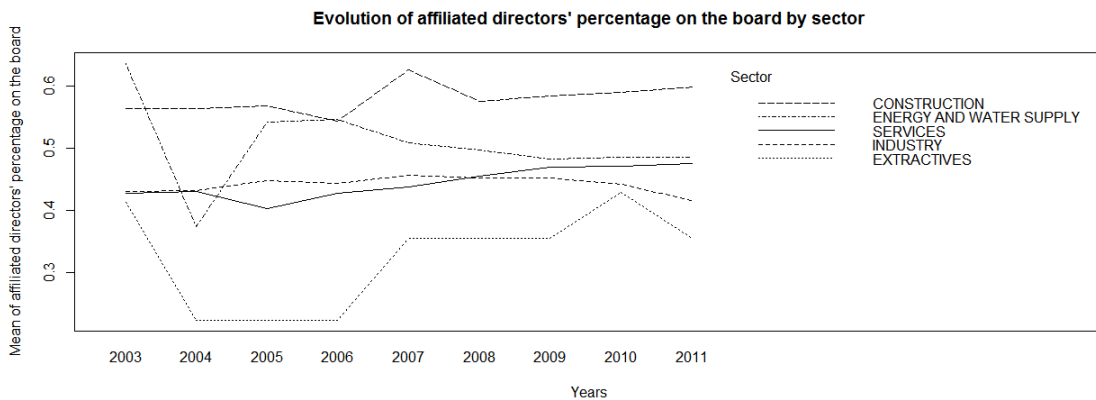


Figure 8. Evolution of the proportion of affiliated directors by sector

Graphs 7 and 8 are related to the proportion of affiliated directors on boards. The percentage of this kind of director has evolved positively since 2004. In addition, the evolution of this percentage has been quite irregular in all sectors over time. Construction has been the sector with a major proportion of affiliated directors and extractives is the sector with the fewest.

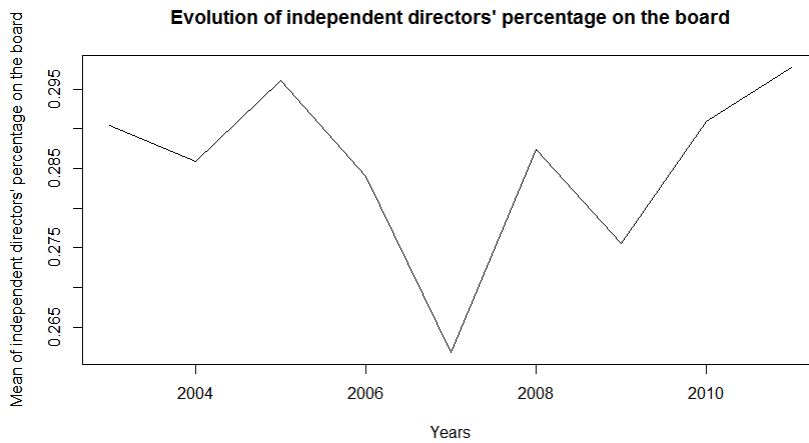


Figure 9. Evolution of the proportion of independent directors

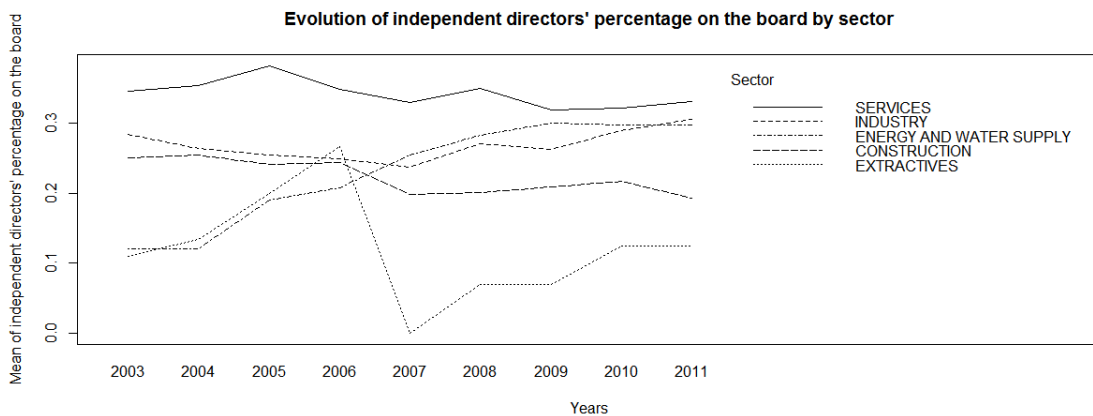


Figure 10. Evolution of the proportion of independent directors by sector

Graphs 9 and 10 show the evolution of the independent directors' proportion. This evolution has been quite irregular with successive ups and downs over time. By sectors, the services sector has the highest level of these kinds of directors and the extractive industry has the lowest.

