Exploring the relationship between the Social Network Profile of S&P1500 Firms and their Environmental and Financial Profiles

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List of Abbreviations

Abbreviation	Description
SN	Social Network Profile
EP	Environmental Profile
FP	Financial Profile
ACARs	Acquirer Cumulative Abnormal Returns
AndrewMetrick	Andrew Metrick's website
AR	Annual Report
ASR	Annual stock returns data
BACEN	Brazilian Central Bank (BACEN) database
BankEmp	Bank's employee database
BF RR	Business Facilities Rankings Report
BMAC	Britain's Most Admired Companies
Board position	Board chairman, audit committee chair, audit committee member
BoardMag	Corporate Board Member Magazine Director Database
BSE	Bucharest Stock Exchange
BW EPB	Business Week: Executive Profile and Biography
CAR	Cumulative Abnormal Stock returns
CC,AB	CaringCompany Research, AB
CDP	Carbon Disclosure Project
CEOs' external	CEO advice seeking from not friend executives / or with different
CEPD	IRRC: Corporate Environmental Profiles Database
CER	Corporate environmental reports
CER-FW	Corporate environmental reports - Firms' websites
CER-PR	Corporate environmental reports - respective firms' public relations
CGC CSD	Chaebol group Chaebol Chong-soo-dle
China ISY	China Industrial Statistics Yearbook
CIC-BW	Business Week Online: Company Insight Centre
CNBS	The Annual Industrial Survey Database of the Chinese National Bureau of
CO	Colombia
Compact D/SEC	Compact Disclosure database
CONFECAMARAS	The Colombian Confederation of Chambers of Commerce
CorporateDisclosure	Other corporate disclosure available on Internet
CR	CorporateRegister.com
CRSP	Centre for Research in Security Prices
CSMAR	The China Stock Market and Accounting Research (CSMAR) financial
CSR	Corporate Social Responsibility
Destatis	German Federal Statistical Office (German: Statistisches Bundesmat)
DJSWI	Dow Jones Sustainability World Index
EDS	Environmental Disclosure Score

Abbreviation	Description
EIN	China Economic Information Network database
EPA	The local environmental protection agency
EPA CLP	Environmental Protection Agency Climate Leaders Program
EPA PCS	Environmental Protection Agency Permit Compliance System
EPA TRI	Environmental Protection Agency Toxic Release Information
ER	Environmental report
F	Fixed-effect model
FAME	Financial Analysis Made Easy
FinnishNBPR	National Board of Patents and Registration of Finland
ForbesGS	Forbes: List of Green States
FS	Firm's financial statement
FW	Firms' website
GC	Granger causality
GES	GES Alert Service
GHG	Greenhouse Gas Emissions
GovWeb	The website of government offices
GRI	Global Reporting Initiative
GVA	Growth of gross value added
Hoover	Hoover database
I	Instrumental Variable
IDDC	Independent Directors on Compensation Committee
Intl.	International
IRRC CEP	IRRC Corporate Environmental Profile
L	Lagged variable
Leverage	the ratio of total debt to total assets
LPC	Dealscan of Loan Pricing Corporation
LSE	London Stock Exchange
MB	Growth opportunities
MDL	Management Diagnostic Limited
NEEDS	Nikkei Economic Electronic Databank System
NEEDS	Nikkei NEEDS-Financial Quest Corporate Financials Database
NEEDS QIT	Nikkei NEEDS Database (Nikkei Quick Information Technology Co. Ltd.)
NEEDS-CAD	NEEDS-the Corporate Attribute Database
NEI RF	National Equity-Issue Registry Forms
Nikkei EMR	Nikkei Environmental Management Ranking survey
NPDES	National Pollutant Discharge Elimination System
NPM	Net profit margin (NPM)
NPRTR	The National Pollutant Release and Transfer Register
OECD	OECD countries (Canada, France, Germany, Hungary, Japan, Norway, US)

Abbreviation	Description
PF-1B	Private firms with annual sale >$1billion
PIB	Powerful Independent Board
PIBC	Powerfully Independent Board Compensation Committee
PID	Powerful Independent Director
PIRC ER	PIRC Environmental Reporting 2000
PortugueseExame	Portuguese financial magazine Exame
PROWESS CMIE	PROWESS of Centre for Monitoring the Indian Economy
PRTR	Pollutant Release and Transfer Registration
PTR	Public Trade Register
RDS-JapanME	Reporting and disclosure system (Ministry of Environment, Japan)
RET	Annual Stock Returns
ROA	Return on Assets
ROCE	Return on Capital employed
ROE	Return on Equity
ROTA=ROA	return on Total Assets
SCSRR	Separate China Security and Regulations (CSR) reports
SDC Platinum MA	SDC Platinum Mergers & Acquisitions Database
SDD	GRI- Sustainability Disclosure Database
SEC	Proxy statement of each firm reported to Securities and Exchange
Selected-DS	IBES/ Marquis Who's Who/ Notable Names / Business Week archives/
SEPA	State environmental protection administration
SIP	The Summit Investment Partnership
SNI	Social Network Index
SR	Sustainability reports, sustainable development report and corporate
SRQ	Sustainability Reporting Quality
SRR	Social responsibility reports
SR-RobertEC	The 2010 Sustainability Reporting of the Wolrd's Largest Petroleum
TEKES	Finnish Funding Agency for Technology and Innovation
TF	Thomson Financial
Toyo Keizai CSR	Corporate Social Responsibility Database (by Toyo Keiai)
Various DS	The Ministry of Labor in Japan/ The American Conference of Governmental
Worldscope	Thomson financial Worldscope
www.irz.cz	the Integrated register of pollutant emissions (www.irz.cz)

Abstract

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Doctor of Philosophy

Exploring the relationship between the Social Network Profile of S&P 1500 Firms and their Environmental and Financial Profile

The purpose of this thesis is to enhance our understanding of the relationship between the social network profile of S&P1500 firms and their environmental and financial profiles. The three dimensions of this research are social network profile, financial profile and environmental profile, which are becoming increasingly interlinked. The nature of this research is multidisciplinary and still in its early stages. The existing studies focus mainly on two streams of research, the first of which explores the relationship between firms' environmental and financial profiles, which reveals contradictory results. The second research stream investigates the impact of the social networks between directors on the firms' financial profiles.

This thesis is submitted in an alternative format and includes four journal papers, which are interrelated in addressing the purpose of this thesis.First, it is essential to provide effective reviews to create a foundation for developing knowledge in this field of research and to explore the area in which more research is required. Therefore, the first two papers attempt to review systematically the existing research streams, namely: (i) the impact of social network profile on financial profile; and (ii) the relationship between environmental profile and financial profile.

Second, the review of the impact of social network profile on financial profile reveals the need to investigate social networks in the organisations from a social network theory perspective. Therefore, the third paper uses quantitative method to provide a concrete definition of social networks and social network centrality metrics in the context of organisations. In addition, a clear process for extracting social networks at both director and board levels from the directors' information repository is defined.

Third, through the fourth paper, this thesis explores the impact of the board's roles on environmental governance as an essential component of environmental profile. This paper uses a combination of qualitative and quantitative evaluation. The roles of the board of directors in relation to environmental profile are twofold, namely board monitoring and board resource provision. In this work, the board's social network is examined as a board resource-provision role.

DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning

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Chapter 1 Introduction

1.1 Background and motivation

This research is exploring the relationship between the social network profile of S&P1500 firms and their environmental and financial profile. To achieve this, this thesis investigates both the impacts of social network profile on financial profile and also the relationships between environmental profile and financial profile. The structure of research background is as follow. First, brief descriptions of these terms are given in the following paragraph. Second, the two streams of research are discussed separately to provide an overview of the theoretical background as well as providing a definition of key variables in the research stream. Third, the justification of our research based on the combination of the two streams is discussed.

The Environmental Profile (EP) of a firm describes the environmental features and characteristics of activities, products and services of the firm that have an impact to the environment in which it operates. By definition, EP is multidimensional and for the purposes of this paper, three dimensions are distinguished, namely: Environmental Management, Environmental Performance and Environmental Disclosure. Environmental Management captures a firm's attitudes and objectives towards environmental responsibility as well as environmental management structure and processes (Schultze&Trommer 2012). Environmental performance is the outcome of a firm's strategic activities that manage (or not) its impact on the natural environment (Walls et al. 2011). Finally, Environmental Disclosure describes the impact firm activities have on the physical or natural environment in which they operate (Wilmshurst & Frost 2000).

The Financial Profile (FP) of a firm captures its financial and organisational characteristics. By definition, FP is multidimensional and for the purposes of this paper, three dimensions are distinguished, namely: market-based, accounting-based and organisational-based. Accounting-based indicators are measuring profitability and they are mainly backward-looking (Al-Matari et al. 2014). Return on Assets (ROA) and Return on Equity (ROE) are examples of accounting-based indicators (Al-Matari et al. 2014). Market-based measures have forward-looking aspects and they are mainly concerned with the firm’s future

performance and investment that has its basis on previous or current performance (Al-Matari et al. 2014). Tobin's Q and market-to-book value are examples of market-based indicators (Al-Matari et al. 2014). Furthermore, FP involves organisational aspects measured by other indicators rather than accounting-based or market-based indexes. We define organisational-based measures as a set of firm characteristics such as corporate governance index (Subrahmanyam 2008) and board characteristics such as director selection (Fracassi & Tate 2012)(Qi 2011) and CEO compensation (Renneboog & Zhao 2011).

The social network profile (SN) of a firm describes the position and behavioural characteristics of a firm in relation to other firms in the network. The focus of this thesis is on two aspects of social network profile which are (i) social network definition, and (ii) social network metrics. For social network definition, we consider whether social network formed in director level or board level (Shahgholian et al. 2015). In addition, some studies define social network as directors belonging to specific groups such as Elite school network (Kim 2005). Then, social network metrics are calculated to define the position and behaviour of nodes (directors or firms) in the network. Studies typically use social network centrality metrics. However, it is important to distinguish between centrality metircs such as degree, betweenness, closeness and eigenvector (Shahgholian et al. 2015).

1.1.1 Social Network and Financial Profile

Since its beginning in the 1930, social network theory and social network analysis have been widely used to study the structure of relationships between individuals, groups, or organisations. Thus the role of social network is not only limited to the sociology (Granovetter1985)(Bonacich 1987)(Wasserman and Faust 1994), but also it has been increasingly adopted in such areas as email communications (Tyler et al. 2005), organizations (Borgatti and Foster 2003), transport(Lovejoy and Handy 2011), health(Wang et al. 2014) and biology (Vashisht et al. 2013). A social network can be defined as a set of nodes (people, organizations, etc.) that are connected through their social relationships or links (friendship, information exchange, or other) (Garton et al. 1997). In the context of organizations, social network could be formed in various ways

such as between stakeholders (Rowley 1997)(Prell et al. 2009) or buyers and suppliers (supply chain management) (Kim et al. 2011). The focus of this research is on social network between directors and collectively between boards of directors which is called board interlocks.

Board Interlock is the preliminary type of social network between firms where firms are nodes and the links between them is forming when a director of one firm is serving in another firm's board. Research using board interlock developed in 1970s and 1980s and with the increase of interest on the inter-organisational relationships, it has even become more popular in 1990s (Mizruchi 1996).

Apart from board interlock, another category of social network could be formed in director level. The network could build up through their current positions, previous fellow workers, association with a school alumni network as well as being member in various non-profit organizations and committees.

A number of existing research works focus on analysing individual board characteristics such as board size, diversity, type and role of directors (Dalton et al. 1999)(Erhardt et al. 2003). However, director networks and board interlocks are revealing the patterns of relationships between boards of directors. This facilitates and constrains the flows of information and resources between board of directors, cognitions and behaviours respectively (Tindall and Wellman 2001, p.266)(Fracassi and Tate 2012)(Brown et al. 2012).This is also supported by resource dependency theory which explain the functionality of the board of directors in enabling access to information and other resources(de Villiers et al. 2011)(Hillman et al. 2009) and consequently, thishas increased concerns over how firms' performance is affected by social network between firms and their directors.

Most recent empirical studies have linked directors' social networking and board interlocks to almost every important aspect of management and financial behaviour of firms including shareholder value (Fogel et al. 2014), corporate finance policy decisions (Fracassi 2009), firm value (Fracassi and Tate 2012)(Larcker et al. 2013), CEO compensation (Hwang and Kim 2009)(Horton et al. 2012), director appointment (Qi 2011) and Mergers and Acquisitions (Fracassi and Tate 2012).

1.1.2 Environmental Profile and Financial Profile

Most activities of any firm are associated with multiple impacts on their environments. The underpinning issues regarding the environmental problems are varying across the firms. Both the sectors and subsectors can have significant different risk context, regulatory environment and structure due to their particular activities and impacts resulted.

Since the 1960s, firms have found themselves under increasing external pressures to pay attention to the environmental performance. Early research on the association between environmental performance and financial performance has led to conflicting results (Konar and Cohen 2001). In addition, numerous points of views are developed in order to explain the consequences of improving environmental performance on financial performance. Porter's hypothesis (Porter and Linde 1995)states that environmental performance is positively correlated with financial performance in certain areas. Traditionalist view is introduced by (Walley and Whitehead 1994) which emphasis that environmental protection incurs "additional costs and investments in a non-productive sector that is not directly related to financial performance". In 2002, (Wagner et al. 2002) develops a theoretical model of a curvilinear (U-shaped or inverse U-shaped curve) relationship between the environmental and financial performance. The number of studies examining this relationship to support one of the above points of view is increasing gradually.

After financial crises in 2008, various not-for-profit organizations have emerged to heighten the crucial importance of identifying governance structures that can accommodate social objectives as part of regular corporate life(Walls et al. 2012).Voluntary initiatives such as the OECD Principles, the UN Global Compact and the World Bank Group encourage firms to integrate environmental and social aspects to their financial performance. In addition, environmental disasters such as BP's Gulf of Mexico oil spill in 2010, illustrates that environmental issues can result in billions of dollars in cleanup costs and fines (de Villiers et al. 2011).

Another reason that motivates the need to examine two areas together relates to regulatory pressures such as the need for integrated reporting (Eccles &Krzus 2010)(IIRC 2011)(Diaz et al. 2013) and stakeholder pressures to start measuring and reporting environmental profiling information (Carbon Disclosure Project 2013). It can be argued that as a result of the need to report on how organisations manage risks associated with environmental and social risks, has given rise to a number of financial indexes (López et al. 2007) such as DJSI (DJSI 2014), FTSE4Good (FTSE4Good 2014), Jantzi Social Index (Jantzi Social Index 2014), Calvert Social Index (Calvert Investments Inc 2014) and KLD (KLD Research & Analytics 2014).

In addition, over the years, a number of comparative studies have been carried out to review the environmental performance and financial performance literature and provide insights on the relationship between environmental performance and financial performance understand the determinants of the relationship and identify gaps and opportunities for further research. These comparative studies employed narrative reviews (Ambec and Lanoie 2008), vote counting (Margolis and Walsh 2001) and meta-analysis (Allouche and Laroche 2005)(Margolis et al. 2009)(Dixon-Fowler et al. 2013)(Albertini 2013)(Endrikat et al. 2014).

However, it is still long debated whether improving environmental performance strengthen or weaken the financial performance, and they still fail to provide a solid theoretical foundation, this being the reason why knowledge consensus is still to be reached (Lankoski 2008).

