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Corporate governance, research and development volatility and firm performance - Evidence from Spain and Ireland

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Abstract: The present study sheds light on the comparative experiences of the two countries originating from differing legal systems and describes how their codes and practices affect the publicly listed firms' performance. It investigates the linkages between Research and Development (R&D) expenditures, Board characteristics and firm performance using a sample of Irish and Spanish firms for the period 2005–2014. To do this, the study uses ROA and Tobin's Q as proxies for financial performance; and board size, non-executive directors, female representation and CEO duality as board structure characteristics; and R&D expenditure volatility, employing different techniques that include OLS, fixed effects model and Quantile regression model. The difference-in-difference model is used to verify the significance of robustness of relationships considering the global financial crisis as an exogenous shock. The descriptive statistics suggests a comparability of boards'

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PUBLIC INTEREST STATEMENT

The present study sheds light on the comparative experiences of the two countries originating from differing legal systems and describes how their codes and practices affect the publicly listed firms' performance. It investigates the linkages between Research and Development (R&D) expenditures, Board characteristics and firm performance using a sample of Irish and Spanish firms for the period 2005–2014.

From the legal origin point of view, Irish corporate governance codes originate from common law jurisdiction while Spain belongs to civil law jurisdiction. Notably, regarding female board representation, Spain has a quota system in place and for Ireland, there is no such quota law on gender diversity. However, on average, the women representation on boards of Spanish corporates is around 10% while for Ireland it is at 8% (Rodríguez-Ferández, 2015). This offers a natural experiment to test financial crisis as an exogenous shock and it shows the effectiveness and relevance of the newly introduced code on female representation in Spain to the firm performance.

independence for the Spanish- and Irish-listed firms. Although the Spanish firms are less dual than Irish firms, the results are comparable on the association between CEO duality and firm performance. The findings of Spanish-listed firms on the relationship between increase and decrease in the R&D expenditures volatility and performance support the creative–destructive perspective that suggests effective governance in funding allocation to R&D.

Subjects: Economics and Development; Risk Management; Corporate Finance; Investment & Securities; Risk Management; Corporate Governance

Keywords: research and development volatility; boards; corporate governance; creative –destructive perspective; Spanish- and Irish-listed firms; difference-in-difference model

JEL classification: G.30; G.32; G.34; N.24

1. Introduction

This study investigates the effects of R&D expenditure and corporate governance, using board characteristics, on the performance of publicly listed firms in Ireland and Spain. In a competitive environment and times of uncertainty, many companies consider investments in R&D as a crucial strategy for increasing firm value, market share (Hall, Jaffe, & Trajtenberg, 2005; Lev & Sougiannis, 1996; Pakes, 1985) and developing sustainable competitive advantages (Kor & Mahoney, 2005). These decisions involve a certain degree of risk (David, Hitt, & Gimeno, 2001) and the role of corporate boards is crucial in influencing such decisions. The present study therefore, considers the role of corporate governance and the effects of the investment decisions on the performance of publicly listed firms in Spain and Ireland. It also examines if the experiences and results during the financial crisis period differ from non-financial crisis period.

The governance mechanisms operate differently in crisis and non-crisis periods (van Essen, Engelen, & Carney, 2013). The tendency to respond to a crisis with more stringent rules might be counterproductive since such measures may compromise executives' ability to respond appropriately to shocks. During a crisis, practitioners are encouraged to optimise rather than maximise their governance choices (van Essen et al., 2013). This might also have implications on the performance of the firm. This study separates firm performance during and after the financial crisis to highlight this governance issue as well.

The 2007–2008 financial crisis has been identified as the world's deepest since the Great Depression of the last century (Gregoriou, 2009). The origins of this crisis were initially attributed to governance failures in the financial sector. The collapse of the US real-estate market and the subsequent failure to offload sub-prime risks ultimately resulted in a credit crisis (Gregoriou, 2009). Others implicate the use of novel and poorly understood financial instruments such as collateralised debt obligations. The use of high-powered incentive compensation for senior banking executives may have exacerbated the problem. In this view, boards of directors were believed to be inadequate in monitoring executives and evaluating the risks they assumed (Muller-Kahle & Lewellyn, 2011).

1.1. Corporate governance codes in Ireland and Spain

From the legal origin point of view, Irish corporate governance codes originate from common law jurisdiction while Spain belongs to civil law jurisdiction. Their codes on gender diversity, board size, duality and non-executive directors' (NED) composition vary. In Spain, the Unified code is the current version of the Spanish corporate governance code. This code harmonises and reviews the recommendations and principles stated by both the Olivencia and the Aldama Committees (Paredes & Núñez-Lagos, 2015).

In Ireland, companies listed on the main securities market are required to comply with both the UK corporate governance code (the corporate governance code) and the Irish corporate governance

annex. An important basis or feature of the corporate governance code is the “comply or explain” approach. Under this approach, the company has to either comply with the regulation or explain as to why it is unable to comply with the regulation. The role of the director is governed principally by the Irish Companies Acts, which is the primary source of corporate law in Ireland, and also by principles established by case law (in this regard, it is worth noting that English case law is regarded as having persuasive authority in Ireland). This body of law is further supplemented by a growing suite of regulations, codes and guidelines (Whit, 2014).