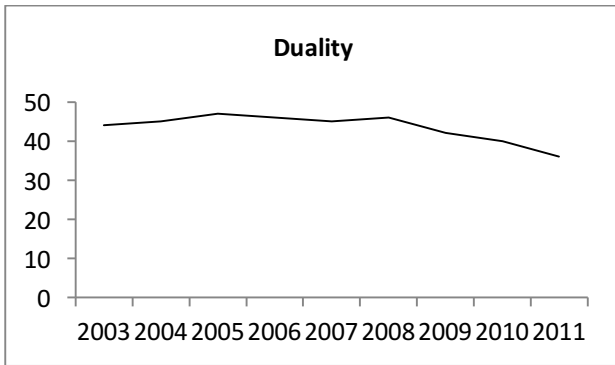


Figure 11. Evolution of duality

Graph 11 is related to the evolution of the proportion of companies with CEO duality. The analysis of this variable is different due to its nature as a categorical variable with two levels. We can observe that the proportion of companies in the sample with CEO duality has been a majority and quite stable over time, with a decreasing tendency since 2008. By sectors, as data in Table 4 shows, the extractive industry has the highest percentage of companies with CEO duality, whilst water supply and energy is the economic sector with the lowest percentage of firms with CEO duality. If we consider each sector separately, the major variations have occurred in sectors with few firms included in our sample.