1.1.3 Social Network Profile, Environmental Profile and Financial Profile

This thesis is examining interlink between mentioned streams of research, namely (i) social network and financial profile and (ii) environmental profile and financial profile. Three dimensions of this research are social network profile, financial profile and environmental profile which are becoming increasingly interlinked as presented in Figure 1-1.

As discussed above, it is clear that majority of existing studies have only concentrated on a pair of dimensions. This includes relationship between environmental profile and financial profile, both theoretically (Hart 1995)(Porter and Linde 1995)(Walley&Whitehead, 1994) as well as empirically (Jacobs et al. 2010)(Fujii et al. 2013)(Alvarez 2012)(Sariannidis et al. 2013). Another stream of research has examined the relationship between financial profile and social network profile of firms and their directors (Schonlau& Singh 2009)(Fracassi and Tate 2012)(Cai and Sevilir 2012)(Qi 2011) which confirms the impacts of social network on financial profile of firms. Considering previous studies, one can conclude that the research examined these three profiles together is still in early stage(Diaz et al. 2013). As this area is premature and at its early stage, only few theoretical and empirical articles have been published. Another reason concerns the process of integrating different point of views this interdisciplinary field is complex and often involves drawing on theories from different fields.

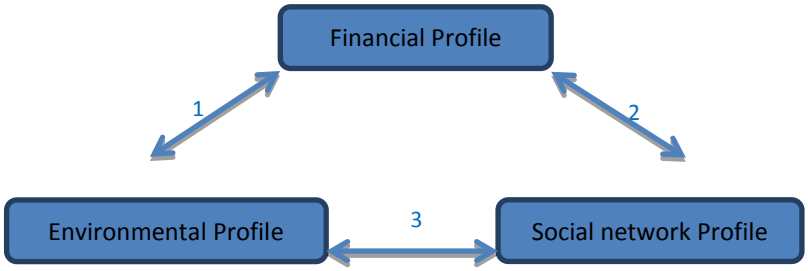

Figure 1-1. Overview of three main dimensions of this study

Integration of the two streams of research could extend our understanding of the firm profile in both environmental and financial profile and the impacts of social profile on them. Resource dependence theory can be employed to fully support combining these two streams of research.

Resource dependence theory directly points to the ability of board to bring resources to the firm (Hillman and Dalziel 2003). One of the primary benefits provided by board of directors is channels of communicating information between external organisations and the firms. This could explicitly refer to access to the real and potential resources embedded in social ties between the directors and the external organisations. Therefore,

the board provides on time and valuable information and reduces the cost of transmitting information to the firm, thereby enhancing the board knowledge which is essential for firm performance(Hillman and Dalziel 2003). On the other hand, resource-rich directors move into broader social networks that make them more appropriate to a resource provision role as well as engage in various practices which further enhance their knowledge and expertise(de Villiers et al. 2011).To this end, it is clear that social network is one of the paramount important factors to influence the decisions made by a board of directors. While, most of research works are focused on examining which factors are influencing the decisions made by a board of directors, in this thesis we argue that it is as important as to know how a firm responses to its board decisions and how the firm's performance is improving accordingly.

Recent empirical researches have examined the social network profile impacts to almost every important aspect of management and financial behaviour of firms including shareholder value (Fogel et al. 2014), corporate finance policy decisions (Fracassi 2009)(Fracassi 2009), firm value (Fracassi and Tate 2012)(Larcker et al. 2013), CEO compensation (Hwang and Kim 2009)(Horton et al. 2012), director appointment(Qi 2011) and Mergers and Acquisitions (M&A)(Fracassi and Tate 2012).

In addition, recent developments in the field of firms performance have led to a renewed interest in examining the role of board of directors in relation to the firms environmental performance(de Villiers et al. 2011)(Ienciu et al. 2012)(Walls et al. 2012)(Walls and Hoffman 2013). The research examining the impact of social network profile on environmental profile has received attention since 2012 and therefore it is still in early stage.

The first study examining the impacts of director interlocks on firms' adoption of proactive environmental strategies is conducted in 2012 by (Ortiz-de-Mandojana et al. 2012). A sample of 90 US electric firms are classified as investor owned firms in 2005. In this research director interlocks is measured as the number of interlocking ties with other firms and define four types of suppliers with director interlocks, i.e. green equipment suppliers, firms providing knowledge-intensive business service, financial institutions and fossil fuel suppliers. The reported analysis confirms that interlocks with green equipment

suppliers have a positive impact on proactive environmental strategies. Other three type of interlocks show negative relationships with proactive environmental strategies.

Similarly, another study investigates the association between director interlocks and environmental performance(Ortiz-de-Mandojana and Aragon-Correa 2013). They analyse a sample of 93 US electric firms in 2005.They define director interlocks as the number of interlocking ties with other firms.Their findings confrim that firms with higher number of interlocking direcotr ties have a positive relationship with the environmental perofrmance measured as a percentage of Global Warming Potential divided by annual net generation. In addition, the firm's diversity interlock ties have a positive relationship with the environmental performance.

(Walls and Hoffman 2013) examines the association between social networks of board of directors and positive environmental deviance. This work analyses 294 US firms from 2000 to 2008.Interlocking directorship is used in to define social network between firms. On this basis, they calculate degree centrality and eigenvector centrality. The findings indicate that more central firms measured by either degree centrality or eigenvector centrality in the network are less likely to deviate positively from norm environmental practices in the institutional field.

In 2013, (Diaz et al. 2013) examines the role of social network on environmental performance. They analyse 310 S&P 1500 firms in year 2008. Their definition of social network is that two firms are considered socially connected if they share at least one director or if one or more of their directors sit in a third firm in which another SP&1500 firm director also sits. The findings show that firms which are socially connected have better environmental performance as well as financial performance measured by Return on Equity (ROE). In addition, socially connected firms are paying incentives related to the climate change; publishing information related to climate change and including information on their annual reports and there is a responsible individual or team for climate change issues.

(Shahgholian et al. 2014)examines how social network between firms (as one of the board characteristics) can impact environmental performance of 202 S&P1500 firms in year 2011.In this work "Current Employment (CE) Network of S&P firms" is defined as

follow: two SP firms are linked through a director if two firms share the same director. This is the traditional interlocking directorship network. Moreover, if directors from two firms sit on the board of a third firm, this will form CE of SP firms as well. The findings confirm that those firms with better social connections are paying higher compensation and environmental incentives; have higher number of independent directors; publishing annual reports and willing to have voluntary communications. In addition, they have committee responsible for climate change.

1.2 Aims and objectives

The background and challenges of examining the impacts of social network profile on environmental profile of firm are presented in section 1.1. Since, the nature of this research is multidisciplinary and still in early stage, it is important to build up the foundation of the research based on the relevant studies. The findings can be groundwork for the academics and practitioners alike to position their work in the context of social network and firm performance and in particular environmental performance.

In constructing this foundation a number of theories from different fields are required. Social network theory could explain and help to build the social network profile of firms. Resource-based theory which justifies the social network profile of board of directors as one of the board attributes as well as clarifies the role of board of director in environmental profile of firms. In addition, the relevant research streams which are (i) social network profile and financial profile, (ii) environmental profile and financial profile also need to be examined systematically. This will lead to provide insight into the research gaps in each research stream and produce a number of future works. Then, the research foundation for the association between social network profile and environmental profile of firms can be established.

More specifically, the objectives of this thesis are:

a) An effective review to create a foundation for developing knowledge in this field of research and to explore the area where more research is required. To do so, it is necessary to systematically review the existing research streams i.e. (i) social

network profile and financial profile; (ii) environmental profile and financial profile.

b) To investigate the effect of the social network in the organisations both from the social network theory and analysis. This study provides a concrete definition of social networks and social network metrics in the context of an organisation. In addition, a clear process for extracting social networks from both director level and board level within directors' information repository is defined.

c) This thesis explores the impacts of board's roles on the environmental profile. The roles of board of directors in relation to environmental profile are twofold, namely board monitoring and board resource provision. In this work, board's social network is examined as a board characteristic which provides resources and information.

This thesis is written in an alternative format which means by publication. The first two papers are addressing objective (a). A third paper is presented the social network analysis on the board of directors to fulfil objective (b). In relation to the objective (c), the fourth paper is analysing a set of hypotheses to examine the impacts of social network on environmental performance.

1.3 Structure of the thesis

Chapter 2 presents the research design, discussing the selected 'Design Science and Information Systems' methodology (Vaishnavi and Kuechler 2004) that outline this work. The chapter started by providing a general definition of the research approach followed by a justification of why this methodology was appropriate for the task at hand. It continued with an in-depth description of how the methodology was implemented.

Chapter 3 and 4 are literature surveys which cover the two base research streams of current study. First one is the literature survey on the relationship between Financial Profile (FP) and Environmental Profile (EP). The second literature survey is reviewing the link between Social network Profile (SN) and Financial Profile (FP). It will be used to develop the research framework and a set of research questions.

Chapter 5 is the third paper which is analysing the social network metrics for BoardEx. The paper provides a broad conceptual overview of the theories and methods that underpin Social Network Theory and Social Network Analysis (SNA) in organisational context and how the revealed patterns could be interpreted in relation to firms' positions in the network. The study also seeks to better understanding the social networks in both directors and firms' levels.

Chapter 6 presents the fourth paper which is the analysing the impacts of social network between firms on the environmental governance of firms. The focus of analysis is to consider a set of board characteristics including social network profile of firms which are categorised into board resource provision and board monitoring functionalities of board. Then, consider the impacts of both boards' functionalities on firms' environmental governance.

Chapter 7summarizes this thesis and its contributions and discusses how the thesis has answered the research questions. This follows by presenting the limitations and future works of research.

Chapter 2 Research Methodology

2.1 Description of the methodology

This chapter discusses the research methodology used in this research to design a solution with which to address the research objectives of this thesis. The chapter begins by providing a general overview of "design science research" (DSR) and its steps and outputs, justifying why this methodology is appropriate for this research. It is followed by a detailed description of how the methodology is applied in this research.

2.1.1 The description of the "Design Science Research" methodology

A generic approach in the information systems (IS) area is "design science research" (DSR). According to Vaishnavi and Kuechler (2004), research is an activity that contributes to the understanding of a phenomenon, while design is about creating something new that did not exist in the past. Design relates to the technique used in the process of understanding and creating. DSR, therefore, can be broadly defined as "learning through building" (Vaishnavi and Kuechler 2004, p.6). Translated into business terms, DSR creates and evaluates IT artefacts intended to solve organisational problems, and there are two paradigms supporting this: behavioural science and design science. The former paradigm has its roots in natural sciences and seeks to develop theories explaining or predicting organisational phenomena related to the problem and problem space (Vaishnavi and Kuechler 2004). The latter has its roots in engineering sciences and seeks to create solutions aimed at problems involving analysis of the use and performance of designed artefacts to comprehend the behaviour of IS aspects. In other words, behavioural science is a problem-definition dimension concerned with understanding or predicting organisational issues, while design science is a problem-solving dimension concerned with developing solutions (Vaishnavi and Kuechler 2004).

2.1.2 Steps and outputs of Design Science Research methodology

Vaishnavi and Kuechler(2004) summarise this research methodology as a reasoning cycle in which processes are used to derive knowledge using a sequence of reasoning activities, as illustrated in Figure 2-1.

The authors (2004) further suggest that all designs begin with *awareness of a problem,* which is built from multiple existing sources such as new developments in industry or

previous academic research works, leading to a research proposal for a new research effort. Following this initial phase, *suggestion* is a creative step where new functionality is planned based on configurations of key concepts extracted from the existing body of knowledge, resulting in a tentative design. The research proposal and tentative design stages are drawn together inside a dotted box because poor research proposals or bad tentative designs will be discarded in the early stages. Moreover, if after *awareness of a problem,* a tentative design is not clear to the researcher, the research proposal will never be put into action. The *development* stage is concerned with the implementation of the tentative design in the form of IS artefacts. During *evaluation*, the researcher analyses the artefact according to criteria usually made explicit in the proposal. The evaluation phase contains an analytics sub-phase, in which hypotheses are made about the behaviour of the artefact. This can be done either qualitatively or quantitatively, but the results must be compared against expectations and then explained. Finally, the *conclusion* is concerned with satisfying the initial hypotheses. Normally, this will either lead to firm facts that can serve as reference points for further studies, or to loose ends in the form of unexpected behaviour, which serve as starting points for further studies. DSR also includes two iterations in its framework: suggestion–development–evaluation is a cycle used until the artefacts reach a good-enough level; the awareness of problem–conclusion, on the other hand, is a cycle used when the results are anomalous and do not explain the initial hypotheses. Knowledge contribution resulting from new knowledge production is indicated in Figure 2-1 by the arrows labelled Circumscription, Operational Principles and Design Theories. Circumscription generates a level of understanding that could only be gained from the specific act of construction. In addition, the conclusion of the research project makes knowledge contributions to operational principles and possibly design theories.

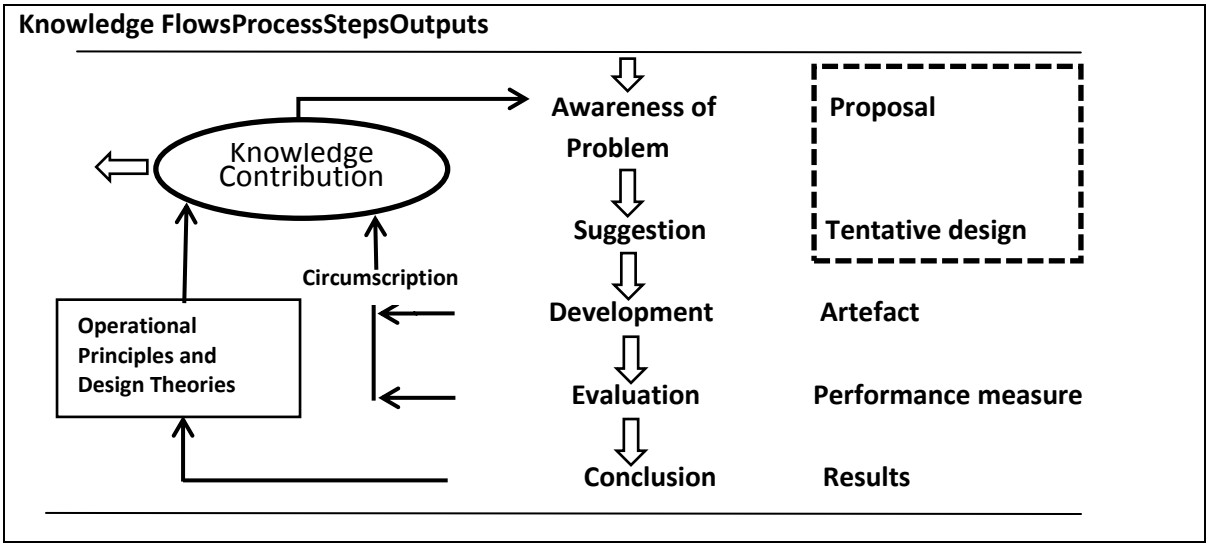

Figure 2-1.Design Science Research Process Model. Taken from (Takeda et al. 1990) as in (Vaishnavi et al. 2004/5)

2.2 Justification of the chosen methodology

There are four main arguments about why this methodology is appropriate for the current research. First, it is appropriate because of the type of problem that this thesis addresses. Firm performance is measured in terms of both financial and environmental indicators, which are complex regarding definition, dimensions and measurements. Although financial performance is always the fundamental component of firm performance, during recent years environmental performance has also been considered an important non-financial performance. Aspects of a firm's operations, such as financial performance, non-financial performance, corporate governance, and so on, are integrated in a way that makes it difficult to enhance the firm's performance without understanding this complex system, its components and the interactions between components. Therefore, DSR provides a structured approach to investigating this complex system (firm) and provides the researcher with the artefact (review of profile) to evaluate.