With regards to the board structure, the Spanish legislation (namely the Companies Law 2010) provides for a standard one-tier board structure for public companies, as mandatory for all listed companies (with an exception to European companies incorporated in Spain). For Ireland, although, the Irish law does not prohibit the two-tier board structure, in general, the board of directors of Irish companies are structured as a one-tier body (usually comprising of both executive and NED). Moreover, the code of corporate governance in Spain stipulates a board size of between 5 and 15 members and it is the only country in Europe to mandate a board size, while, the Irish company code suggests a minimum of at least two directors on the boards and no upper limit. Neither Spain nor Ireland has formulated a standard rule on CEO duality (Paredes & Núñez-Lagos, 2015).

Corporate governance codes play an increasingly important role in addressing gender balance on corporate boards. Notably, regarding female board representation, Spain has a quota system in place. In 2007, Spain adopted a law on effective equality between women and men, which recommends to large companies with more than 250 employees and to companies listed on IBEX 35 to gradually appoint women on their boards until an even number of male and female members has been achieved (Whit, 2014). These companies were required, within eight years, to gradually modify the composition of their boards until a proportion of between 40 and 60% of each gender has been reached. For Ireland, no quota law or proposal for private companies is underway on gender diversity. However, on average, the women representation on boards of Spanish corporates is around 10% while for Ireland it is at 8% (Rodríguez-Ferández, 2015).

In the case of Spain, the Code suggests a balance between external and internal directors. External directors can be of two different types: proprietary (those representing controlling shareholders) and independent (those with no links with the company, its managers or controlling shareholders). Under the Code, while the proprietary members should represent the significant shareholders in a proportion that matches the capital they represent, the number of independent directors should be at least one-third of all board members. However, Irish law does not make any distinction between the executive and NED.

According to La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1998), countries with legal rules originating in the common law tradition (Australia, Canada, US, the UK) protect investors significantly more than the countries whose laws originate in French civil law (Argentina, Belgium, France, Italy, Poland and Spain) (Inkpen & Ramaswamy, 2005). It is noteworthy, to examine how the two legal jurisdictions will affect the corporate governance codes and their effects on firms’ performances and earnings volatility.

This paper contributes to the literature in many ways. First, it sheds light on the comparative experiences of the two countries originating from differing legal system and describes how their codes and practices affect the publicly listed firms’ performance. Second, it empirically tests existing theories relating to board characteristics and R&D expenditure volatility to firm performance. This is done in the context of Spain and Ireland, which was impacted by the financial crisis. This offers a natural experiment to test financial crisis as an exogenous shock. This enables better understanding of how board characteristics and R&D volatility can affect firm performance in different contexts, such as cultural differences across countries which may affect the significance or even the direction of the relationship, the effective governance in funding allocation and lastly, it shows the effectiveness and relevance of the newly introduced code on female representation in Spain to the firm performance.

By doing so, it compares with Irish firms' experiences and underscores the relevance of the individual institutional settings of the countries.

The rest of the paper is organised as follows: Section 2 presents the review of literature, Section 3 describes data sources and methodology, Section 4 presents the empirical findings and Section 5 presents discussion and conclusions.

2. Literature review

This research considers three theories: resource dependency theory and agency theory, to explain the effects of board characteristics (female representation, NED, board size and CEO duality) on firm performance.

A general and popular view in the literature is that the board size is negatively related to performance for firms regardless of the firm size. For instance, studies that show a negative board size effect on performance of firms outside US include: Conyon and Peck (1998) who analyse firms in the UK, France, the Netherlands, Denmark and Italy; Mak and Kusnadi (2005) who analyse firms in Malaysia and Singapore; Loderer and Peyer (2002) who analyse firms in Switzerland; and de Andres, Azofra, and Lopez (2005) who analyse firms in 10 OECD countries. In contrast, Jong, DeJong, Mertens, and Wasley (2000) and Black, Jang, and Kim (2006) report non-significant effects of board size on performance in Dutch and Korean firms, respectively. Kiel and Nicholson (2003) find positive board size effects in Australia. Thus, with few exceptions, the negative board size effect is well established for large publicly held corporations across countries. Further, Hermalin and Weisbach (2003) conclude that: "The data therefore appear to reveal a fairly clear picture: board size and firm value are negatively correlated". This is in contrast to the theoretical literature (resource dependency and agency perspective on boards), which holds that a negative board size effect should only apply to firms with a relatively large number of directors: From the perspective of the resource dependency theory, the board members are the nexus between the company and the resources it needs to maximise value (Pfeffer, 1973; Pfeffer & Salancik, 1978). This theory suggests a positive association between the board size and performance (Barroso Castro, Villegas Perrián, & Perez-Calero, 2010). On the other hand, the agency theory (Fama, 1980; Fama & Jensen, 1983; Jensen & Meckling, 1976) supports any mechanisms that solve the conflict between managers and owners. Given that the board of directors is seen as a good tool to align their respective competing interests, it can be assumed that the larger boards can exercise better control on managers than those with smaller number (Donaldson, 1990; Donaldson & Preston, 1995; Freeman, 1984).

Hypothesis 1: Board size will have a positive effect on firm performance.