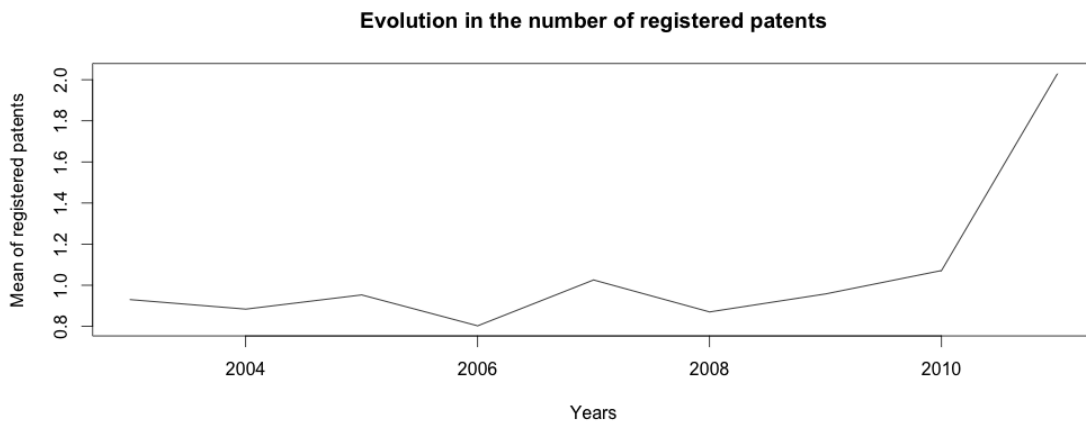


Figure 12. Evolution in the number of registered patents

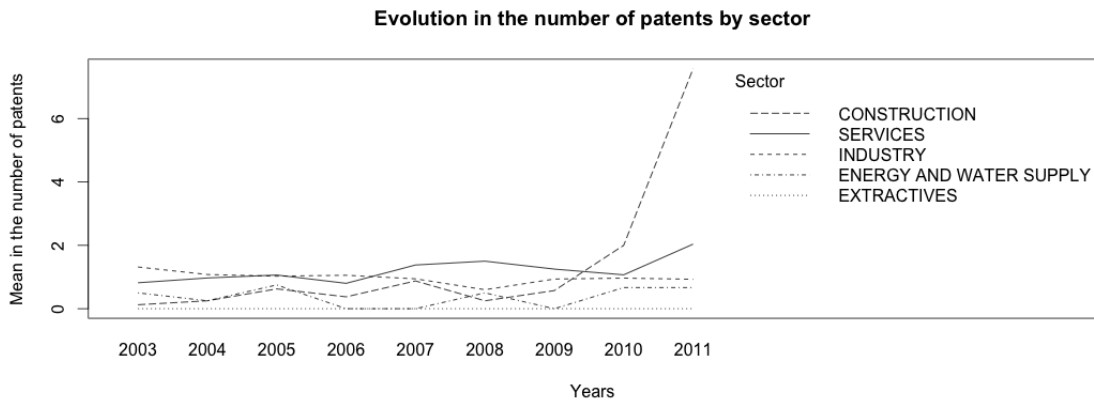


Figure 13. Evolution in the number of registered patents by sectors

Finally, Graphs 12 and 13 show the evolution in the number of registered patents. This variable related to innovation is included to analyse if the innovative behaviour of the companies considered has improved or not during the studied period. To do so, we could establish some conclusions about the coincidence of certain composition in the board and the innovative behaviour of companies. Graph 12 indicates that Spanish firms are not particularly well-known by their number of registered patents. The mean values are really low in all sectors but we can observe a maintained increase since 2008. By sectors, Graph 13 shows that companies of the sample in the extractive industry do not have any registered patent in the period considered. On the other hand, construction is the sector with the highest number of registered patents, especially in the last years.

Table 4 indicates the mean values by sector and year of each of the variables of this study, and also includes statistics tests to analyse the effects of time and the economic activity on the mean values of the variables considered. As we can see, the mean values of all the variables are significantly different amongst sectors. On the contrary, the effect of time is not always significant. The results confirm that time yields significant differences in the proportion of women, and in the number of registered patents. It means that the positive evolution of patents and the proportion of women is significant over time, although their absolute values are really low. On the other hand, for the rest of the characteristics in the board composition, we have not detected significant differences over time.

Variables	Sectors	Mean									ANOVA analysis F test
		2003	2004	2005	2006	2007	2008	2009	2010	2011	
Board size	Energy and water supply	15.25	14.5	14.25	13	12.5	12	12.67	12.33	12.33	3.51**
	Extractives	6.33	6	6	6	7	7	7	7.5	7.5	
	Construction	13.12	13	13.12	13.12	12.87	12.87	12	11.86	11.71	
	Industry	9.33	8.97	8.61	8.78	9.06	9.43	9.65	9.66	9.46	
	Services	10.87	10.70	10.78	10.67	11.24	11.68	11.5	11.31	11.81	
	ANOVA analysis F test	0.79									
Proportion of women	Energy and water supply	0.02	0.04	0.04	0.08	0.08	0.1	0.13	0.16	0.13	5.29***
	Extractives	0	0	0	0	0	0	0	0.03	0.03	
	Construction	0	0	0.01	0.02	0.02	0.04	0.04	0.04	0.05	
	Industry	0.05	0.05	0.07	0.07	0.06	0.08	0.06	0.06	0.06	
	Services	0.04	0.05	0.04	0.05	0.09	0.12	0.13	0.14	0.15	
	ANOVA analysis F test	14.09***									