Second, knowledge contribution is a key focus of design science research and involves some iteration to reach a good-enough level of artefact(s), which is essential to describing and improving information management (Vaishnavi and Kuechler 2004). Therefore, this methodology is appropriate for the current study because it examines an information management problem and contributes to knowledge about it. Arguably, providing an organised body of knowledge or framework can contribute to an understanding of the problem by clarifying the relationships between environmental performance, financial

performance and board of directors' decisions, and the impact of informal information flow between directors through their social networking. These have not previously been part of the knowledge base. Another aspect of DSR is that the philosophical perspective of the design science researcher changes as progress is iteratively made through the phases of Figure 2-1 (Vaishnavi and Kuechler 2004). The current research has the same nature. The financial performance of firms is evolving as a result of changes in the business models of firms. Nowadays, firms are more conscious about the non-financial performance, especially environmental performance, of firms. Social networking has emerged as one of the key information sources for the board of directors, which could be justified by resource-based theory (Hillman et al. 2009). In a way, the problem is not fixed and is evolving constantly. In fact, in the literature a problem with these characteristics is considered a serious problem (Hevner et al. 2004). Hevner(2004, p.8)argues that design science is especially concerned with problems "...characterised by unstable requirements and constraints based upon ill-defined environmental contexts; complex interactions among subcomponents of the problem and its solution; an inherent flexibility to change design processes, as well as design artefacts (i.e. malleable processes and artefacts); a critical dependence upon human cognitive abilities (e.g. creativity) to produce effective solutions; and a critical dependence upon human social abilities (e.g. teamwork) to produce effective solutions".

Third, the methodology is appropriate for this research because the philosophical perspective of this thesis implies one of design research that cannot be derived from other philosophical perspectives. Design science research, by definition, changes the state-of-the-world through the introduction of novel artefacts, and *positivist* ontology; for instance, assuming that there is only *one* reality and truth. Moreover, this positivist reality is objective and can be discovered but not altered. At the other extreme of the philosophical spectrum, the *interpretative* epistemology suggests there are many subjective realities. In contrast to positivism and interpretivism, design science philosophy is based on a belief in an objective, an *evolving* but *single* underlying physical reality that limits the multiplicity of outcomes. The epistemological perspective of design science research is unique in the sense that it resembles that of natural science research more closely than that of either positivist or interpretive research. In terms of the creation of

knowledge, design science assumes the existence of physical laws and knowledge previously gained there from, which is to be used in the tentative design; and it assumes that knowledge is extracted through not only observation of the world but also the making and using of the artefact (Vaishnavi and Kuechler 2004).

2.3 Methodology application

This paper is presented in an alternative thesis format, which includes four journal papers. Using the general design science research (DSR) methodology, each paper is presented following a cycle of awareness of the problem, suggestion, development, evaluation and conclusions. In general, for each paper we follow the steps presented in Table 2-1.

Design Science Research	Steps
Awareness of problem	An introduction and research background are given regarding the context of each paper.
Suggestion/ Development	The methodology for constructing the artefact/model and data sample is presented for each paper.
Evaluation/ Conclusion	The results are discussed with the objective of reaching a conclusion for each paper and its connection to the overall work.

Table 2-1.Design Science Research for each paper

Paper 1: ***Literature Review on the Interrelationships between Firms Environmental and Financial profiles(EP–FP)***

and

Paper 2: ***Literature Review on the Interrelationships between*** **Firms** ***Social Network and Financial Profiles (SN–FP)***

Awareness of problem: The study aims to bridge three academic research streams that are becoming increasingly interlinked: social network profile, environmental profile and firm financial profile, as presented in Figure 1-1. Considering previous studies, someone can conclude either that each of them has been studied in their own right or that the interdependencies and correlation between each pair have been examined but unifying theories are yet to emerge. In this study we critically review the existing literature that

has been examined, the interdependencies and correlation between each pair, that is, the financial and environmental profiles (arrow number 1), and the financial and social network profiles (arrow number 2).

Several studies consider the relationship between environmental profile and financial profile. Although the topic has been raised during recent decades and several theories have been developed in order to explain this relationship (Porter and Linde 1995)(Palmer et al. 1995)(Russo and Fouts 1997)(Elkington 1998)(Schaltegger and Synnestvedt 2002)(Fujii et al. 2013), there has still been significant interest in considering the relationship between the environmental and financial profiles in recent years. However, the findings are contrasting, and it is impossible to identify the unique trend of the literature to support a specific theory.

Moreover, previous studies have considered the impact of the social networks of firms and their boards of directors on their financial performance, CEO compensation and bonuses and corporate governance (Fracassi and Tate 2012)(Horton et al. 2012)(Hwang and Kim 2009). Most studies confirm that the social network of firms and their directors could explain their financial performance.

To the best of our knowledge, the literature pays less attention to investigating the relationship between social network profile and environmental profile. Since the nature of this research is multidisciplinary and still in its early stages, it is important to build up the foundation of the research based on the relevant studies. Therefore, two literature surveys are presented, as follows:

- The literature survey to explore the relationships between environmental profile and financial profile (EP–FP);
- The literature survey to explore the relationship between social network profile and financial profile (SN–FP).

Both literature surveys help in understanding the existing research, identifying the existing doubts and providing the essential background to build both the theoretical and practical foundations for the relationship between Social Network Profile, Financial Profile and Environmental Profile.

Suggestion/ Development: Following the above discussion, in order to investigate the impact of social networking on the environmental profile of firms, we need to have an adequate understanding of environmental profile, financial profile and social networking between firms, and the association between each pair. When examining the relationship between environmental and financial performance, inconsistency in terminology and key terms, using various attributes from both financial and environmental performance and applying various research methods are the main obstacles to finding positive, negative or neutral relationships. Moreover, the same problems appear when investigating the relationship between social networking and financial performance. Each study has its own definition of creating a social network, as well as using various social network metrics to measure the power of the social network. In summary, new insights into this research domain require a critical overview of existing studies in each domain. The final deliverables of the literature survey are:

- Defining key terms, definitions and terminologies;
- Presenting insights into different arguments, theories and approaches;
- Presenting an extensive review of recent studies on the problems arising from data and the variables used in each study;
- Through systematic reviews, comparing the different views of existing research in order to identify similarities and disparities between works and criticising various aspects of the data-collection methodology.

In order to achieve this goal, the existing literature from 2004 to 2014 was examined. An extensive search was conducted for the reported relationships between environmental profile and financial profile using a different combination of keywords (e.g. environmental performance/disclosure/regulations, pollution, financial performance, profitability, CEO compensation and board characteristics) in multidisciplinary journals, including management, the environment, accounting, marketing, economics and finance. In addition, manual searches were also performed to identify additional articles using the reference lists of the studies identified in step one. The final sample consists of 72 studies, which examine the relationship between the environmental and financial profiles of firms. In addition, a comprehensive sample of studies investigating the association between the social network and financial profile of firms was collected. The previous strategy was

followed, namely searching using different combinations of keywords (e.g. social network/board interlock, financial performance, CEO compensation, profitability) in multidisciplinary journals, including management, business, social science, accounting, marketing, economics and finance. In addition, manual searches were also performed to identify additional articles using the reference lists of the studies identified in step one. The final sample comprises 21 studies, which examine the relationship between the social network and financial profile of firms.

Evaluation/ Conclusion: Evaluation takes place continuously in the previous steps, which helps to find a good-enough level of artefacts. The evaluation and conclusion phases in both papers consider whether the conducted literature survey could highlight the specifications and limitations of previous studies and identify a promising direction for future research.

Paper 3: ***SOCIAL NETWORK METRICS: THE BOARDEX CASE STUDY***

Awareness of problem: Social network analysis has its roots in the social sciences to study the relationships between individuals, communities or organisations. The application of social network analysis is not limited to social sciences research; social network analysis is also used extensively in a wide range of research areas, such as biology (Vashisht et al. 2013), economics (Balkundi &Kilduff 2006), finance (Fracassi &Tate 2012) and organisational studies (Borgatti &Foster 2003). Recently, researchers have shown an interest in examining the impact of social networks between firms in relation to firms' performance and, in particular, firms' financial performance (Kim 2005)(Subrahmanyam 2008)(Kuhnen 2009)(Crespí-Cladera &Pascual-Fuster 2010)(Renneboog &Zhao 2011)(Fracassi &Tate 2012)(Larcker et al. 2013)(Chiu et al. 2013)(Fogel et al. 2014).

The literature survey on social networks and financial profiles highlights the importance of the social network profile between firms. Studies have used various definitions to build up the social network, either at director or firm level. Moreover, they use various combinations of social network metrics, and, in many cases, the results obtained on the

association between social network metrics and financial performance have not been clearly explained.

Suggestion/Development: At this stage of the research, we discovered that it is essential to investigate the social network between firms and their directors, as well as discussing social network metrics for such types of network and examining their interpretation and correlations from a domain-specific viewpoint. The final deliverables of this paper are:

- Defining the social networks at both director level and firm level;
- Defining social network centrality metrics, as these have been used in the literature, and providing their interpretations in relation to the business domain;
- Discussing the correlations between the various social network centrality metrics.

The data sample in this paper is the BoardEx dataset for 2011. The BoardEx (BoardEx 2011) dataset is one of the preliminary datasets of S&P1500 directors. Specifically, the firm keeps information about individuals, mainly from the USA and Europe that work in publicly quoted firms and major private entities at board of director and executive management levels. The information, including in-depth profiles such as academic qualifications, current and past job positions and membership of professional and other bodies, is collected and revised semi-automatically by analysts, who are in charge of collecting, processing and updating information about such individuals. Once the information has been validated, BoardEx provides business networking services to firms and individuals wanting to obtain information about certain individuals and their contacts (positive interpersonal ties) and the relationship of their contacts with other individuals (social network). In this study we use the BoardEx datadset from 2009 to 2011.

Evaluation/ Conclusion: The paper provides the definition and interpretation of the social network between boards of directors based on social network theory. This paper could form the basis of future studies examining the social networks of boards of directors. Interpretation of the centrality metrics presented in this paper could help to provide a better insight into the position of firms within the network in terms of providing and transmitting resources and information.

Paper 4:The roles of board of directors in firms' environmental governance

Awareness of problem: Firms have direct responsibility for global environmental problems. In recent years firms have started measuring and reporting their environmental profile as part of worldwide efforts to achieve sustainable development and to trace the ecological footprint of their managerial decisions. The environmental profile of firms is a very complex subject, with various types of complex assessment and measurement involved (Rademaekers et al. 2012).

During the last decade corporate governance discussions have shifted progressively towards contemporary social issues (e.g. climate change, labour rights and corruption) that matter to a wide range of consumers, shareholders, stakeholders and owners (Walls et al. 2012). Therefore, corporate governance scholars are increasingly interested in firms' social and environmental performance (Walls et al. 2012). It is obvious that the governance mechanism is not an isolated component of a firm and there is a complex relationship between the governance agenda and the other initiatives and activities of a firm. Hence, understanding how the environmental activities of firms are governed is one of the main challenges.

Referring to resource-dependence theory, social networking ties (both informal and formal) are known to facilitate access to information and to play a significant role in shaping the behaviour and decision-making processes of their members and the firms for which they work. Research exists that considers the effects of board characteristics on the environmental performance of firms (de Villiers et al. 2011). Building on this research and acknowledging the previous research examining the effects of social networking links on financial performance (Fracassi and Tate 2012)(Fogel et al. 2014), the researcher can argue that social network metrics as one of the board characteristics could play an important role in improving the environmental profile of firms. Considering the research background, the first awareness of the problem is that "*to the best of our knowledge, there is not any research considering the impact of social network on environmental governance of firms*".

Suggestion/Development: After considering the research context, we examined the two roles of the board of directors, namely, board monitoring and board resource provision, which are derived from agency theory and resource-dependence theory respectively. Board social networking is considered a board resource-provision role, namely, toprovide resources and information for the firm. Then, the impact of both roles in relation to environmental governance was investigated. The dimensions of environmental governance include the establishment of environmental committees, the provision of incentives for climate change activities and publishing environmental information.

At this stage, the researcher analysed the unique dataset created from the aggregation of a variety of secondary data sources, including CDP for environmental governance data, and BoardEx for information on the board of directors and social networks. In addition, a number of board characteristics were obtained from RiskMetrics. Data mining was the methodology used in this paper to highlight the existing patterns between board characteristics and social network profile and environmental governance.

The Carbon Disclosure Project (CDP)(Carbon Disclosure Project 2013)is a not-for-profit organisation that receives funding through corporate sponsorship. It works extensively with strategic partners, including banks, investment firms, audit firms, data providers, service providers, data analysis firms, consultants, global corporations and fellow non-governmental organisations (NGOs), to set targets, monitor or benchmark the environmental performance of its contributors using a centralised system. CDP is chosen as the provider of environmental data because it holds the largest global collection of primary climate change and environmental risk information gathered through an online response system open for data input to firms worldwide on a yearly basis. This study considered the CDP datasets for the years between 2008 and 2011. The data provided includes information on: (1) environmental governance; (2) physical, regulatory and other risks and opportunities; (3) greenhouse gas emissions; (4) environmental reporting; (5) strategies put in place to cope with environmental risks and to take advantage of environmental opportunities; and (6) Emissions Investor Short.

The BoardEx (BoardEx 2011) dataset is one of the preliminary datasets of S&P1500 directors. Specifically, the firm keeps information about individuals, mainly from the USA

and Europe that work in publicly quoted firms and major private entities at board of director and executive management levels. The information, including in-depth profiles such as academic qualifications, current and past job positions and membership of professional and other bodies, is collected and revised semi-automatically by analysts, who are in charge of collecting, processing and updating information about such individuals. Once the information has been validated, BoardEx provides business networking services to firms and individuals seeking to obtain information about certain individuals and their contacts (positive interpersonal ties), and the relationship between their contacts and other individuals (social network). In this study, the BoardEx dataset from 2009 to 2011 was used.

The RiskMetrics directors' database provides details on the structure and practices of the boards of directors at a large number of US firms. The dataset includes historical information for each director, such as the committees they belong to, board affiliation, shares held, total voting power and other useful information. This database was produced by the Investor Responsibility Research Centre (IRRC). The data is provided annually and covers directors of S&P1500, S&P MidCaps and S&P SmallCaps firms, starting in 1996(Wrds 2015).

Chapter 3 Literature Review on Environmental Profile and Financial Profile

Abstract

A growing number of empirical studies have explored the relationship between Environmental Profile and Financial Profile but the results are still inconsistent. These studies use various data sources and data samples with different characteristics, and a wide range of environmental and financial variables. All of these are essential determinants with direct impacts on the findings in each study. Before comparing the findings and draw an overall conclusion on either positive or negative relationships between environmental and financial profile, it is necessary to undertake an in-depth literature review on the basis of these determinants. An overview of 72 studies published between 2004 and 2014 is presented in four main categories: data-related characteristics, environmental profile, financial profile and findings and endogeneity.The findings of this study reveals that researchers need to consider the effects of data quality, data sources, data collection method and other data sample characteristics on the results.