Agency theory argues that separating the roles of CEO and chairman of the board can mitigate agency costs (Chen, Cheung, Stouraitis, & Wong, 2005; Jermias, 2007). As a leader of the board, the chairman is responsible for monitoring the CEO's decision-making and overseeing the process of CEO hiring, firing, evaluation and compensation. The combination of two leadership roles would constrain the chairman from taking on an effective and objective monitoring role, thus promoting CEO entrenchment and intensifying agency conflicts. Beasley, Carcello, and Hermanson (1999) find that CEO duality was involved in 72% of the frauds examined by the SEC. Hence, we consider duality as a key driver of agency conflicts due to reduced monitoring and allowing the CEO to act in his or her own interests. Further evidence about the potential problems associated with duality is found in relation to corporate decline, where duality is frequently cited as an important factor that influences the downward spiral of companies. Daily and Dalton (1994) find that duality is more common in failed firms than in non-failed firms.

Hypothesis 2: Duality will have a positive effect on firm performance.

Notwithstanding the value of vigilant board oversight, the managerial discretion literature suggests that overzealous monitoring and frequent interference in a firm's affairs may discourage managerial initiatives (Burkart, Gromb, & Panunzi, 1997). In a large body of work, Finkelstein and his colleagues (Finkelstein & D'Aveni, 1994; Finkelstein & Hambrick, 1990) find that powerful CEOs, for example, those with dual role, tend to have a beneficial effect on firm performance in uncertain environments where, encumbered by fewer constraints, they can make quick decisions without the need to build consensus. In these contexts, CEO duality allows a single unified voice to guide a firm during a crisis as there is little ambiguity regarding who is in charge.

Hypothesis 3: Duality will have a negative effect on firm performance during the crisis.

Similarly, NED are believed to be more vigilant monitors of firm management, but Williamson (2007) contends that NED have an information disadvantage compared with insiders and are typically slow to react in situations of adversity. Williamson warns that boards comprising of a high ratio of NED typically "failed to act promptly and with urgency when a crisis occurs" (2007, p. 262). Accordingly, following van Essen et al. (2013) this study reasons that while good governance board characteristics associated with vigilant oversight may represent best practice in stable state conditions, these same characteristics can inhibit managerial discretion and limit their capacity to respond to the contingencies of a financial crisis with negative effects for a firm's financial performance.

Hypothesis 4: A high fraction of independent directors, will have a more negative impact on a firm's financial performance during financial.

Hypothesis 5: A high fraction of independent directors, will have a positive impact on a firm's financial performance during non-financial crisis period.

Prior research suggests that, as per R&D manipulation hypothesis, managers routinely manipulate R&D expenditures to smooth earnings or to meet earnings forecasts (DeGeorge, Patel, & Zeckhauser, 1999). For instance, Baber, Fairfield, and Haggard (1991) argue that managers reduce R&D expenditures when earnings will be less than analysts' forecasts. Generally, managers are thought to make myopic decisions regarding R&D investments, focusing on short-term earnings instead of concentrating on value creation (Cheng, 2004). Firms that interrupt R&D investment have less knowledge and a diminished ability to learn (Kor & Mahoney, 2005). Such firms making frequent and substantial changes in R&D spending may sacrifice long-term R&D performance in favour of short-term earnings' predictability (Baber et al., 1991; Bushee, 1998; Cheng, 2004; Dechow & Sloan, 1991; DeGeorge et al., 1999; Elliott, Richardson, Dyckman, & Dukes, 1984; Perry & Grinaker, 1994). These occurrences lead to R&D volatility.

Hypothesis 6: If research and development volatility stems from earnings management activity, then we expect a negative effect of research and development expenditures volatility on firm performance.

In contrast, the creative-destructive perspective suggests that if fluctuations in R&D are due to effective governance of the funding allocation to R&D process, then it can be valuable, since it frees up firm resources that may be redeployed in future search activities (Schumpeter, 1942; Swift, 2008). From the frame of "essential fact about capitalism" coined by Joseph Schumpeter (1942), creative destruction refers to the incessant product and process innovation mechanism in which new production units replace outdated ones (Schumpeter, 1942). Accordingly, the study investigates the relation between R&D volatility and firm performance.

Hypothesis 7: Firm performance is positively related to changes in research and development expenditure.

3. Data source and methodology

This study investigates the relationships between corporate governance and firm financial performance of listed firms in Ireland and Spain. We have selected 21 firms listed on Irish stock exchange Index, ISEQ20 and the 52 major companies in Spanish stock market, including all the companies listed on index IBEX35, for the period 2005–2014. The firm-year observations that did not have three-year continuous data were eliminated to reduce errors. The final panel data are strongly balanced for the two countries. Company performance data and other accounting data for explanatory variables were downloaded from *Thomson One Banker (Worldscope database)*. Data on board structure determinants were hand collected from the annual reports of each observed company and all the annual reports were downloaded from companies’ official website.

The study uses R&D expenditure volatility as empirical proxy to capture the intensity of the process of creative destruction in the funding reallocation decisions. The magnitude of R&D expenditure volatility is captured by changes in R&D expenditure and is consistent with Swift (2008).

Table 1 describes the dependent and independent variables used in the study.