Variables	Sectors	Mean									ANOVA analysis F test
		2003	2004	2005	2006	2007	2008	2009	2010	2011	
Proportion of inside directors	Energy and water supply	0.06	0.32	0.09	0.09	0.07	0.07	0.09	0.09	0.09	4.89***
	Extractives	0.25	0.3	0.3	0.37	0.36	0.36	0.36	0.26	0.26	
	Construction	0.18	0.18	0.17	0.16	0.15	0.15	0.14	0.15	0.17	
	Industry	0.28	0.29	0.28	0.29	0.25	0.22	0.22	0.20	0.20	
	Services	0.17	0.19	0.19	0.19	0.19	0.16	0.17	0.15	0.14	
	ANOVA analysis F test	2.05									
Proportion of affiliated directors	Energy and water supply	0.64	0.37	0.54	0.55	0.51	0.50	0.48	0.49	0.49	18.03***
	Extractives	0.41	0.22	0.22	0.22	0.36	0.36	0.36	0.43	0.36	
	Construction	0.56	0.56	0.57	0.54	0.63	0.58	0.58	0.59	0.60	
	Industry	0.43	0.43	0.45	0.44	0.46	0.45	0.45	0.44	0.41	
	Services	0.43	0.43	0.40	0.43	0.44	0.46	0.47	0.47	0.48	
	ANOVA analysis F test	0.09									
Proportion of independent directors	Energy and water supply	0.12	0.12	0.19	0.21	0.26	0.28	0.30	0.30	0.30	14.30***
	Extractives	0.19	0.13	0.20	0.27	0	0.07	0.07	0.12	0.12	
	Construction	0.25	0.25	0.24	0.24	0.20	0.20	0.21	0.22	0.19	
	Industry	0.28	0.26	0.25	0.25	0.24	0.27	0.26	0.29	0.31	
	Services	0.34	0.35	0.38	0.35	0.33	0.35	0.32	0.32	0.33	
	ANOVA analysis F test	0.39									
Duality (proportion of 'yes')	Energy and water supply	0.25	0.25	0.25	0.25	0.25	0.25	0.33	0.33	0.33	Chi square test 15.04**
	Extractives	0.33	0.33	0.66	0.66	0.5	0.5	0.5	1	1	
	Construction	0.37	0.37	0.5	0.5	0.5	0.5	0.57	0.43	0.43	
	Industry	0.58	0.61	0.61	0.61	0.6	0.63	0.61	0.55	0.54	
	Services	0.52	0.52	0.52	0.55	0.6	0.62	0.59	0.62	0.56	
	Chi square test	1.88									
Patents	Energy and water supply	0.5	0.25	0.75	0	0	0.5	0	0.67	0.67	11.13***
	Extractives	0	0	0	0	0	0	0	0	0	
	Construction	0.12	0.25	0.62	0.37	0.87	0.25	0.57	2	7.57	
	Industry	1.32	1.08	1.03	1.06	0.94	0.60	0.94	0.97	0.93	
	Services	0.82	0.97	1.06	0.8	1.38	1.50	1.25	1.07	2.04	
	ANOVA analysis F test	2.92+									

***p<0.001; **p<0.01; *p<0.05; +p<0.1

Table 4. (Continued) Mean values over time of board composition and innovation by sectors and ANOVA

The third question of this study seeks to determine the variability profile of board composition in the companies of the sample. To do so, we have developed a principal component analysis (PCA) including the numeric variables of board composition.

Variables	PC1	PC2	PC3
Board size	0.358	0,511	-0.298
Proportion of women	-0.138		0.892
Proportion of insiders	-0.486	-0.480	-0.287
Proportion of affiliated directors	0.676	-0.211	0.170
Proportion of independent directors	-0.400	0.681	
Proportion of variance	0.38	0.27	0.21
Cumulative proportion of variance	0.38	0.65	0.86

Table 5. Principal components analysis on board composition

Table 5 shows the three principal components obtained, which capture 86% in data variance. From Graph 14, we observe that in the first principal component, the highest variability depends on the proportion of affiliated directors, which covariates with the board size, the proportion of inside and independent directors, and the proportion of women. Thus, the major variability in data is explained by the variance in board size, and in the directors' typology. Board size and the proportion of affiliated directors covariate in a similar manner and are opposed to the proportion of independent and inside directors. From the third principal component, which captures 21% of data variance, we observe that this variability is influenced by the proportion of women on boards, although it is a board characteristic of third order and, as it is observed in Graph 14, this variability depends especially on certain firms with a good practice in terms of including women on boards. Again, values of the loadings in Table 5 indicate that the proportion of women covariates with board size in opposite ways.