Keywords: environmental Profile, financial profile, data characteristics

3.1 Overview

The relationship between Environmental Profile (EP) and Financial Profile (FP) has been examined extensively over the last 40 years in the academic literature but the empirical results are still inconsistent. Some studies have provided evidence of positive relationship (e.g. (Hourneaux et al. 2014), (Iatridis 2013)); others have shown a negative relationship (e.g. (Chen et al. 2014), (Sariannidis et al. 2013)) or even have supported insignificant results (e.g. (Böhringer et al. 2012), (Post et al. 2011)).To examine the apparent conflict between empirical results, a number of meta-analysis efforts have been carried out that take either an empirical approach (Orlitzky et al. 2003)(Allouche & Laroche

2005)(Margolis et al. 2009)(Albertini 2013)(Dixon-Fowler et al. 2013)(Endrikat et al. 2014)or a narrative/vote counting approach (Ambec & Lanoie 2008)(Margolis & Walsh 2001)(Endrikat et al. 2014).

All previous meta-analysis efforts, examine the variables used for defining EP and FP, the direction of the relationship, the moderators and the strength of the relationship. The inconsistency between previous studies on the relationship between EP and FP, is partially attributed to issues that relate to methodological artefacts that include measurement (dataset) characteristics such as the measurement approach, the quality of the measurements, the sample under investigation (sectors, countries, etc.), and the time period covered (Endrikat et al. 2014)(Albertini 2013)(Guenther & Hoppe 2014).Yet, none of the previous meta-analysis efforts examines the measurement (dataset) characteristics and whether they could explain the inconsistencies. This implies that they do not examine whether studies that refer to the same dataset (source, years) produce inconsistent results or studies that use different datasets produce different/same results.

One of the reasons for this lack of examining the measurement characteristics might be the fact that many of the studies that examine the relationship between EP and FP do not contain enough information such as the sample selected i.e., they are non-replicable (Hartshorne & Schachner 2012).

We argue that considering the measurement characteristics is a key methodological artefact in examining the relationship between EP and FP and that this allows studies to be more directly comparable and as a follow-up, more replicable (Hartshorne & Schachner 2012). To limit the number of studies, we include studies that have been published from 2004 onwards. We, also, include studies that are based on the same datasets unlike previous meta-analysis studies that have excluded them to provide a statistically independent sample (Albertini 2013).

In order to collect our study sample, we assumed that the the major contributions are found in journals of high reputation and quality (Webster & Watson 2002) and thus, we conducted a systematic search in management, accounting, marketing and finance journals from 2004 to 2014. In our initial search, we used different combinations of keywords for EP and FP such as corporate environmental performance, environmental

performance, environmental management, environmental disclosure, financial performance, corporate governance, board characteristics, profitability, etc. Finally, we manually reviewed the reference lists of previous meta-analysis studies and cross-referenced them with our sample. To construct the final set of studies, we excluded studies that are conceptual and do not provide an empirical analysis such as (Perrini & Tencati 2006)(Claver et al. 2007)(Petrini & Pozzebon 2009)(Oberhofer & Dieplinger 2014). The final sample consists of 72 studies published from 2004 to 2014. Table 3-1 lists the studies included in the review.

Our meta-analysis dimensions are given in Table 3-2. The EP profile of a firm describes the environmental features and characteristics of activities, products and services of the firm that have an impact to the environment in which it operates. By definition, EP is multidimensional (Endrikat et al. 2014; Albertini 2013) and the three dimensions used are: *Environmental Management, Environmental Performance* and *Environmental Disclosure*. Environmental Management captures a firm's attitudes and objectives towards environmental responsibility as well as environmental management structure and processes (Schultze & Trommer 2012). Environmental performance is the outcome of a firm's strategic activities that manage (or not) its impact on the natural environment (Walls et al. 2011). Finally, Environmental Disclosure describes the impact firm activities have on the physical or natural environment in which they operate (Wilmshurst & Frost 2000).

Year			Total
2004	**[2014-1]:** (Al-Tuwaijri et al. 2004) **[2014-3]:** (Filbeck& Gorman, 2004)	**[2014-2]:**(Clarkson et al. 2004)	3
2005	**[2005-1]:** (Cormier et al. 2005) **[2005-3]:**(Gonzalez-Benito&Gonzalez-Benito 2005) **[2005-5]:** (Hassel et al.,2005) **[2005-7]:**(Wagner, 2005)	**[2005-2]:**(Elsayed& Paton 2005) **[2005-4]:**(Gupta &Goldar, 2005) **[2005-6]:**(Russo & Harrison, 2005)	7
2006	**[2006-1]:** (Brammer&Pavelin, 2006)	**[2006-2]:**(Cole et al. 2006)	2
2007	**[2007-1]:** (Lopez et al., 2007)	**[2007-2]:** (Nakao et al, 2007)	2
2008	**[2008-1]:** (Cordeiro&Sarkis 2008) **[2008-3]:** (Ngwakwe, 2008) **[2008-5]:**(Stanny& Ely 2008)	**[2008-2]:**(Lucas & Wilson, 2008) **[2008-4]:**(Sharfman& Fernando 2008) **[2008-6]:**(Yamaguchi, 2008)	6
2009	**[2009-1]:** (Berrone& Gomez-Mejia, 2009) **[2009-3]:** (Iraldo et al., 2009) **[2009-5]:** (Lopez-Gamero et al., 2009)	**[2009-2]:**(Elsayed& Paton, 2009) **[2009-4]:**(Johnstone &Labonne, 2009)	5
2010	**[2010-1]:** (Earnhart&Lizal, 2010) **[2010-3]:** (Henri &Journeault, 2010) **[2010-5]:** (Lundgren & Olsson 2010) **[2010-7]:** (Prado-Lorenzo & Garcia-Sanchez 2010) **[2010-9]:**(Wagner, 2010)	**[2010-2]:**(Hibiki&Managi, 2010) **[2010-4]:**(Jacob et al., 2010) **[2010-6]:** (Monteiro &Aibar-Guzmán 2010) **[2010-8]:**(Rassier&Earnhart, 2010)	9
2011	**[2011-1]:** (Busch & Hoffmann 2011) **[2011-3]:** (De Villiers et al., 2011) **[2011-5]:** (Iwata & Okada, 2011) **[2011-7]:** (Post et al.,2011)	**[2011-2]:**(Cong & Freedman, 2011) **[2011-4]:**(Fisher-Vanden&Thorburn, 2011) **[2011-6]:**(Lanoie et al., 2011) **[2011-8]:**(Rassier&Earnhart 2011)	8
2012	**[2012-1]:**(Alvarez, 2012) **[2012-3]:**(Bohringer et al., 2012) **[2012-5]:**(Boiral et al., 2012) **[2012-7]:**(Hofer, C. et al.,2012) **[2012-9]:**(Ionel-Alin et et al.,2012) **[2012-11]:** (Nishitani&Kokubu, 2012) **[2012-13]:** (Uhlaner et al. 2012)	**[2012-2]:**(Ameer & Othman, 2012) **[2012-4]:**(Barnett & Salomon 2012) **[2012-6]:** (Hatakeda et al., 2012) **[2012-8]:** (Horvathova, 2012) **[2012-10]:** (Lioui& Sharma, 2012) **[2012-12]:** (WALLS et al.,2012)	13
2013	**[2013-1]:** (Forsman, 2013) **[2013-3]:** (Iatridis, 2013) **[2013-5]:** (Sariannidis et al., 2013)	**[2013-2]:**(Fuji et al., 2013) **[2013-4]:**(Meng et al.,2013)	5
2014	**[2014-1]:** (Amran et al. 2014) **[2014-3]:**(Frias-Aceituno et al., 2014) **[2014-5]:**(Hourneaux Jr. Et al., 2014) **[2014-7]:**(Pintea et al., 2014) **[2014-9]:**(Qi et al., 2014) **[2014-11]:** (Zou et al. 2014)	**[2014-2]:**(Chen et al., 2014) **[2014-4]:**(Goktan, 2014) **[2014-6]:**(Lewis et al., 2014) **[2014-8]:**(Post et al., 2014) **[2014-10]:**(Tao & Zhang 2014)	11
Total			72

Table 3-1. List of studies included in this review

The FP profile of a firm captures its financial and governance characteristics. Similar to EP, FP is multidimensional and for the purposes of this paper, the three dimensions used are: *market-based*, *accounting-based* and *organisational-based*. Accounting-based indicators are measuring profitability and they are mainly backward-looking. ROA and ROE are examples of accounting-based indicators (Al-Matari et al. 2014). Market-based measures have forward-looking aspects and they are mainly concerning with the firm's future performance and investment that has its basis on previous or current performance. Tobin's Q and market-to-book value are examples of market-based indicators (Al-Matari et al. 2014).Furthermore, FP involves organisational aspects measured by other indicators rather than accounting-based or market-based measurements. We define organisational-based measures as a set of firm characteristics such as firm size (Cole et al. 2006)and board characteristics such as number of independent directors (Post et al. 2014)and CEO characteristics such as CEO compensation (Goktan 2014).

This study could be a reference for the researchers who are concerned with the relationship between EP and FP. The unit of analysis in this study is determinant factors of the relationships between EP and FP.

Field name	Description
Paper No.	Paper number
Paper reference	Paper reference in reference list
Datasets	Measurement characteristics such as sample size, country coverage, industrial sector and period of analysis
FP variables	List of FP variables
EP variables	List of EP variables
Findings - **Left** - **Right** - **Predicted** - **Support?**	 The dependent variable in the hypothesis The independent variable in the hypothesis The predicted result for the hypothesis (e.g. positive, negative, U-shaped) The result supported after analysing the hypothesis (e.g. positive, negative, insignificant, U-shaped)
Endogeneity	Whether studies deal with endogeneity
How?	How a study deal with endogeneity i.e. using lagged value, fixed-effect model or instrumental variable regression

Table 3-2. The dimensions of the meta-analysis

The remainder of the paper is organised as follows. Section 3.2 discusses each study within our sample in terms of the comparison dimensions. The studies are ordered chronologically first and then alphabetically. Section 3.3 discusses each one of the dimensions across the study sample and highlights possible dependencies between the dimensions that explain agreement or disagreement between individual studies. Finally, section 3.4 summarises the results and contributions and discusses the limitations and future directions for the research.

3.2 Literature review

The overview of selected studies is presented in this section. For each paper we provide the main aim of the study, the definition of the environmental profile of firms, the characteristics of sample of firms and the data sources used in the study and finally the findings of each paper in relation to social network profile and financial profile of firms.

(Al-Tuwaijri et al. 2004)

The paper examines the interrelations among environmental disclosure, environmental performance and financial performance. To define environmental performance, they employ a quantitative measure that is a ratio of toxic waste recycled to total toxic waste generated. They analyse a sample of 198 US firms listed on S&P500 in 1994. The additional information on measuring environmental performance is collected from the Corporate Environmental Profiles Directory from IRRC's 1994, environmental disclosure data is collected from SEC Forms 10-K, RiskMetrics and annual reports available from LexisNexis database, financial data from COMPUSTAT and firm's public visibility from Wall Street Journal news announcement. The findings confirm a positive relation between economic performance measured by industry-adjusted annual stock return and environmental performance measured by the percentage of total waste generated that is recycled. In addition, economic performance is not a significant determinant of environmental performance.

(Clarkson et al. 2004)

The paper examines the market valuation of environmental capital investment (ECE) in the pulp and paper industry. To define environmental profile, they use environmental capital investment (ECE) related to pollution reduction. In addition, they categories firms as low-polluting and high-polluting firms by using EP_{TRI} and EP_{BOD}. EP_{TRI} is about the release and transfer of toxic chemicals from manufacturing facilities. EP_{BOD} is based on Biological Oxygen Demand (BOD) and it is a reliable indicator of water pollution for the pulp and paper industry. In order to classify firms as low- and high-polluting, we partition the sample at the median EP_{TRI} (EP_{BOD}) for that year. Then they create a variable, POLLUTE, and set this variable to 1 for high-polluting firms. They analyse a sample of 29 US pulp and paper firms during the period 1989-2000. They find 45 public firms listed in the US with pulp and paper mills by searching Lockwood-Post's Directory of Pulp and Paper and Allied Trades. By examining 10-K, they eliminate 16 firms that have only limited operations in the pulp and paper industry. They collect environmental performance (EP) data based on publicly available dataset from EPA's Toxic Release Inventory (TRI) and EP_{BOD} from EPA's Permit Companies System. Their findings confirm that the market positively values ECE investment for low-polluting firms. In addition, there is not any ECE investment for high-polluting firms. Market assesses the existence of unbooked liabilities for high-polluting firms.

(Filbeck & Gorman 2004)

The paper examines the relationship between environmental performance and financial performance. To define environmental performance, they use IRRC Compliance Index that provides detailed information on the number and dollar amount of penalties assessed to firm based on the violations of the following federal environmental status. These items are Resource Conservation and Recovery Act, Clean Air Act, Clean Water Act, Safe Drinking Water Act, Toxic Substances Control Act, Federal Insecticide, Fungicide and Rodenticide Act, Mining Safety and Health Act, Atomic Energy Act, and the Endangered Species Act and related statuses. They analyses 24 firms that are IRRC/S&P500 electric company industry from 1996 to 1998. The environmental performance measure is

collected from the Investor Responsibility Research Centre (IRRC)'s 2000 Corporate Environmental Profiles Database (CEPD). Information on the environmental record of S&P500 Index companies is from Online Analyst database, transformed raw data from 20 Federal Agency sources into environmental data in five categories are from Corporate Benchmarking Service. In order to determine the aggressive environmental policy, they collect data from the Summit Investment Partners and finally the information on regulatory climate data are from Value Line Investment Survey publishes. Their findings confirm the negative relationship between environmental and financial performance. They find out that IRRC Compliance Index has negative impact on market value and they could not confirm that firms with higher (lower) IRRC Compliance Index in an individual year will experience lower (higher) returns in the following year.

(Cormier et al. 2005)

The paper focuses on identifying determinants of corporate environmental disclosure using multi-theoretical lenses that rely on economic incentives, public pressures and institutional theory. To define corporate environmental disclosure, they employ qualitative approach that captures the quality of disclosure rather than its quantity. They use comprehensive coding instrument to categorise environmental disclosure comprises thirty-nine items into six categories namely, environmental expenditures and risks, laws and regulations, pollution abatement, sustainable development, land remediation and contamination (including spills), and environmental management. The rating is based on a score of one to three: three for an item described explicitly in monetary or quantitative terms (thus allowing for an assessment of its relative importance), two when an item is described specifically and one for an item discussed in general. They analyse a sample of 55 German non-financial firms that are indexed in DAX 30/ DAX 70. Financial data is collected from Datastream and annual reports and environmental data is collected from their annual and/or environmental reports available on Antwerp University library. Their analysis confirms that market return has positive impact of environmental disclosure quality, while leverage shows a negative impact.