3.1. Model estimation

This study employs OLS Pooled regression model as a basic model and compares the findings to alternative approaches i.e. fixed effects and difference-in-difference model (DiD). To address the concern that corporate governance variables, performance and R&D volatility are jointly determined by unobservable firm-specific variables, the study employs a fixed effects model and random effects

Table 1. Describing the dependent, independent and control variables used in the study

Determinants	Operationalisation
<i>Dependent: Firm performance variable</i>	
Tobin's Q ratio (TQ)	Tobin's Q ratio is the sum of the market value of equity and the book value of total debt divided by the book value of total assets
Return on assets (ROA)	ROA is expressed as the net income divided by total assets
<i>Independent: Corporate governance variables</i>	
Gender diversity (Female)	The proportion of female directors on the board
Board independence (NED)	The ratio of non-executive and/or independent directors to total number of directors on the board
Duality	Duality is a dummy variable which equals to zero if CEO and chairman of the company taken by separate person, and equals to one otherwise
Board size	Board size is the natural logarithm of board size. Board size is the total number of directors on the board
<i>Independent: Performance variables</i>	
Earnings risk	Standard deviation of net income
R&D intensity	R&D intensity is the ratio of research and development expenditure to total assets
R&D volatility	R&D volatility is measured using a coefficient of variation (Standard deviation of R&D expenditure/ Mean of R&D expenditure)
R&D expenditure changes <ul style="list-style-type: none"> • Decrease R&D • Increase R&D 	R&D expenditure changes are shown as dummy variables and are expressed as: Decrease R&D and Increase R&D
Sales to total assets (STA)	STA is expressed as sales divided by total assets
Sales growth	Sales growth is expressed as difference between the current year sales minus previous year sales divided by previous year sales
<i>Control variables</i>	
Firm age	The natural logarithm of firm age (<i>lnfage</i>) is used in the models. Firm age is the number of years from the time that the company incorporated
Firm size	The natural logarithm of firm size (<i>lnfsize</i>) is used in the models. Firm size is the book value of total assets
Leverage	Leverage is the percentage of the book value of long-term debt to the book value of total assets

regression model, which represents a common method of controlling for omitted variables in a panel data-set (Wintoki, Linck, & Netter, 2012; Yermack, 1996). The fixed effect model explains the variations about the mean of the dependent variable in terms of variations about the means of explanatory variable for a group of observations relating to a given firm. The main interest for using this model is that it controls for heterogeneity bias. This model assumes spatial dimension and is expressed as follows:

The basic specification with controlling firm characteristics is expressed as below:

$$Y_t = \alpha + \beta_1 \text{Female}_t + \beta_2 \text{NED}_t + \beta_3 \text{Duality}_t + \beta_4 \text{BSize}_t + \delta_1 \text{FAge}_t + \delta_2 \text{firm size}_t + \delta_3 \text{Leverage}_t + \delta_4 \text{DecreaseR\&D}_t + \beta_8 \text{IncreaseR\&D}_t + \beta_9 \text{R\&DIntensity}_t + \beta_{10} \text{R\&DVolatility}_t + \beta_{11} \text{Earnings risk}_t + \varepsilon_t \quad (1)$$

where Y_t is dependent variable and two proxies are used as performance variables: Tobin's Q (TQ) and return on assets (ROA).

X_{1it} is a vector of independent variables including board and firm characteristics (leverage, gender diversity, NED, board size, firm age, firm size (total assets), R&D expenditure changes, R&D volatility, R&D intensity and X_{2it} is a vector for dummy variable which is 1 for Duality and 0 for non-Duality. The description of variables is shown in Table 1 before reference list. In an attempt to alleviate the potential bias caused by omitted variables, we control for other general firm characteristics including firm age, firm size and leverage.

The baseline model in this study is as follows:

$$\text{Tobin's } Q_{it} = \alpha + \beta_1 \text{Female}_{it} + \beta_2 \text{NED}_{it} + \beta_3 \text{Duality}_{it} + \beta_4 \text{Board size}_{it} + \beta_5 \text{Firm size}_{it} + \beta_6 \text{Leverage}_{it} + \beta_7 \text{DecreaseR\&D}_{it} + \beta_8 \text{IncreaseR\&D}_{it} + \beta_9 \text{R\&DIntensity}_{it} + \beta_{10} \text{R\&DVolatility}_{it} + \beta_{11} \text{Earnings risk}_{it} + \varepsilon_{it} \quad (2)$$

$$\text{ROA}_{it} = \alpha + \beta_1 \text{Female}_{it} + \beta_2 \text{NED}_{it} + \beta_3 \text{Duality}_{it} + \beta_4 \text{Board size}_{it} + \beta_5 \text{Firm size}_{it} + \beta_6 \text{Leverage}_{it} + \beta_7 \text{DecreaseR\&D}_{it} + \beta_8 \text{IncreaseR\&D}_{it} + \beta_9 \text{R\&DIntensity}_{it} + \beta_{10} \text{R\&DVolatility}_{it} + \beta_{11} \text{Earnings risk}_{it} + \varepsilon_{it} \quad (3)$$

It is important to identify the suitable empirical model for the study. Towards this the study performs diagnostics tests that include: Hausman tests (to decide between the fixed and random effects) and Breusch-Pagan Lagrange multiplier tests (to decide between pooled and random regression model).