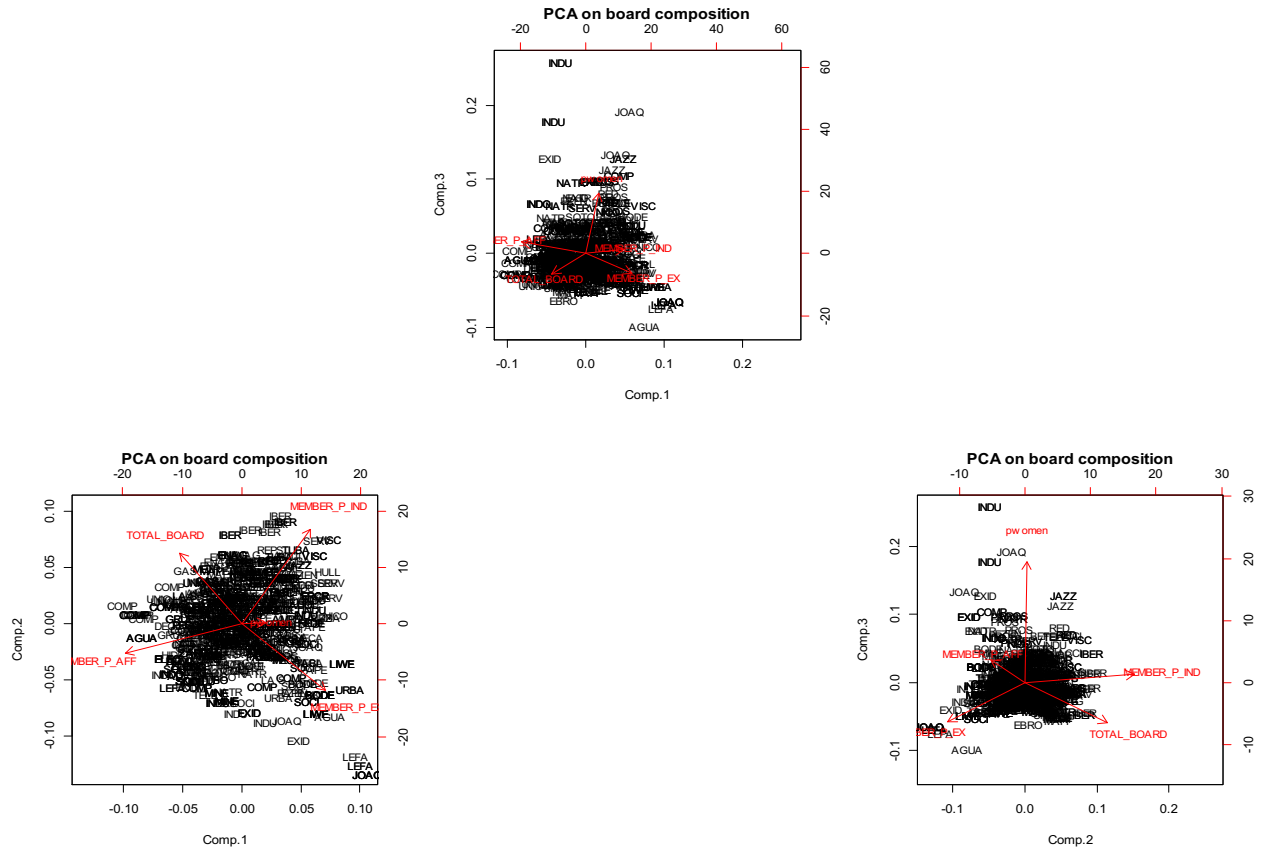


Figure 14. PCA biplots

5. Discussion

The main findings of this study show that boards of directors of Spanish companies in innovative sectors have around 10 members, with members ranging between 1 and 24. Most of directors are affiliated ones and are basically men. In addition, CEO duality is a common structure on boards. These results mostly agree with those of previous research. For example, regarding the board size, studies of other countries have shown board sizes between 3 and 24 members in the UK (Peasnellet *al.*, 2005), with an average size of 8 members (Osma, 2008; Peasnellet *al.*, 2005); or between 4 and 26 members in the USA (Cheng, 2008), with an average number of 7 directors (Lincket *al.*, 2008). The medium numbers in Norwegian and Australian companies respectively (Kang *et al.*, 2007; Torchiaet *al.*, 2011) are 7 or 8 directors. . Whilst in France, between 11 and 15 members are the most common medium number of directors on boards (Galia&Zenou, 2012; Godart&Schatt, 2005). Our results indicate an average number of 10 members, which is in line with boards of these other countries, with little and non-significant changes over time. Also, this study has demonstrated that amongst Spanish innovative sectors, the activity with the biggest boards is energy and water supply, and the one with the smallest boards is the extractive industry.

Related to gender diversity, not surprisingly, Spanish boards are composed of a majority of men. It is a quite generalised characteristic of boards all around, as we can see in other studies, like the work of Carter *et al.* (2010) who found an average of 1% of women on boards in USA firms. Other examples show that women represented around 6% of the board in French companies (Galia&Zenou, 2012), 7% in Norwegian firms (Torchiaet *al.*, 2011), and 10% in Australian companies (Kang *et al.*, 2007). In our study, the average proportion of women is around 7%. This average is low but its increase over time is statistically significant. The proportion of men is much higher than the proportion of women in all sectors, but the activity with more men on the board is construction and the activities with more women are energy and water supply, and services.

Regarding the typology of directors, executive directors do not represent a majority in the period considered, and even more, their percentage has been descending since 2006. The sector with more executives on its boards is the extractive sector. On the other hand, affiliated directors are the most numerous. The addition of affiliated and independent directors represents an average of 75% of the board in our sample, although the evolution of both kinds has not been similar. Affiliated directors have evolved positively practically since 2004, whilst independent directors have had successive ups and downs over time.