(Elsayed & Paton 2005)

The study conducts static and dynamic panel data analysis of the link between the environmental performance of firms and their financial performance. To define environmental profile, they use Management Today's community and environmental responsibility (CER) scores. The CER scores represent the perceptions of managerial peers concerning environmental performance rather than measuring such performance directly. The score for each firm, according to the MT methodology, ranges between 0 (for poor or bad performance) and 10 (if the firm is judged to have achieved excellent performance).They analyse 227 UK public limited firms listed in the Management Today Survey of Britain's Most Admired Companies (BMAC) from 1994 to2000.These firms have average total assets (over the period 1994–2000) worth £2833.7 million (median £1133.4 million) with 22,476 employees on average (median 10,549 employees) and average total sales £2633.0 million (median £1113.4 million). They obtain accounting data from Datastream and Financial Analysis Made Easy (FAME) databases, and they obtain environmental measure from Management Today' community and environmental responsibility (CER). Their analysis presents static and dynamic data estimates of relationship between environmental and financial data. Their static panel data estimates suggest no significant impact of lagged environmental performance (as measured by managerial peers) on two measures of performance and a negative impact that is only weakly significant on the third measure (return on assets). Similarly, our dynamic panel data estimates reveal only very weak evidence that environmental performance affects financial performance. In contrast, cross-section and pooled estimates using the same data suggest that lagged environmental performance exerts a strongly significant impact on firm performance. The most likely explanation for the difference between these findings is that there exist unobservable firm effects that are important in explaining financial performance. Specifically, environmental performance appears to have a positive impact on the return on assets for firms in the chemical and telecommunication industries and a negative impact for firms in textiles, clothing, metals and motor vehicles. However, there is no evidence of a differential impact across industries for other measures of financial performance.

(Gupta & Goldar 2005)

This study examines the impact of environmental rating of large pulp and paper, auto and chlor alkali firms on their stock prices. They use the announcement of environmental rating of large pulp and paper, auto, and chlor alkali plants as the environmental profile. They analyses 17 pulp and paper, 15 auto firms, 18 chlor alkali firms in India. They choose firms included in the Green Rating Project of CSE. They collect firms' stock prices from the corporate database PROWESS of Centre for Monitoring the Indian Economy (CMIE), the market returns is collected from Bombay Stock Exchange (BSE) "Sensex". Their analysis confirms that the average abnormal return for 17 pulp and paper firms on the first day after the announcement of green ratings is negative but not statistically significant, while this is negative and statistically significant for the 5 trading days period (0-5) and the 10 trading days period. In case of chlor alkali firms, the average abnormal return for day 0-1, 0-5 and 0-10 are negative and not statistically significant. In contrast, for automobile firms, the average abnormal return for day 0-1, 0-5 and 0-10 are positive and statistically significant.

(González-Benito & González-Benito 2005)

The paper examines the relationship between environmental proactivity and business performance. To define environmental profile, they ask each operations manager of each firm to score each of the following practices: use Planning and organizational practices, Logistics processes practices, Product design practices, internal production processes practices. They analyse 428 Spanish firms from 2002 Dune & Bradstreet census of the 50,000 largest firms with more than 100 employees in three industrial sectors: chemical products (except pharmaceutical firms), electronic and electrical equipment and furniture and fixtures. They collect data through a postal questionnaire and they collect financial performance data from the Dune& Bradstreet 2002 database. Their analyses confirm that none of the environmental performance indicators has significant effects on ROA.

(Hassel et al. 2005)

The paper provides insight into how environmental information is reflected in the market value of listed Swedish firms. To define environmental performance measure, they use an index provided by the Swedish firm, CaringCompany (CC) Research AB. They analyse data integrated from three different data sources. Stock prices and the number of shares are collected from the Trust Database of Bonnier-Findata, Sweden, accounting information collect manually from the firms' financial statements (interim reports) and environmental performance measures from CaringCompany (CC) Research, AB. The findings confirm that the high level of environmental performance are costly and has a negative impact on the net income.

(Russo & Harrison 2005)

The study examines the link between plant manager and environmental quality managers' compensation and environmental performance. To define environmental profile, they use toxics release index which is calculated as follow:

$$Toxicsreleaseindex = \ln\left[1 + \sum_i \left({E_i}/{RQ_i}\right)\right]$$

Here E_i is emissions of chemical *i* to air, land, and water, if emissions are above the reporting threshold and 0 otherwise; RQ_i is the EPA reportable quantity for chemical *i* and *i* is an index denoting each of the 529 chemicals that are tracked by the TRI. They analyse 169 US electronic plants in 1999. Data is collected from six industry environments: SIC 3571 (electronic computers), SIC 3651 (household audio and video equipment), SIC 3661 (telephone and telegraph equipment), SIC 3671 (electronic tubes), SIC 3672 (printed circuit boards), SIC 3674 (semiconductors and related devices). Data furnished by Dun and Bradstreet listed 1104 such firms in the US. Other necessary data is collected through survey conducted by a university survey research centre. The analysis confirms that a facility in which the plant manager's salary is influenced by environmental performance experiences greater emissions reductions than a facility without such a compensation component. However, they could not confirm that if the environmental quality manager's

salary tied to environmental performance, then firm experiences greater emissions reductions.

(Wagner 2005)

The paper explores the relationship between environmental and economic performance and the impact of corporate strategies concerning the environment. Environmental performance is defined on the basis of quantitative indicators describing mass, energy, and pollutant flows and different specifications of environmental performance. They use five variables as environmental performance indicators. COD is emission of chemical oxygen demand per output; SO_2 which is emission of sulphur dioxide per unit of output; NO_x which is emission of nitrogenous oxides per unit of output; Energy input which is the total energy input per unit of output and water input which is the total water input per unit of output. Then, the indicators used to calculate scores for the first (outputs-oriented) index score are SO_2, NO_x and COD. The inputs-oriented index score are total energy input and water input. They analyse a sample of 571 firms from four European countries; Germany, Italy, the Netherlands and the UK; in the pulp and paper-manufacturing sector. They obtain data from publicly available information sources such as financial reports or pollutant release and transfer registers (e.g. the Dutch Emissions Register for Industry (ER-I), the US Toxic Release Inventory (TRI) and the UK Pollution Inventory. Their analysis confirms that input-based environmental index has no significant impact on economic performance measured by ROCE or ROE or ROS. Output-based environmental index has negative impact on economic performance which is measured by ROCE and ROE and inverse U-shaped relationship with ROS.

(Brammer & Pavelin 2006)

The paper examines the patterns in voluntary environmental disclosures. To define environmental profile, they construct two variables. The first is DISCLOSE which takes a value of one if a company participates in any of the six components of environmental disclosure identifies in the 'PIRC Environmental Reporting 2000' and zero otherwise. The

second variable is QUALITY, which is the number of the aspects identified by the PIRC apparent in the disclosure of each firm. They analyse the 447 largest UK firms in 2000. Environmental data is obtained from the "PIRC Environmental Reporting 2000" and Environmental Agency data, ownership data from London Stock Exchange, organisational visibility from Factiva database and other firm characteristics from Datastream. Their analysis confirms that participating in voluntary environmental disclosure is positively related to firm size and share ownership, while is negatively related to leverage. In addition, its association with return on total asset (ROTA) and the number of non-executive directors are not statistically significant. Regarding the quality of voluntary environmental disclosure, large firm tend to have higher level of the quality of voluntary environmental disclosure. However, share ownership and leverage have negative impact of the quality of voluntary environmental disclosure. Their analysis reports not statistically significant relationship between the number of non-executive directors and return on total assets (ROTA) or the number of non-executive directors.

(Cole et al. 2006)

The paper attempts to identify and quantify the factors that influence the environmental management. To define environmental profile, they measure 14 different aspects of a firm's environmental management as follow; (i) overall environmental management performance and 13 more environmental management for specific environmental issues namely, (ii) total industrial waste management, (iii) total treated industrial waste management, (iv) CO_2 emission management, (v) land and ground water pollution control, (vi) industrial waste outsourcing and recycling, (vii) management of global warming and energy saving, (viii) environmental accounting, (ix) environmental management structure, (x) disclosure of environmental statement, (xi) disclosure of chemical treatment, (xii) ISO 14001, (xiii) environmentally friendly products, (xiv) environmental cooperation. They analyse a sample of 400 Japanese firms in 1999. They gather information on environmental management practices from Nihon Keizai Shimbun. This dataset is a result of questionnaire sent to all publicly quoted firms and a random selection of major non-public firms in the Japanese manufacturing sector and selected non-manufacturing

industries (construction and electricity and gas). They obtain other firm level characteristics from Toyo Keizai Shinpo. Their analysis confirms that firm size, total factor productivity (TFP) as well as marketing intensity has significant positive impact on overall environmental management. The ratio of debt to assets is negative and significant. Average age of employees (Age) seems to have little effect.

(López et al. 2007)

The paper provides insight into the relationship between Corporate Social Responsibility (CSR) and accounting indicators. To define environmental profile, they consider whether firms have adopted Corporate Social Responsibility (CSR). This requirement is determinate based on firms included in the Dow Jones Sustainability Index (DJSI). Therefore, they select one group of firms included in the Dow Jones Sustainability Index (DJSI) and another group of firms included in Dow Jones Global Index (DJGI) and not on the DJSI. They analyse 55 European firms included in DJSI and 55 European firms included in DJGI from 1998 to 2004. They obtain financial data from the database AMADEUS and the financial statements and other corporate disclosures are available on the Internet. They use Dow Jones Sustainability Index database and Dow Jones Global Index (DJGI) to select two groups of firms. They analyse two time intervals of 3 years: 1999 to 2001 and 2002 to 2004. For the period 1999 to 2001, in which no differentiation exists between firms that disclose information on sustainability practices and those that do not, there is no relationship between the growth of profit before tax (PBT) and Corporate Social Responsibility.

(Nakao et al. 2007)

The paper examine the association between firms' environmental performance and financial performance in two-way. To define environmental performance, they use environmental performance indices the 'score' evaluated in the Nikkei Environmental Management survey report. They analyse data for 121 Japanese firms in manufacturing sector excluding the energy and construction industries for 2002 and 2003. They collect

environmental performance data from Nikkie Environmental Management Survey Reports, aggregate market value from Kaisha Shikiho (Japan Company Handbook), basic financial data from Nikkei Financial Data CD-ROM and sample firms' financial statements. The findings confirm that a firm's environmental performance has a positive impact on its financial performance measured by ROA, Tobin's q-1 or earning per share and vice versa for Japanese data. This two-way positive interaction is a general trend among firms covered by Nikkei environmental management surveys.

(Cordeiro & Sarkis 2008)

The study examines the linkage between CEO compensation and environmental performance. To define environmental performance, they use the Toxic Release Inventory (TRI) emission index, which reflects environmental risks related to the total legal releases of approximately 325 toxic chemicals required to be reported to the federal government. This data is scaled by dividing total releases by firm sales to control for production-level differences across firms. The compliance index reported by the IRRC is the total dollar amount of penalties incurred by the firm under nine environmental statutes. This number is also scaled by dividing it by firm sales, as is the IRRC spill index, which is the combined number of chemical and oil spills experienced by the firm. Larger values of these measures indicated poorer environmental performance. Finally, whether or not the firm employed environmental performance as a factor in compensation is coded as a dummy variable based on the IRRC firm survey data. They analyse 172 S&P500 firms, which complete IRRC survey in 1996. They collect data on environmental efforts and performance from the 1996 IRRC Corporate Environmental Profile. They collect CEO characteristics data from Execucomp dataset and data on ownership and boards from CD-Disclosure database. Their analysis confirms that only the full sample and the sub-sample of firms with the environmental performance–compensation linkage have significant associations with the compliance and spill index but not for the emission index.

(Lucas & Wilson 2008)

The paper examines the relationship between environmental management and financial performance in the service industry. To define environmental profile, they use a variety of measures. They construct three environmental indexes namely, i.e. a sub-index of environmental strengths, a sub-index of environmental concerns and a global environmental index using the combination of the two previous sub-indexes by subtracting the sub-index of environmental concerns from the sub-index of environmental strengths. In addition, they focus in two groups of firms with opposite environmental behaviour. "Environmental Leaders" defines as those firms that have experienced no environmental concerns and engage in at least one environmental initiative (strengths), and "Environmental Laggards" defines as service organisations that have experienced at least one environmental concern, but do not engage in any environmental management initiative (strengths). Moreover, they separate service-sector firms into two distinct groups: dirtier service industries and cleaner service industries. They analyse a cross-sectional dataset of 1228 publicly traded firms representing a wide range of service-sector firms in 2004. They are a subset of Russell 3000 index of firms. They collect data for environmental profile from KLD and data for financial performance from Thomson Baseline database. Their findings confirm that "Environmental Leaders" have higher financial performance than "Environmental Laggards". In addition, firms in "cleaner" service sector will be associated with higher financial performance than firms in "dirtier" service sector. Environmental leaders in "cleaner" service sectors will be associated with higher financial performance than Environmental Laggards in "cleaner" service sector. Environmental Leaders in "cleaner" service sectors will be associated with higher financial performance than Environmental Leaders in "dirtier" service sector. Finally, service firms with higher environmental ratings will be associated with higher financial performance.

(Ngwakwe 2008)

The paper examines the relationship between environmental responsibility and firm performance in Nigeria. To define environmental profile, three sustainable indicators are

used as a measure of environmental responsibility, namely: employee health and safety (EHS), waste management (WM) and community development (CD). In addition, two types of firms are distinguished within their sample, environmentally responsible firms and environmentally irresponsible firms. If firms report up to 50% of the following indicators in terms of environmental and social disclosure, firm is listed as environmentally responsible firm. These indicators are greenhouse gas (GHG) including carbon capture and storage (CCS), biodiversity through waste recycling, water treatment and quality of waste water discharged into the environment, product life cycle management, employee health and safety, business ethics charter, environmental research and development, community development, equal opportunity in employment, product innovation and packaging and employee training and development.The paper analyses 60 manufacturing firms from the chemical and paints industry group, the automobile and tyre group and breweries from 1997 to 2006. These firms filed their annual report within the last ten years. The data is collected from financial statements and questionnaire. The findings confirm the significant difference between the return on total assets of the environmentally responsible firms and those of environmentally irresponsible firms. The results show that investment in social and environmental responsibilities such as employee health and safety (EHS), waste management (WM) and community development (CD) are related to improving Return on Total Assets (ROTA). The same results obtain for the relationship between the level of fines and penalties and firm's investment in social and environmental responsibilities.

(Sharfman & Fernando 2008)

The paper examines the relationship between environmental risk management and the cost of capital. To define environmental risk management, they use both quantitative and qualitative approaches. For quantitative measures, they selected four measures from TRI data, which are total TRI emissions, total TRI emissions treated on site to reduce their toxicity, total TRI emissions reused or recycled on-site for energy and total waste generation including TRI emissions. For qualitative measure, they use KLD score by averaging the strength and the concerns separately. They analyse 267 S&P500 firms in

2002. They obtain environmental risk data from KLD dataset and the United States EPA TRI data, which is available on IRRC, other financial data from Research Insight, COMPUSTAT and Bloomberg Financial database. Their findings confirm that environmental risk management has positive impact on tax shield from debt, dispersed share ownership and weighted average cost of capital. However, it has negative impact on Beta, percentage of institutional shareholders, cost of debt capital and cost of equity capital.