3.2. Robustness check: Difference-in-difference model

Besides using a multivariate OLS regression with fixed effects, this paper also uses DiD model analysis in measuring the linkages between R&D, Board Independence (non-executive directors) and firm performance using a sample of Irish and Spanish firms. This empirical model is appropriate in identifying the effects of a specific intervention as exogenous shock, in this case, the financial crisis period of 2008–2010. The effects of board characteristics and R&D on performance will be examined during the crisis period by comparing the outcomes after and before the intervention for groups affected by the intervention to the same difference for the unaffected groups (Bertrand, Duo, & Mullainathan, 2003).

Treatment and control groups. This paper considers financial crisis as an exogenous shock on firms. Thereafter, a treatment and a control group can be assigned among the Spanish- and Irish-listed firms. The firms whose R&D expenditure is below the mean are considered as treatment group and those which are above the mean are referred as control group. Using ROA and Tobin's Q as the main dependent variable to measure firm performance, the DID model specification is expressed below:

Table 2. Summary statistics of the Irish-listed companies (210 observations)

Variable	Mean	SD	Min	Max
ROA	6.07	9.73	-40.10	36.81
TQ	1.19	1.14	0.04	6.13
Female	0.08	0.08	0.00	0.33
NED	0.63	0.15	0.30	1.00
Duality	0.32	0.47	0.00	1.00
Board size	10.66	3.83	5.00	23.00
Firm size	6.65	2.01	1.52	10.02
Leverage	23.59	19.08	0.00	114.45
STA	1.16	0.97	0.05	10.36

Table 3. Summary statistics of the Spanish-listed companies (520 observations)

Variable	Mean	SD	Min	Max
Female	0.08	0.10	0.00	0.50
NED	0.79	0.16	0.00	1.00
Duality	0.54	0.50	0.00	1.00
Board size	11.57	3.47	4.00	26.00
Firm size	6.94	2.05	1.68	11.94
ROA	4.29	7.19	-26.13	36.21
TQ	0.79	0.88	0.03	5.98
Leverage	0.34	0.22	0.00	2.35
STA	0.68	0.40	0.02	4.06

$$ROA_{it} = \beta_0 + \beta_1 Treatment_i + \beta_2 Post_t + \beta_3 Treatment_i \times Post_t + \mu_{i,t} \tag{4}$$

The coefficient of interest, i.e. β_3 will be the DiD estimate:

$$\beta_3 \left(\overline{\Delta ROA^{Treated}} \right) - \left(\overline{\Delta ROA^{Control}} \right) \tag{5}$$

4. Empirical findings

4.1. Descriptive statistics

Table 2 shows that the boards in *Ireland* are mostly comprised of independent directors. The representation of the independent or NED is seven for a board size of 10.66 and fourteen if the board size is 23. While the representation of female board members are 0.85 and 1.84 on the boards with a mean size of 10.66 and on the boards with a maximum size of 23. With regards to duality, it is evident from the Table 2 that out of the total 21 companies considered in the study, six companies have the chairman as chief executive officer (CEO) while the rest consider the roles of the chairman and CEO as separate.

In the case of *Spain*, Table 3 shows that the representation of the NED is 9 and 20.54, respectively, for the boards with a mean size of 11.57 and for the boards with a maximum size of 26. While, the female board members are 0.92 and 2.08 on the boards with a mean size of 11.57 and a maximum size of 26. With regards to duality, out of the total 52 companies, 28 companies do not separate the role of the chairman from that of the CEO, while the remaining 24 companies have the roles of the chairman and CEO separated.

Table 4. Effects of R&D Volatility and corporate governance on performance of Spanish-listed firms for the period 2005–2014

	ROA-OLS	ROA-FE	TQ-OLS	TQ-FE
Female	-12.08	-17.73	-0.31	0.396
	(4.29)***	(4.52)***	0.87	1.04
Non-executive directors	-0.507	-0.695	0.294	0.509
	0.27	0.3	1.35	(2.28)**
Duality	-461	-0.432	-0.151	-0.124
	0.73	0.55	(2.06)**	1.65
Board size	-0.423	-0.494	-0.113	-0.089
	(3.43)***	(2.51)**	(6.99)***	(4.49)***
Firm size	2.665	3.536	0.328	0.524
	(11.60)***	(8.31)***	(10.58)***	(12.73)***
Leverage	-11.89	-11.73	-0.855	-0.582
	(9.29)***	(8.10)***	(6.14)***	(-4.15)***
Decrease R&D	2.317	2.439	0.641	0.533
	1.24	1.3	(3.37)***	(2.94)***
Increase R&D	2.234	2.039	0.613	0.444
	1.21	1.09	(3.25)***	(2.46)**
R&D intensity	-2.437	-1.477	-0.314	0.386
	1.52	0.58	-1.48	1.57
R&D volatility	-1.925	-0.445	0.111	0.202
	(1.80)**	0.39	0.98	(1.82)
Earnings risk	-0.001	-0.001	0	0.001
	(2.08)**	0.48	0.78	0.69
_cons	-3.516	-9.751	-0.62	-2.751
	1.22	(2.05)**	(1.72)	(5.97)***
N	520	520	520	520
R ²	0.42	0.38	0.26	0.09
Wald $\chi^2(10)/F(10, 179)$	296.32	22.4	229.6	24.96
Pro > χ^2	0.000	0.000	0.000	0.000

**Significance at 5% level.

***Significance at 1% level (t-values in parentheses).

It is evident from the Table 4 that, in the case of Spanish-listed firms, the female representation on the boards affect performance negatively and significantly at 1% level when ROA is used as a performance measure. While the effects of NED on performance is not significant with the exception of TQ measure under fixed effects model which is significant at 5% level and doesn't support the proposition stated in the study (refer to Hypothesis 5).