Previous literature on board composition agrees with these findings about the majority presence of independent and other external directors in the board composition. For example, Peasnellet *al.* (2005) found an average of 43% of outside directors on UK companies' boards; Coles *et al.* (2008) reported that the average proportion of different kinds of outside directors is 80% of the total board in US companies. In a comparative study made between different countries by Aguilera (2005), the proportion of outside directors was over 50% in all the compared countries (US, UK, the Netherlands, Canada and Italy). Just Spain and South Africa, in this study, were below 50%. However, in those cases, only independent directors were considered within the group of outsiders, not affiliated ones. By sectors, we can observe many significant differences; for example, service sector and construction have the highest proportion of independent and affiliated directors respectively, whilst the extractive industry has the lowest of both. On the contrary, non-significant differences were observed in the evolution of the typology of directors over time.

In relation to duality, the proportion of companies in our study with CEO duality has been a majority and quite stable, with a decreasing tendency since 2008, although the findings show that changes over time are not relevant. Previous research, however, does not reach a clear consensus on this issue; thus, depending on the country and the moment of the study, data shed different information. For example, the study of Linck *et al.* (2008) shows that 58.3% of US companies had CEO duality. Aguilera (2005), comparing the separation of the CEO and the chairman of the board in different countries, concluded that this separation was majoritarian in Spain (contrary to our results), South Africa, the Netherlands, UK and Canada, whilst, in the US and Italy, the CEO duality is quite frequent. By sectors, again our results conclude that there are significant differences. The extractive industry has the highest percentage of companies with CEO duality, whilst water supply and energy is the economic sector with the lowest.

An analysis of the variability profile of board composition in the companies showed that board size and the proportion of affiliated directors covariate in the same way, but opposite to the proportion of inside and independent directors. Also, the major variability in data is explained by the variance in board size, and in the directors' typology. The variability in the proportion of women is not really relevant amongst board composition, although it captures some variability especially motivated by the behaviour of specific companies with a high proportion of women on their boards.

These conclusions on board composition of Spanish companies converge with a situation in which innovation, determined through the number of registered patents, although low in absolute terms, grows significantly over time, with relevant differences between economic sectors.

6. Conclusions

The objective of this work was to develop an exploratory analysis of the board composition of Spanish companies in innovative sectors to respond to three different research questions. First, we seek to study the main characteristics of the board composition in terms of its size, gender, typology of directors, and CEO duality amongst different innovative economic sectors in Spain. The mean values of board characteristics indicate that boards of directors of Spanish companies in innovative sectors have around 10 members and are basically composed of men. Most of the directors are affiliated directors, those who represent great shareholders. The CEO duality is a common option in Spanish boards of companies in innovative sectors. The analysis by sectors reveals significant differences in the mean values of all the characteristics considered on board composition. These results, with the exception of the CEO duality, match quite well with the recommendations of corporate governance codes (Unified Code on Good Corporate Governance, 2006) on boards' composition, in terms of medium sized boards, with a number of directors ranging between 5 and 15, and a balanced composition with a high proportion of outside directors distributed between independent and affiliated directors. The proportion of independent directors in our sample is close but does not arrive at 1/3, as recommended by the Spanish corporate governance code, showing the relevance of the capital concentration in the Spanish companies of innovative sectors.

Second, we analyse the evolution of the main characteristics of the board composition. The results confirm that board composition does not change a lot over time. There is just a characteristic of the board, the proportion of women, whose positive evolution has been significant. Although the percentage of women is still very low, at least it has begun to appear that there is some concern for encouraging gender diversity on boards. This characteristic of board composition begins to be relevant in some specific companies (Unified Code on Good Corporate Governance, 2006).

Third, we determine that the major variability in board composition appears in board size and the directors' typology. Also, board size and the proportion of affiliated directors covariate in the same way, but opposite to the proportion of inside and independent directors.

These are the main board composition characteristics of companies that also show an active role in innovation strategies, as confirmed by their significant growing number of registered patents.

This research that compares the board composition and the innovative behaviour of some Spanish companies does not pretend to explain or predict innovation through board composition. Our purpose is more limited, as we try to contribute to the literature and corporate governance practices by showing how the majority of Spanish boards in innovative companies are actually composed and whether this composition is prominent in a situation in which the innovation results of these companies are growing. The findings obtained could serve to propose more ambitious future research that establishes what possible effects board composition could have on innovation.

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