(Stanny & Ely 2008)

The paper examines the factors associated with the firms' decisions to disclose information about climate change to Carbon Disclosure Project (CDP).They consider whether firms are disclosing information about climate change to CDP in year 2007. They analyse sample of 494 S&P500 firms in 2007. They collect environmental data from CDP and financial data from COMPUSTAT. Their analysis confirms that large firms are more likely to respond to CDP. In addition, there is a positive association between the degree of foreign sales and disclosure. However, they could not find any support for disclosure being associated with Tobin's Q, Leverage or profitability.

(Yamaguchi 2008)

The paper examines how environmental performance of a firm affects firm's stock price. To define environmental performance indicator, they use the announcement of the ranking of firms in Nikkei Environmental Management Ranking survey. The total ranking comprises the following seven items: (1) environmental management systems, (2) long-term objectives, (3) pollution prevention, (4) resource circulation, (5) product measure, (6) carbon reduction and (7) office. The study analyses 69 Japanese firms using event study methodology to analyse the period of eight years from July 31, 1998 to October 13, 2006. They collect stock price data as a financial indicator from Datastream and environmental performance indicator from Nikkei Environmental Management Ranking survey. The analysis confirms that the corporate environmental performance influence its stock price

in a positive way for the higher frequency of ranking and a negative effect for the lower frequency of ranking in the given period.

(Berrone & Gomez-Mejia 2009)

The paper examines the impact of good environmental performance on CEO payment in polluting industries. They define two environmental performance measures. The first is "pollution prevention measures" which is calculated as estimating total waste generation levels and contrasting this estimation with real values. The second measure is end-of-pipe pollution control defined as a ratio in which the numerator was the sum of chemicals recycled, treated on-site, and transferred to other locations for further treatment and the denominator was the total waste generated by a firm. They analyse 469 US firms from 1997 to 2003. They select firms from industries reporting under EPA's Toxic Release Inventory (TRI). They collect data on CEO characteristics from Execucomp, financial data from COMPUSTAT, board characteristics from RiskMetrics and environmental governance information from proxy statements reported to the Securities and Exchange Commission (SEC).Their findings confirm the impact of pollution prevention and end-of-pipe pollution control on CEO total pay. However, the results show that pollution prevention has a greater impact on CEO total pay than end-of-pipe pollution. Firms with environmental governance mechanism in place, the positive effect of environmental performance on CEO's pay is lower. In addition, firms with environmental governance mechanism in place do not necessary put greater emphasis on pollution prevention than end-of-pipe pollution control as criteria for CEO pay. Long-term pay has a positive effect on environmental performance and this positive effect is greater on pollution prevention than end-of-pipe results. This effect is greater for firms in polluting industries.

(Elsayed & Paton 2009)

The paper provides insight into the impact of financial performance on environmental policy vary with firm life cycle. To define environmental profile, they use corporate environmental policy, proxied by the mean annual Community and Environmental

Responsibility (CER) score for each firm. They analyse 227 UK firms listed in the Management Today Britain's Most Admired Companies survey (BMAC) from 1994 to 2000. They collect environmental policy data from Management Today's BMAC survey. The findings confirm that in the initial growth stage, the relationship between financial performance and environmental policy is positive. However, in rapid growth stage this relationship is not significant. Firms in the maturity stage of their life cycle have the strongest impact of financial performance on environmental policy. There is a positive impact on environmental policy in the revival stage but at a lower level than in the maturity stage.

(Iraldo et al. 2009)

This paper investigates whether or not an EMS implemented within the EMAS Regulation has any effect on firm's competitive performance. To define environmental profile, they use answers provided to the question "How has the environmental performance of your organisation changed in recent years?" and "How does the environmental performance of your organization compare to other organizations in your sector?"They analyse data collected within the EVER study (Evaluation of EMAS and Ecolabel for their revision) carried out by a consortium of universities, research institutes and consultants coordinated by IEFE (the Institute for Energy and Environmental Policy and Economics of the "Bocconi" University on Milan, Italy) on behalf of the European Commission-DG Environment. Data is collected by way of interviews "on-site" and by telephone based on a standard questionnaire in spring and summer 2005.Their final sample includes 101 firms in manufacturing firms, Service sectors and other industrial sectors. Their findings confirm that EMAS-registered firm with higher environmental performance have better competitive performance in terms of innovation capabilities, but the results does not show any association between environmental performance and competitive performance measured as market performance, intangible assets or resource productivity.

(Johnstone & Labonne 2009)

This paper explores the motivation for the introduction of environmental management system and their certifications. The environmental management decision is reflected in the binary response to the question "has your facility actually implemented an environmental management system?". They analyse the survey data collected in seven OECD countries (Canada, France, Germany, Hungary, Japan, Norway and the US). The data covers all manufacturing firms. Their findings confirm that firms which gain market advantage from introducing an EMS for example competing on the basis of brand image are more likely to have it certified since it helps them to distinguish themselves from other market participants. In addition, more profitable facilities which already have advanced management practices in places are more likely to implement and certify an EMS.

(López-Gamero et al. 2009)

The paper examines the relationship between environmental variables and firm performance.

To define environmental profile, environmental competitiveness is defined which could be influenced by environmental management activities. Two groups of items are considered to measure competitive advantage, i.e. competitive advantage on costs (4 items) and competitive advantage in differentiation (5 items). Firms' managers rated their firms' competitiveness relative to that of other firms in the sector. They analyse data collected through a mail survey from 240 hotels and 208 Spanish firms affected by the IPPC law in September 2004.Their findings confirm that there is a significant, positive effect of cost and differentiation competitive advantage on financial performance in hotels and IPPC law sector.

(Earnhart & Lizal 2010)

The paper examines the effect of corporate environmental performance on financial performance. To define environmental profile, they use air pollutants which include

carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter and nitrous oxides (NO_x). All four pollutants are added into one composite measure of air emissions. They analyse 429 Czech firms between 1996 and 1998. They collect accounting-based financial data from three segments of a database provided by the private data vendor Aspekt. Two segments provide information drawn from firm's balance sheet and income statements and the third segment provides information on ownership structure. Air emissions data collects from the REZZO-1 database which maintains by the Czech Hydro meteorological Institute. Their findings reveal that better environmental performance improves operating profitability as well as overall profitability. In addition, environmental performance negatively affects both sales and costs and better environmental performance appears to reduce revenues.

(Hibiki & Managi 2010)

This study examines whether Japanese market values a firm's environmental performance. To define environmental profile, they use environmental management ranking of firms (NIKKEI Index), toxic chemical data and information about the carcinogenic risks. They analyse a sample of 804 manufacturing firms listed in the first section of the Tokyo Stock Exchange in 2003 and 2004. They collect market data from the Nikkei Needs database provided by Nikkei Quick Information Technology Co. Ltd., data for toxic chemical data from Japanese Ministry of the environment. Risk information is collected from the following seven sources: the Ministry of Labour in Japan (1999), the American Conference of Governmental Industrial Hygienists (2003), the International Agency for Research on Cancer (2003), the European Union (2002), the U.S. Environmental Protection Agency (2003), the U.S. Nation- al Toxicology Program (2003), and the Japan Society for Occupational Health (2003).Their analyses confirm that risk information on carcinogenicity is positively correlated with replacement cost, while information on chemical pollution is insignificant. This indicates that a firm pays attention to carcinogenicity, rather than total volume of chemical substances, in assessing its risk. In addition, the adoption of ISO 14001 is not significant whereas the Nikkei index is significant and positive. In relation to intangible assets, neither the information on

carcinogenicity nor chemical pollution is statistically significant. This implies that market does not value environmental risks as represented by the firm's toxicity. On the other hand, higher risks of carcinogenicity decrease Tobin's Q, overall, we can conclude that poor environmental performance such as higher carcinogenic risk, increase replacement cost but does not affect intangible assets. In relation to intangible assets, the Nikkei index is significant and negative while the ISO 14001 parameter is not significant.

(Henri & Journeault 2010)

The paper examines the impact of eco-control; as an application of financial and strategic control methods to environmental management; on environmental and economic performance. They use perceptual instrument to define environmental performance and eco-control. They use following questionnaire items to define environmental performance: (1) reduction in material costs, (2) reduction in process/production costs, (3) reduction in costs of regulatory compliance, (4) increased process/production efficiency, (5) increased in productivity, (6) increased knowledge about effective ways of managing operations, (7) improved process innovations, (8) improved product quality, (9) improved product innovations (10)organizational-wide learning among employees, (11) better relationships with stakeholders such as local communities, regulators and environmental groups, (12) improved employee morale, (13) overall improved company reputation or goodwill, (14) filters and controls on emissions and discharges. In addition, they use following items to define eco-control : (1) use of performance measures includes monitor internal compliance with environmental policies and regulations; provide data for internal decision-making; motivate continuous improvement; provide data for external reporting, (2) Budgeting includes environmental expenses; environmental investment; incomes form material scrap or recycled wastes, (3) Incentives includes environmental indicators are important in reward systems; environmental performance objectives are included in the planning systems; and environmental performance indicators are weighted on par with economic performance indicators. They collect data from a survey to a random sample of 1500 Canadian manufacturing firms from Scott's Manufacturing database. Their final sample includes 303 firms. Environmental and financial performance is measured using a

perceptual instrument. Their findings show that environmental performance has negative impact on financial performance. In addition, eco-control has negative direct impact on financial performance for firms (a) facing greater environmental exposure, (b) dealing with greater public visibility, (c) reflecting greater environmental concern, (d) facing more pressure from stakeholders and (e) reflecting larger size. On the other hand, eco-control indirectly influences financial performance in the context of (a) higher environmental exposure, (b) higher public visibility, (c) higher environmental concern, (d) more pressure from stakeholders and (e) larger size.

(Jacobs et al. 2010)

The paper examines the shareholder value effects of environmental performance by measuring the stock market reaction (abnormal returns) associated with announcement of environmental performance. To define environmental profile, two categories of announcement are considered. First category includes 417 announcement of Corporate Environmental Initiative (CEIs) that provide information about self-reported efforts to avoid or minimise the environmental impacts of the firm's product, service or processes. The CEIs contains the following 7 subcategories: i) environmental business strategy, ii) environmental philanthropy, iii) voluntary emission reduction, iv) Eco-friendly products, v) Renewable energy, vi) Recycling, vii) Miscellaneous. The second category includes 363 announcements of Environmental Awards and Certifications (EACs). This category includes two certification subcategories, namely, ISO 14001 and LEED, and three award subcategories, namely, federal, state or local government and non-government. They analyse 780 announcements (417 CEI announcements and 363 EAC announcements). They search the headlines and lead paragraphs of announcements in the three major business wire services, the ten most widely circulated US daily newspapers and the leading European business daily during the period 2004 to 2006. The sample covers 340 unique firms. In addition, they capture firm's environmental reputation by considering whether the firm was included in the Dow Jones World Sustainability Index (DJSI World) at the time of announcement. The findings confirm that the market does not react significantly to the aggregated CEI and EAC announcements. However, market reacts to

the certain subcategories of CEI and EAC. The market reaction to CEI announcements is marginally positive. The market does not react to environmental business strategy announcements. The voluntary emission reductions are viewed negatively by the market. The market reaction to the remaining CEI subcategories- eco-friendly products, renewable energy, recycling, and miscellaneous- are statistically insignificant. In relation to EACs, market reaction is negative. The market reacts positively to announcements of ISO 14001 certifications. However, market reaction to LEED certifications is all positive and statistically insignificant. Market reacts positively to government awards and negatively to non-government awards.

(Lundgren & Olsson 2010)

The paper examines stock price reactions to Environmental (EV) incidents.They use incident data reported to GES. GES data contains identification codes and incident reporting dates that are the dates the incidents reports to the clients of GES. They analyse 74 international firms from 2003 to 2006. They obtain environmental incidents report from GES and financial data from Datastream. Their analysis confirms that the environmental incidents are generally associated with a loss of firm value for firms in Europe.

(Monteiro & Aibar-Guzmán 2010)

The paper attempts to study of environmental reporting practices developed by Portuguese firms and identify the factors that explain the extent to which these firms disclose environmental information. They identify a comprehensive list of 16 environmental items; nine times are related to environmental information to be included in the management reports and six items refer to information to be disclosed in the notes. They analyse 109 Portuguese firms listed by the Portuguese financial magazine Exame in September of 2004. They request financial statements corresponding to the years 2002, 2003 and 2004 from firms directly. Information about environmental data is collected from the annual reports. Their findings confirm that firm's size and the quotation on the

stock market can explain that Portuguese firms disclose environmental information in their annual reports. Industry membership, profitability and foreign ownership could not explain disclosing environmental information in the annual reports of Portuguese firms.

(Prado-Lorenzo & Garcia-Sanchez 2010)

The paper examines the role of board of directors in disseminating information on greenhouse gas (GHG).To define environmental profile, they use CDLI which reflects the suitability of the information used to respond to each item on the questionnaire but does not include any evaluation of its content, or in other words the appropriateness of the practices carried out by each company. They analyse 283 firms listed in FTSE Global Equity Index in 2008. They collect data on environmental performance from Carbon Disclosure Project (CDLI).The percentage of board members who are independent on the Boards of Directors of companies with lower environmental records and/or those which do business in industries with a higher risk of litigation will have a less positive impact on the amount of information disseminated on greenhouse gases than the others. The percentage of board members who are independent on the Boards of Directors of companies whose country of origin has developed a favourable institutional macro- context for CSR will have a higher positive impact on the amount of information disseminated on greenhouse gases than the others. The percentage of board members who are independent on the Boards of Directors of companies with lower environmental records and/or those which do business in industries with a higher risk of litigation and whose country of origin has developed a favourable institutional macro-context for CSR will have the same positive impact on the amount of information disseminated on greenhouse gases as the others.H2a: When the duties of the CEO and Chairman of the Board of Directors are performed by the same person in those companies with lower environmental records and/or those which do business in industries with a higher risk of litigation, there will be a less positive impact on the amount of information disseminated about greenhouse gases than the others.H2b: When the duties of the CEO and Chairman of the Board of Directors are performed by the same person on the Board of Directors of companies whose country of origin has developed a favourable institutional macro- context for CSR, there will be

the same positive impact on the amount of information disseminated about greenhouse gases as the others.H2c: When the duties of the CEO and Chairman of the Board of Directors are performed by the same person on the Board of Directors of companies with lower environmental records and/or those which do business in industries with a higher risk of litigation and whose country of origin has developed a favourable institutional macro-context of CSR, there will be a less positive impact on the amount of information disseminated about greenhouse gases than the others.H3a: Greater diversity in the Board of Directors of those companies with lower environmental records and/or those which do business in industries with a higher risk of litigation will have the same positive impact on the amount of information disseminated about greenhouse gases as the others.H3b: Greater diversity in the Board of Directors of companies whose country of origin has developed a favourable institutional macro- context for CSR will have the same positive impact on the amount of information disseminated about greenhouse gases as the others.H3c: Greater diversity in the Board of Directors of companies with lower environmental records and/or those which do business in industries with a higher risk of litigation and whose country of origin has developed a favourable institutional macro-context of CSR will have the same positive impact on the amount of information disseminated about greenhouse gases as the others.