Duality is negative and insignificant across three specification models with the exception of TQ-OLS. This doesn't support the proposition stated in the study (refer to Hypothesis 2) suggesting a positive association between duality and performance during non-crisis periods. The effect of board size on performance is negative and significant at 1% level in general and does not support the hypothesis stated in the study (Hypothesis 1).

The firm size has a positive relationship with firm performance at 1% level of significance and leverage has a significant and negative relationship across the four model specifications. The increase and decrease in the R&D expenditure show a positive and significant relationship with the

Table 5. Effects of R&D volatility and corporate governance on performance of Irish-listed firms for the period 2005–2014

	ROA-OLS	ROA-FE	TQ-OLS	TQ-FE
Female	-15.57	-20.313	-2.042	-1.672
	1.58	(1.96)**	(2.18)**	(1.77)*
Non-executive directors	-15.36	-19.136	-1.244	-1.089
	(2.80)***	(2.80)***	(2.16)**	(1.74)*
Duality	0.951	0.772	-0.016	0.027
	0.54	0.36	0.09	0.14
Board size	0.038	-0.233	-0.06	-0.065
	0.15	-0.75	(2.28)**	(-2.30)**
Firm size	3.053	4.48	0.442	0.556
	(5.12)***	(5.52)***	(6.81)***	(7.48)***
Leverage	-0.212	-0.187	-0.015	-0.013
	(5.66)***	(-4.04)***	(-4.10)***	(3.11)***
Decrease R&D	0.069	0.09	-0.011	-0.062
	0.03	0.47	0.06	0.33
Increase R&D	1.132	0.905	0.102	0.22
	0.58	0.47	0.57	0.13
R&D intensity	2.605	4.432	-0.746	-0.65
	0.68	0.99	(1.93)*	1.58
R&D volatility	0.001	0.001	0.001	0.001
	0.12	0.89	0.33	0.98
Earnings risk	0.001	0.001	0.001	0.001
	0.100	0.58	-0.48	0.03
_cons	-0.35	-3.357	0.307	-0.618
	0.06	0.62	0.44	-0.78
N	210	210	210	210
R ²	0.27	0.22	0.15	0.1
Wald $\chi^2(10)/F(10, 179)$	96	9.29	107.69	10.77
Pro > χ^2	0.000	0.000	0.000	0.000

*Significance at 10% level.

**Significance at 5% level.

***Significance at 1% level (t-values in parentheses).

Tobin's Q at 1% level. This suggests that the boards are effectively monitoring the allocation of funds to those channels that adds value by replacing those that are outdated and supports the study hypothesis (7th). While R&D intensity and volatility and earnings risk have insignificant effects with the exception of ROA-OLS specification.

It is evident from the Table 5 that, in the case of Ireland, the female representation on the boards affects performance negatively and significantly at 5% level. While the effects of NED on performance is negative and significant at 1% level for ROA measure and 5% level for TQ measure and doesn't support the proposition stated in the study (refer to Hypothesis 3). Duality is insignificant across the four model specifications. This doesn't support the proposition stated in the study (refer to Hypothesis 2) suggesting a positive association between duality and performance during non-crisis periods.

The effect of board size on performance is negative and significant at 5% level for TQ performance proxy does not support the hypothesis stated in the study (Hypothesis 1). The firm size is positive at

Table 6. Performance (Tobin's Q) of Spanish- and Irish-listed companies during the Financial crisis for the period 2008–2010

Variables	Spain		Ireland	
	Quantile regression	Regression	Quantile regression	Regression
Female	0.094	-0.195	-1.345	-1.167
	-0.31	-0.48	-1.7	-0.83
Non-executive directors	0.06	-0.116	-0.028	-0.27
	-0.37	-0.54	-0.07	-0.39
Board-duality	-0.03	-0.023	-0.328	-0.598
	-0.52	-0.3	(2.76)***	(2.83)***
Board size	-0.022	-0.037	-0.012	-0.003
	(1.92)*	(2.53)**	-0.69	-0.11
Firm age	-0.002	-0.002	-0.002	-0.003
	(1.96)*	-1.34	-1.66	-1.63
Leverage	-0.897	-1.178	-0.014	-0.019
	(4.42)***	(4.46)***	(4.88)***	(3.75)***
Expenses efficiency	-1.175	-0.97	-0.083	-0.119
	(5.05)***	(3.20)***	(2.93)***	(2.38)**
Firm size	0.084	0.186	0.103	0.118
	(3.46)***	(5.89)***	(2.57)**	-1.65
Sales growth	-1.604	-1.312	-0.816	0.546
	(2.95)***	(-1.85)*	-1.37	-0.52
Sales to total assets	0.387	0.385	-0.247	-0.426
	(4.20)***	(3.21)***	(3.06)***	(2.98)***
Research & development	0.0034	0.0065	0.0098	0.0010
	(2.15)**	(3.98)***	(2.61)**	(2.87)***
Constant	1.389	1.055	1.246	1.945
	(4.80)***	(2.80)***	(3.94)***	(3.47)***
N	156	156	63	63
R ²		0.5		0.48

*Significance at 10% level.