(Rassier & Earnhart 2010)

The paper examines the association between clean water regulation and expected future financial performance. They use the permitted wastewater discharge limits as the proxy of Clean Water Act regulation. They analyse 54 chemical manufacturing firms from January 1995 to December 2000. They obtain environmental data from the Environmental Protection Agency's (EPA's) Permit Compliance System (PCS) database and financial data from S&P COMPUSTAT Research Insight. Their analysis indicates a negative relationship exists between clean water regulation and expected future financial performance measured by Tobin's Q.

(Wagner 2010)

This paper examines the link between sustainability management and economic performance. To define environmental profile, they use an overall corporate sustainability performance index calculated including all KLD strengths and concerns. The index ranges from 0 to 19 with a mean value of 10.1.They analyse 3697 US firms indexed in S&P500 from 1992 to 2003. They obtain data from COMPUSTAT, Worldscope Disclosure and BankerOne databases and data for ratings of corporate social responsibility and environmental management from KLD. Their findings confirm that overall sustainability performance index is positively affect economic performance measured by Tobin's Q. Corporate sustainability performance impacts economic performance less positively in low innovation firms (as measured by R&D intensity) than it does in high-innovation firms. In addition, corporate sustainability performance affects economic performance less positively in firms with low levels of differentiation and signalling (as measured by advertising intensity) than it does in firms with high levels of differentiation and signalling.

(Busch & Hoffmann 2011)

The paper examines the association between corporate financial performance (CFP) and corporate social performance (CSP).To define environmental profile, they focus on carbon emissions as an outcome-based measurement and carbon management as a process-based measurement which are two different measures for CEP. Regarding carbon emissions as, they utilize a firm's carbon intensity, measured as the ratio between the total GHG emissions (in tons) and a firm's sales (in US$). Then, they take the natural logarithm of the obtained carbon intensity. Second, they centre the data using the median as described in Aiken and West (1991). Third, they multiply the resulting rescaled carbon intensity with (–1). Regarding carbon management, they design a questionnaire with 13 questions covering the following areas: use of carbon information in management systems (two items), sophistication of applied carbon indicators (two items), existence of management systems that seek to increase energy/fossil fuel efficiency and to become carbon independent (three items), existence of efforts that target carbon offsetting and

out- sourcing (three items), and exploration of new markets and low-carbon business strategies (three items). For each question, we developed a dummy variable coded 0 or 1. The overall score for carbon management is the sum of all 13 items. They analyse 174 firms cap within the Dow Jones Global Index. They covered carbon- and energy-intense industries. They obtain data regarding firms' carbon performance from Sustainable Asset Management. In addition, they cross-checked all emission data with other sources, such as the answers to the CDP and official company reports in cases where this information is available. They collect financial data and general firm characteristics from COMPUSTAT. Their analyses examine the effect of carbon intensity (outcome-based CEP) on financial performance. For ROA and ROE, no significant results are obtained. For Tobin's q, the coefficient for carbon intensity is in the direction anticipated and is highly significant ($p < .01$). In addition, they analyse the effect of carbon management (process-based CEP) on financial performance and shows the negative association with Tobin's q and ROE as CFP measurements. Moreover, their analyses fail to support that Process-based CEP moderates the positive relationship between outcome-based CEP and CFP; for firms with a low outcome- based CEP, this relationship will be strengthened by a highly sophisticated process-based CEP; for firms with a high outcome-based CEP, this relationship will be strengthened by a less sophisticated process-based CEP.

(Cong & Freedman 2011)

This study assesses the relationships between good corporate governance and environmental performance and disclosure. In their analysis, they focus on environmental disclosure and environmental performance measures. A disclosure index was then developed on the basis of the scheme utilized by Freedman and Stagliano (2008). The disclosures are categorized by the following criteria: 1) Provide the TRI amount for each reporting year of 2003–2005; 2) Report releases by specific chemical/compound for each reporting year; 3) Disclose emissions data by plant for each reporting year; 4) State the TRI amount for the recent three years (i.e., 2001–2003 in the 2003 report); and 5) Categorize releases by method (i.e., via air, water, or land). From these five categories we develop a disclosure index. A score of "1" was given for each category of disclosure found

in a firm's reporting. The disclosure score is the aggregate of the scores of all the five categories. For environmental performance, they use pound-based TRI, the risk-related metric RRR and hazard-based measure MHPR accounts. They analyse firms that were the top 50 volume metric releases of toxics in 2003 to 2005. They collect corporate governance in the SOX era from GOV-Score data compiled by (Brown and Caylor 2006). They collect the disclosure data from the firms' environmental reports and their websites. Their findings confirm that environmental performance; measure by pound-based TRI, the risk-related metric RRR or hazard-based; is not related to the score of corporate governance. They obtain same results in relation to environmental disclosure. In addition, the primary effect of SOX, which is the financial accountability of public firms, does not improve the environmental performance and disclosure of the firms.

(de Villiers et al. 2011)

This study investigates the relationship between strong environmental performance and board characteristics that capture boards' monitoring and resource provision abilities in respect to environmental performance and the related strategic opportunities. They define environmental profile for each firm which indicates whether a firm display any of five environmental strengths reported in KLD database. They analyse the sample of US publicly traded firms indexed in S&P with the data coverage on the KLD database for the 2003 and 2004 fiscal years. They collect environmental performance data from KLD, financial data from S&P COMPUSTAT files, board governance data from the Corporate Library's Board Analyst database. Their finding confirms that environmental strengths is positively and significantly related to director independence, and negatively and significantly related to directors appointed after CEO. However, environmental strengths is insignificantly related to CEO-chair duality. Moreover, the results indicate insignificant relationship between environmental strengths and CEO-director ownership, insider-director ownership or outsider-director ownership. The findings do not provide strong support for association between multiple directorships and board tenure in relation to environmental strengths. On the other hand, environmental strengths have positive association with board size, active CEO and law expert.

(Fisher-Vanden & Thorburn 2011)

The paper provides evidence on shareholder wealth effects of membership in voluntary environmental programs (VEPs).They define environmental profile of firms as announcing firms' membership in one of two voluntary environmental programs (VEPs) namely, the EPA's Climate Leaders (CL) program and Ceres. They analyse a sample of 117 announcements for 195 publicly held US firms over the period 1993 to 2008. They collect articles and press announcement by searching Factiva, Lexis-Nexis Environmental. Then they search Factiva, Lexis-Nexis Academic and Google Finance on the day of the announcement and the surrounding days for articles and press releases with competing news that could potentially affect the stock price. In addition, they obtain financial and industry characteristics of the sample firms from the Centre for Research in Security Prices (CRSP) and COMPUSTAT. They use Carbon Disclosure Project (CDP) to classify industries based on their overall use of fossil fuels. They obtain environmental performance of the sample firms in the year prior to the announcement from KLD Research and Analytics. Their findings reveal that firms announcing membership in Climate Leaders experience a significant drop in stock price. Moreover, when firms as part of the CL program subsequently announce a specific goal for the reduction of their GHG emissions, their stock price declines further.

(Iwata & Okada 2011)

The paper examines the effects of environmental performance on financial performance. To define environmental profile, they use two different environmental issues of waste and greenhouse gas emissions. They analyse 268 Japanese manufacturing firms from 2004 to 2008. They collect data from three different sources. The data on waste and greenhouse gas emissions is collected from Corporate Social Responsibility Database released by Toyo Keizai, stock price data from "Kabuka" (Stock Price) CE-ROM 2010 provided by Toyo Keizai and other data (financial data) from NEEDS (Nikkei Economic Electronic Databank System) released by Nikkei Digital Media. Their findings confirm that

the effects of waste emission are not statistically significant to all financial performance. The effect of greenhouse gas emissions is significantly negative on ROA, ROI and ROIC. In addition, the effect of greenhouse gas emissions on ROE and ROS is insignificant. Greenhouse gas emission shows insignificant effect on Ln(Tobin's q) and significant negative effect on Tobin's q-1; which could be concluded that a decrease in greenhouse gas emissions leads to an increase in the value of intangible assets. Moreover, they investigate the effects of environmental performance on financial performance on two subsets of clean and dirty industries derived from their main sample. In the case of clean industry, waste emissions do not have significant impacts on financial performance except its significant negative effect on ROE, whereas greenhouse gas emissions have significantly negative impacts on financial performance. In the case of dirty industries, both waste and greenhouse gas emissions do not have significant impacts on financial performance.

(Lanoie et al. 2011)

The paper examines the association between firm performance and environmental performance. They define environmental R&D as environmental profile. They ask each firm whether their firm has environmental R&D budget. They collect data by using survey undertaken in seven OECD countries (Canada, France, Germany, Hungary, Japan, Norway and US) in 2003. The data cover facilities with more than 50 employees in all manufacturing sectors. Their findings present that existing budget for environmental R&D has positive impact on business performance of firm.

(Post et al. 2011)

The paper examines the role of board composition and corporate social responsibility to the environmental domain. They measure environmental corporate social responsibility (ECSR) in two different ways. Firstly, they use qualitative approach that is not out concern in this study. In the second approach, they use data from KLD dataset and calculate the following measures: i) KLD strengths which is the sum of the KLD ratings in the

environmental strengths; ii) KLD concerns which is the sum of the KLD ratings in the environmental concerns; iii) Total KLD which is the sum of environmental strengths from which we subtract the sum of environmental concerns. They analyse 78 firms in electronic and chemical sectors. They collect environmental data from KLD and data for board of directors composition from annual reports, Dun & Bradstreet, the Company Insight Centre of Business Week Online, Reuters, Lexus Nexus Academic, firms' websites, ECSR reports and social responsibility reports. Their findings confirm that only boards with high proportion of outside directors associated with KLD environmental strengths. In addition, the presence of three or more female directors on a board is associated with higher KLD environmental strengths scores. They could not report any other significant association between KLD strengths, concerns or Total KLD with mean average of directors, educated in Western Europe or having master degree or above.

(Rassier & Earnhart 2011)

This study provides empirical evidence regarding the short-run and long- run effects of Clean Water Act regulation on financial performance. To define environmental profile, they use the measure of clean water regulation, which is defined as the permitted wastewater discharge limits. They analyse 53 chemical manufacturing firms from US. They obtain financial data form COMPUSTAT and environmental data from EPA PCS or authorized state regulatory agencies on major chemical manufacturing facilities regulated as point sources within the National Pollutant Discharge Elimination System (NPDES) Program. Their analysis confirms a positive relationship between tighter clean water regulation and financial performance in both the short run and long run, with a stronger effect in the long run.

(Alvarez 2012)

The paper examines the impact of CO_2 emissions variation on firm performance. Environmental profile is represented by the variation (increase or decrease) in CO_2 emissions 2006-2007.They analyse 89 firms listed in Fortune 500 in year 2006 and 2007.

ROE for financial performance and ROA for operating performance are collected from annual reports presented by each firm on their websites. Data for CO_2 emissions are obtained from the sustainability reports, sustainable development report and corporate social responsibility report presented by each firm on its website. The findings confirm that emission variation in time period 2006-2007 does not impact financial performance measured by ROE in the following year, i.e. 2007 to 2010. In addition, an emission variation in time period 2006-2007 negatively affects operating performance (ROA) in 2007 and does not affect ROA in 2008 to 2010.

(Ameer & Othman 2012)

The paper examines the sustainability practices and Corporate Financial Performance of companies for the 100 top global firms in compare to the controlled companies. Unlike other studies, they do not use any environmental profile indicator(s). Their work is more focus on comparing the financial performance of 100 top sustainable global firms and other (controlling) firms. They analyse 100 top sustainable global firms in 2008. The name of firms is obtained from www.global100.org which is annual project of the Global Sustainable Research Alliance. They download firms' sustainability reports from firms' websites or the Global Reporting website www.globalreporting.org/GRIReports/. Financial data is obtained from Thomson financial Worldscope. Their findings confirm that the 100 top sustainable firms have higher Sales/revenue growth, ROA, Profit before tax (PBT) and Cash flow from operating activities.

(Böhringer et al. 2012)

The paper examines the impact of environmental investment, environmental and energy expenditure on production growth. To define environmental profile, they use environmental investment, environmental expenditure and energy expenditure. They define environmental investment as an increased investment in environmentally friendly technologies. They refer to increased expenditure due to higher environmental taxes, levies, monitoring or administrative cost as environmental expenditure. They analyse a

panel dataset of all firms in 23 sectors in German manufacturing industry. They collect all data from German Federal Statistical Office (StatistischesBundesamt) except ICT investment which is taken from OECD databases. Their analysis confirms that environmental investment has positive impact on production growth. While environmental and energy expenditure does not show a significant impact on production growth.

(Barnett & Salomon 2012)

The paper studies the shape of the relationship between Corporate Social Performance (CSP) and Corporate Financial Performance (CFP).To define environmental profile, they calculate net KLD score by aggregating the strengths and weaknesses ratings from KLD to create a net social performance score for each firm. The initial net KLD score measure varied from −12 to 15, with a mean of −0.43. In order to use quadratic net KLD score in their analysis they simply transform the net KLD score by adding 12 to each observation. They analyse 1214 publicly traded firms from 1998 to 2006. They collect financial data from COMPUSTAT and environmental data from KLD. Their analysis confirm that the impact of corporate social responsibility (net KLD score) on financial performance is U-shaped.

(Boiral et al. 2012)

The paper proposes an integrative framework for understanding the determinants of business strategies to reduce greenhouse gas emissions and the impact of these determinants on performance. They use GHG emissions performance as environmental profile indicator. They ask firms to rate the overall performance of your facility over the past three years relative to others in your industry on each of the following items: Regulatory compliance, air emissions levels and GHG emissions. They analyse a sample of 319 Canadian manufacturing firms. They collect data from a survey from firms with more than 20 employees. Their findings confirm that GHG emission performance has positive

impact on financial performance of firms, while economic motivation shows negative impact on GHG emissions performance.

(Hatakeda et al. 2012)

The paper examines the relationship between a firm's GHG emissions and its profitability in Japanese manufacturing firms. They analyse a sample of 1089 firms belongs to manufacturing industries in Section 1 and 2 of the Tokyo Stock Exchange (TSE) and the Osaka Stock Exchange (OSE) at the end of 2007. They collect data from databases contained in the Nikkei NEEDS-Financial Corporate Financials Database and the Corporate Attribute Database. Some data on corporate governance is collected from NEEDS-Corporate Governance Evaluation System, data for ISO 14001 adoptions from the Japanese Standards Association, the Japan Accreditation Board for Conformity Assessment as well as firms' webpages. GHG emissions data is obtained from the Greenhouse Gas Emissions Database which is publicly available by the Ministry of the Environment and financial data from Ministry of Finance. Their findings confirm that reducing GHG emissions has positive impacts on profitability.

(Hofer et al. 2012)

This paper examines whether a rival firm's past EM activity affects a focal firm's EM activity and how firm characteristics could affect this relationship. To define environmental profile, they use firm's Environmental Management (EM) activity. They measure EM activity as the sum of all relevant and statistically significant EM themes in the firm's corporate environmental report and, thus, represent the degree of a firm's overall EM activity. They analyse a sample of publicly listed firms in the US. They obtain financial data from COMPUSTAT and EM activity from corporate environmental reports. These reports are obtained from ResponsibilityReports.com, firms' websites or from the respective firms' public relations departments. Their findings confirm that the firm size measured as firm's sale has positive impact on the firm's EM activity. While, a firm with the greater firm's profitability measured as ROA shows the less EM activity. In addition,

the greater the focal firm's size, the lower the positive effect of a rival firm's past EM activity on the focal firm's EM activity. The greater the focal firm profitability shows the greater the positive effect of a rival firm's past EM activity on the focal firm's EM activity.