**Significance at 5% level.

***Significance at 1% level (t-values in parentheses).

1% level of significance and leverage is significant and negative across the four model specifications. The increase and decrease in the R&D expenditure, R&D intensity and R&D volatility and earnings risk have insignificant effects on the performance of Irish-listed firms and do not favour the study hypothesis (refer to Hypothesis 7).

Regarding results presented in Table 6, the corporate governance variables are mostly insignificant in driving performance during the crisis period. In the case of Ireland, duality has a significant and negative influence on the performance during the crisis and supports the views of Finkelstein and D'Aveni (1994) and Finkelstein and Hambrick (1990) who state that powerful CEOs, for example, those with dual role, tend to have a beneficial effect on firm performance in uncertain environments. Our results support that CEO duality allows a single unified voice to guide a firm during a crisis. The effects of NED on the performance are negative and suggest outside directors have information disadvantage in reacting quickly during the time of crisis and hence, affect the performance negatively (van Essen, Engelen, & Carney, 2013; Williamson, 2007). The findings do not support the hypotheses proposed in the study with regards to the association between board size, NED and duality with the firms' performance (Hypothesis 1, 3 and 5).

Table 7. Effects of R&D on performance during the financial crisis period of 2008–2010 using difference in difference regression model

	Spain		Ireland	
	ROA	TQ	ROA	TQ
Treat	-1.119	-0.27	-1.96	-0.539
	-1.61	(2.96)**	-1.13	(2.74)**
Post	-3.552	-0.519	-0.413	-1.294
	(4.61)**	(5.14)**	-0.21	(5.79)**
Treat * post	2.309	0.177	1.263	0.348
	(2.43)**	-1.42	-0.52	-1.27
Firm size	1.977	0.203	1.18	0.255
	(11.73)**	(9.20)**	(2.38)*	(4.56)**
Leverage	-10.394	-1.223	-0.212	-0.012
	(9.52)**	(8.55)**	(5.70)**	(2.93)**
Duality	-0.327	-0.059	-0.209	-0.544
	-0.7	-0.96	-0.15	(3.53)**
Board size	-0.022	-0.033	0.217	0.015
	-0.25	(2.83)**	-1.21	-0.75
Sales to assets	3.464	0.636	1.689	-0.003
	(5.52)**	(7.74)**	(2.73)**	-0.04
Efficiency ratio	-17.177	-1.552	-0.881	0.004
	(9.68)**	(6.68)**	(2.64)**	-0.1
Sales growth	7.212	-0.264	11.395	1.683
	-1.91	-0.53	-1.13	-1.48
_cons	9.283	1.483	0.676	0.529
	(4.22)**	(5.15)**	-0.18	-1.23
R ²	0.54	0.46	0.36	0.4
N	520	520	210	210

*Significance at 5% level.

**Significance at 1% level (t-values in parentheses).

The Table 7 reports the regression results for the DiD model, as stated in Section 3.2, the variable of interest is the interaction variable i.e. R&D expenditure variable and financial crisis period, Treatment × Post. It is evident from Table 7 that the co-efficient of interaction variable in the case of Irish firms is insignificant while the Spanish results suggest a positive and significant association between the interaction variable and performance for the ROA-OLS model specification and the co-efficient is 2.309 with the t-statistics value of 2.43% which is significant at 5% level of significance. This suggests that the R&D expenditure has relevance to the Spanish-listed firms' performance during the financial crisis period. The results support the creative-destructive (restructuring) view of the incessant product and process innovation mechanism in which new production units replace outdated ones (Schumpeter, 1942) and deals effectively with R&D expenditure towards value creation.

Table 8 reports the regression results for the DiD model, as stated in Section 3.2, the variable of interest is the interaction variable i.e. Treatment × Post. It is evident from Table 8 that the co-efficient of interaction variable in the case of Irish and Spanish firms is insignificant across all the four model specifications. This suggests that the NEDs have less relevance to the performance of the Spanish- and Irish-listed firms during the financial crisis period. The results support do not favour the perspective of the resource dependence theory which takes a positive view and underscores the importance of NED on boards as a resource in helping the firm secure access to diverse resources in

Table 8. Effects of NEDs on performance during the financial crisis period of 2008–2010 using difference in difference regression model

	Spain		Ireland	
	ROA	TQ	ROA	TQ
Treat	0.48	-0.182	-2.914	-0.347
	-0.54	-1.53	-1.61	-1.56
Post	-0.493	-0.055	0.084	0.131
	-0.81	-0.68	-0.06	-0.74
Treat * post	-0.737	-0.033	3.012	-0.167
	-0.7	-0.23	-1.23	-0.56
Firm size	1.519	0.1	1.295	0.028
	(12.66)**	(6.20)**	(3.80)**	-0.68
Leverage	-11.675	-1.521	-0.198	-0.022
	(11.05)**	(10.76)**	(6.15)**	(5.70)**
Duality	-0.237	-0.004	0.043	-0.696
	-0.51	-0.07	-0.03	(4.23)**
Sales to assets	4.197	0.806	1.826	-0.007
	(6.92)**	(9.94)**	(2.98)**	-0.09
Efficiency ratio	-18.087	-1.783	-0.939	-0.046
	(10.06)**	(7.41)**	(2.73)**	-1.09
Sales growth	9.988	0.162	11.222	1.684
	(2.62)**	-0.32	-1.1	-1.35
_cons	11.499	1.772	1.476	1.863
	(5.50)**	(6.33)**	-0.48	(4.90)**
R ²	0.52	0.42	0.36	0.3
N	520	520	210	210

*Significance at 5% level.

**Significance at 1% level (t-values in parentheses).

which they can add value to the firm’s performance by using their networks and outside connections (Pfeffer & Salancik, 1978) and, views governance structure and the board composition as a resource that can add value to the firm (Carpenter & Westphal, 2001).

5. Conclusions

This study investigates the linkages between R&D, Board characteristics and firm performance using a sample of Irish and Spanish firms during the period 2005–2014. The study includes 21 companies listed on Ireland stock exchange Index, ISEQ20 and 52 major companies in Spain stock market, including all the companies listed on index IBEX35, for the period 2005–2014.

The results suggest a comparability of boards’ independence for the Spanish- and Irish-listed firms. Likewise, three-fourth (3/4) of the sample size considered in the study have duality in which the role of chairman (governance) and CEO (management) are separated. The female representation in Ireland case is comparable to Spain, in which quota for female representation is in practice through the codes. However, the Spanish firms are less dual i.e. nearly 54% of the boards do not separate the roles of the chairman and CEO and therefore, differ from Irish firms in the case of duality.

The results suggest that NED affect performance of the Irish-listed firms significantly and negatively while they are insignificant in the case of Spanish firms. Moreover, the term independence doesn’t merely, ensure independence to the NED. This could be because of the different institutional

expectations regarding their boards' composition and this institutional context may lead to a different relationship with firm performance (Judge, Naoumova, & Koutzevol, 2003). This can be substantiated with the findings of Clifford and Evans (1997) which shows that in spite of the Australian boards being composed of a majority of NED, 35% of those NED were involved with financial transactions which potentially threaten their independence.

Further, during the financial crisis, the NED have negative and insignificant effects on the performance in the cases of the Spanish firms and Irish firms. The results are robust to alternate model specifications that include difference in difference model, Quantile regression model and OLS regression models. These findings are consistent with the literature that suggests information disadvantage to NED compared with insiders, hence, are typically slow to react in situations of adversity and have negative effects for a firm's financial performance (van Essen et al., 2013; Williamson, 2007).

Although the Spanish firms are less dual than Irish firms, the results suggest a comparable association between duality and firm performance. With regards to duality, the results of the Spanish firms suggest a negative association with performance (TQ-OLS model) for Spanish firms. The findings do not favour the agency argument that separating the roles of CEO and chairman of the board can mitigate agency costs (Chen et al., 2005; Jermias, 2007).

During the financial crisis period, the association between duality and firm performance for the Irish firms are negative and significant. There is a variation in the degree of magnitude in which they affect the firm performance. However, these findings do not support the view that powerful CEOs, i.e. those with dual role, tend to have a beneficial effect on firm performance in uncertain environments where, encumbered by fewer constraints, they can make quick decisions without the need to build consensus. In these contexts, CEO duality allows a single unified voice to guide a firm during a crisis as there is little ambiguity regarding who is in charge (Finkelstein & D'Aveni, 1994; Finkelstein & Hambrick, 1990).

With regards to the female representation, Spain and Ireland are negative and significantly associated with firms' financial performance in two of the four model specifications. The results are comparable in the case of the two countries regardless of the quota system on gender equality in Spain and no quota or law in Ireland to support gender balance.

The effects of board size on performance are significant and negative for Spanish firms and Irish (for two model specifications) firms. This is consistent with the literature (Conyon & Peck, 1998; Loderer & Peyer, 2002). Nonetheless, it is in contrast with the theoretical (agency and resource dependency) that suggests a positive association between the board size and performance (Barroso Castro et al., 2010). The agency supports any mechanisms that solve the conflict between managers and owners (Fama, 1980; Fama & Jensen, 1983; Jensen & Meckling, 1976). Given that the board of directors is seen as a good tool to align their respective competing interests, and exercise better control on managers than those with smaller number (Donaldson, 1990; Donaldson & Preston, 1995; Freeman, 1984). Meanwhile, the effects of firm size while leverage and R&D have negative association for both countries.

The findings of Spanish-listed firms show a positive and significant relationship between increase and decrease in the R&D expenditures volatility and performance and support the creative-destructive perspective suggested in the study. Creative-destructive (restructuring) perspective suggests that fluctuations in R&D occur due to effective governance in funding allocation to R&D. Further, the results obtained from using DiD model during the financial crisis suggests that the R&D expenditure has relevance to the Spanish-listed firms' performance during the financial crisis period. The evidence supports the creative-destructive (restructuring) view of the incessant product and process innovation mechanism in which new production units replace outdated ones (Schumpeter, 1942) and deals effectively with R&D expenditure towards value creation.

It can be concluded that in general, there is no significant difference between the Irish and Spanish boards in influencing performance although they vary in their codes on corporate governance relating to gender diversity, board size and board composition relating to NED.

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