(Horváthová 2012)

The paper examines the impact of environmental performance on firm performance. To define environmental profile, they use environmental certificate and environmental performance which is calculated by dividing an absolute amount of emission for pollutant J ($P_{i,j,t}$) by a reporting threshold for pollutant J (RT_j) where $P_{i,j,t} \geq RT_j$.They analyse 1176 yearly observation firms from Czech Republic from 2004 to 2008. Environmental performance data is collected from the Integrated register of pollutant emissions (freely available at www.irz.cz) and data for missing years are available in the national registers (www.irz.cz), environmental managerial data are collected from publicly available database (www.iso.cz) and double-checking the websites of companies. Financial data are obtained from a commercial firm database CreditInfo. Their analysis indicates that higher emissions increase ROA in the subsequent year, but decrease financial performance after two years. In addition, environmental certificates have no impact on ROA. They report same result for ROE as financial performance indicator.

(Ionel-Alin et al. 2012)

This study investigates the impacts of good practice of corporate governance on environmental reporting. They define environmental reporting which represent the level of discussing emissions, energy sources and consumption, environmental incidents and violations, material use, mitigations and remediation, waste produced and water used. They analyse 54 firms on the Petroleum and Petroleum Refining sector lists. They collect environmental reporting data from the 2010 Sustainability Reporting of the World's Largest Petroleum Refining Companies published by Roberts Environmental Centre. They collect other data from 2009 annual reports or 2009 corporate governance report of the

analysed companies. The findings show that revenue could not explain the level of environmental reporting.

(Lioui & Sharma 2012)

The paper examines the impact of environmental corporate social responsibility (ECSR)on corporate financial performance. To define environmental profile, they build two aggregate measures related to firms' ECSR concerns and strengths. They analyse 17,465 firms from 1991 to 2007. They collect ECSR ratings data from KLD, and financial and accounting information from COMPUSTAT. Their findings confirm that environmental concerns and environmental strengths have negative and significant effects on financial performance measured by Tobin's Q or ROA. They also report that the interaction between environmental concerns, environmental strengths and R&D has positive and significant impact on financial performance measured by ROA. Then, they conclude that investors consider that ECSR has potential cost for their firms. However, investment in ECSR has a positive relationship with firms' investment in R&D.

(Nishitani & Kokubu 2012)

The paper examines the impacts of reducing greenhouse gas (GHG) emissions on firm value measured by Tobin's Q. To define environmental profile, they use Carbon dioxide productivity which is the ratio of net sales by carbon dioxide emissions. They analyse 641 manufacturing firms in Japan which were listed in 2009 on the First Section of the Tokyo Stock Exchange and meet the reporting requirements of Japan's mandatory GHG accounting and reporting system from 2006 to 2008. They collect financial data from Nikkei NEEDS Financial Quest, GHG data from the Japanese Ministry of the Environment and those concerning ISO 14001 adoptions are from the Japanese Standards Association, the Japan Accreditation for Conformity Assessment and firms' websites. Their findings confirm that the reduction of GHG emissions can enhance firm value.

(Uhlaner et al. 2012)

The study examines the engagement level of SMEs on environmental management based on internal characteristics of firms. To define environmental profile, they ask each firm whether their firms engage actively or deliberately (coded 3), passively (coded 2), or not at all (coded 1) in each of three activities: monitoring the amount of the company's waste; producing or selling environmentally friendly products; and searching for more environmentally friendly products, services or production methods. A scale was created based on the mean of the non-missing answers to those questions. They analyse 689 Dutch SMEs. The sample for this research was drawn from a representative panel of approximately 2,000 Dutch SMEs (defined as firms with a maximum of 100 employees),participating in a longitudinal study undertaken by a Dutch research institute for the Dutch Ministry of Economic Affairs. The firms were chosen randomly, but stratified by size class and sector. The survey took the form of a telephone interview conducted with either owner or director. The data used for the present study were collected in two waves (2006 and 2008). Their results confirm that larger SMEs are more likely than smaller SMEs to engage in environmental management practices. Although the analysis supports this hypothesis, the results indicate that this effect is indirect. It is most likely mediated by one or more of the other independent variables, including innovation orientation, perceived financial benefits and/or tangibility of sector.

(Walls et al. 2012)

The paper examines the link between corporate governance and environmental performance. To define environmental profile, they use Environmental concerns to capture pollution levels fairly well, and Environmental strengths to capture underlying strategic capabilities that firms develop to improve their environmental performance. They analyse a sample of 313 S&P500 firms in the primary and manufacturing sectors in 29 industries from 1997 to 2005. The collect environmental performance measures from KLD, Ownership data from Thomson/Reuters; shareholder activism and board characteristics from RiskMetrics. Their analysis confirms that firms with higher CEO salaries generally do less well environmentally. In general, ownership aspects of

governance are very relevant for environmental strengths, whereas board aspects are important for environmental concerns. Shareholder activism and shareholder concentration have a direct impact on environmental performance. Firms with poor environmental performance can expect investor activism to be rifer and firms with concentrated ownership have less freedom to pursue environmental activities. In addition, firms do not have good environmental performance when their boards are more independent, larger and less diverse.

(Fujii et al. 2013)

The study examines the relationship between environmental performance and economic performance. To define environmental performance, they use CO_2 emissions and toxic chemical substances emissions to calculate environmental efficiency (EE).They analyse Japanese manufacturing firms. They have two datasets. The first sample is 758 firms which have CO_2 emissions obtained from the GHG emissions accounting, reporting and disclosure system by the Ministry of Environmental Japan. Dataset covers 3 years of data from 2006 to 2008.They calculated EE_{co2} as the ratio of sale per CO_2 emissions. Second sample contains 2498 firms from 2001 to 2008 which has emissions from 134 toxic chemical substances. Data is collected from Pollutant Release and Transfer Registration (PRTR) from the Ministry of Economy, Trade and Industry in Japan. They calculated EE_{toxic} as Slaes divided by integrated risk score for PRTR emissions. Financial data is obtained from the Nikkei Economic Electronic Database Systems. Their findings confirm that the relationship between ROA and EE_{co2} is linear and positive. They report a linear and positive relationship between ROS andEE_{co2}. However, there is no any significant effect on Capital Turnover. Their results report an inverted U-shaped relationship between ROA and EE_{toxic}. EE_{toxic} has an inverted U-shaped relationship with Capital Turnover, while EE_{toxic} has a positive and linear relationship with ROS.

(Forsman 2013)

The paper examines the association between developed environmental innovations and the competitiveness of firms. They are mainly working on green innovator firms in Finland and their performance is examined over three periods of preceding period, development period and exploitation period. In addition, they distinguish between successful and unsuccessful innovators. They group firms into successful and unsuccessful innovators based on their performance using the sales growth during the exploitation period and the rate of operating earnings during the exploitation period. They analyse a sample of 128 Finnish firms from 2002 to 2010. These firms have developed one or more environmental innovations. The data covering nine years has been divided into three examination periods. The years from 2002 to 2004 represent the preceding period prior to the development innovations. The years from 2004 to 2007 are the development period and 2008 to 2010 is the period when the innovations have been exploited in business. The data which describes the developed environmental innovations and reports the preliminary results are obtained from TEKES (the Finnish Funding Agency for Technology and Innovation). The data of competitiveness is collected from the Public Trade Register. The data of Intellectual Property Rights (IPR) is obtained from the National Board of Patents and Registration of Finland. Their findings confirm that the sales growth of green innovators has been significantly higher during the development period than during the preceding period. In addition, the sales growth is significantly higher during exploitation period than during development period. Overall, during the exploitation period, the sales growth of green innovators is significantly higher than the average sales growth in their industrial sector. In terms of rate of operating earnings and ROA, there are not statistically significant differences among green innovators across the different examination periods. In addition, the equity ratio falls while the innovation process shifts from preceding period towards exploitation period. In addition, during the preceding period, the successful green innovators have better efficiency-related advantage in compare to unsuccessful green innovators. The successful green innovators keep their efficiency-related advantage better than unsuccessful innovators during the development period. In addition, during the exploitation period, the successful green innovators differ from unsuccessful innovators regarding the market-related, efficiency-related and risk-related advantages.

(Iatridis 2013)

The paper examines the association between environmental disclosure and environmental performance and financial characteristics of firms. They define environmental disclosure index which is based on GRI guidelines. The scoring index includes 95 equally weighted line items and consists of 7 main categories. The points obtained for each firm are summed and subsequently divided by the maximum points available to determine a percentage score of each company. The score range is between 0% and 100%.They analyse firms listed on Bursa Malaysia from 2005 to 2011. Data for environmental performance is collected from firms' annual reports and firms' websites. Accounting and financial data is collected from DataStream. Their findings confirm that the environmental disclosure score is positively associated with the percentage of independent directors sitting on the board of directors, the percentage of independent directors sitting on the audit committee of the board, the presence of an audit committee, managerial ownership, institutional ownership, changes in firm management and if firms are cross-listed. Moreover, environmental disclosure is value relevant measured as the stock price at the end of the year or market value scaled by book value of equity.

(Meng et al. 2013)

This paper examines whether economic performance could affect Environmental Information Disclosure (EID) and how the form of ownership determines the relationship. To define environmental profile, they use a score of Environmental Information Disclosure (EID), which is measured by environmental disclosure content and degree in detail. They use the following environmental regulations to measure the quality of corporate EID. (1) Information related to ISO environmental system authentication; (2) Lawsuit, atonement, penalty, and bounty related to environmental protection; (3) Influence of government environmental protection policy; (4) Firm's environmental protection policies, strategies, and goals; (5) Firm's environmental investment expenditure for technologies development; (6) Government appropriate funds finance

allowance and taxes abatement related to the environment; (7) Loans related to environmental protection; (8) Disposal and treatment of generated waste, recycling, and integrated utilization of waste products; (9) Construction and operation of environmental improvement; and (10) Other environmental-related information, such as environmental education, tree planting, biodiversity conservation, and other environmental projects to promote the public welfare. Each component is scored between 0 and 3 and thus each firm gain a score for its EID by sum up its scores for each component. They analyse 2360 manufacturing firms listed in the stock 'A' market of Shanghai and Shenzhen Stock Exchange from 2006 to 2008. They obtain data on environmental disclosure by content analysis from the listed firms' annual reports from the websites of Shanghai and Shenzhen Stock Exchange. The data on economic performance is collected from CSMAR database. Their analysis confirms that there is a positive relationship between economic performance measured by ROE and the level of EID under the voluntary settings. In addition, ownership moderates this relationship and such relationship is stronger for non-state owned firms under the voluntary setting. On the other hand, there is a negative relationship between economic performance measured by ROE and the level of EID under the mandatory regulation setting. Ownership is weakly moderates this relationship.

(Sariannidis et al. 2013)

The paper examines the robustness of financial performance for socially responsible firms to the increasing trend of global carbon dioxide emissions compared with the financial performance of equal size conventional firms. They use the Dow Jones Sustainability Index (DJSI) as a proxy for social and environmental responsible firms. In addition, they use concentration of CO_2 in the atmosphere as another environmental variable. They analyse more than 300 firms listed in financial, industrial, oil and gas, consumer goods and services sectors from 1999 to 2011. They use financial and environmental information provided by the Dow Jones Sustainability Index (DJSI).Their findings confirm that an increase in the carbon dioxide emissions affects in a negative way the stock price behaviour of socially responsible corporations.

(Amran et al. 2014)

This paper examines the role of the board of directors in sustainability reporting quality (SRQ) in the Asia-Pacific region. They use content analysis to construct a measure of the SRQ. Ten criteria modified from the index assessing a firm's disclosure and environmental reporting quality capture the SRQ measure, which are, i) adoption of sustainability reporting guidelines, ii) Independent verification/assurance about information disclosed in the sustainability report, iii) periodical independent verifications/audits on environmental and/ or social performance and/ or systems, iv) certification by environmental and/ or social (labor) program by independent agencies, v) product certification with respect to environmental impact and/ or product safety, vi) external CSR-related award, vii) stakeholder engagement in sustainability reporting process, viii) participation in voluntary CSR-related initiatives endorsed by Department of Energy and/ or Department of Employment and industry relation in respective country, ix) participation in industry specific association/ initiatives to improve environment and labor management practices, x) participation in other environmental and/ or labor organisations/ associations to improve environmental and/ or labor practices. Then each item of 10 items is scored and a maximum score 10 points is obtained if all the items existed in a particular sustainability report. They analyse 113 firms in 12 countries in the Asia-Pacific region in 2010. They use data from published sustainability reports, assurance statements and governance data from the annual report. Sustainability reports for firms in Asia-Pacific region is collected from the CorporateRegister.com, GRI report list and the Internet, while the annual reports are collected from the firms' websites. Their analysis confirms that board size has positive impact on SRQ, while board independence and higher proportion of female directors are negatively associated with SRQ. Moreover, the existence of a CSR committee is positively associated with SRQ.

(Chen et al. 2014)

This paper investigates the relationship between environmental management practices (EMPs) and firm performance in manufacturing companies in Sweden, China and India. To define EMPs, they use 33 EMPs in three main categories: i) Operational practices, ii)

Tactical practices, iii) Strategic practices. They define other specific EMPs such as recycling, waste reduction, remanufacturing, environmental design, specific design targets/goals, surveillance of market, environmental information, supply chain management, environmental standard for suppliers and environmental risk analysis. This study analyse the manufacturing industry with selected samples from 16 Swedish, 9 Chinese and 12 Indians firms. For each sample company, i) F0D8 The firm should belong to a manufacturing industry; ii) F0D8 The firm should originate from Sweden, China or India; iii) F0D8 The firm should have a GRI report in 2010. Data is collected from GRI reports and annual financial reports of the sample firms. Financial data for Swedish firms is double checked with data obtained from Affarsdata (Business data).Their findings show no correlation between operational, tactical, strategic or total EMPs with either Return on capital employed or Sales growth. Their further analysis also do not show any correlation between recycling, waste reduction, remanufacturing, environmental design, specific design targets/goals or surveillance of market with either Return on capital employed or Sales growth. Only environmental information has a positive strong correlation with sales growth. Supply chain management, environmental standard for suppliers and environmental risk analysis are negatively correlated with sales growth and none of them have any correlation with Return on capital employed.

(Frias-Aceituno et al. 2014)

The paper examines the effect of industry concentration, together with other factors, in the development of integrated reporting. They focus on whether firms disclose following reports on their web sites: financial statements, corporate social reporting or integrate all of them into single document, integrated reporting. They analyse 1590 international firms from Forbes Global 2000 list from 2008 to 2010. The sample is from 20 countries; however the majority of them are from USA (42.6%) and Japan (18.1%). They explore firms' websites to find out which one of the abovementioned reports. Their findings confirm that firm size; measured by total assets; ROA and level of concentration have a positive impact on the likelihood of producing the integrated sustainability and financial

reporting. On the other hand, business sector and firms' growth opportunities are not significant in this respect.

(Goktan 2014)

The study examines the relationship between Chief Executive Officer (CEO) compensation and green management practices. To define environmental profile, they use green states concept which is driven from following criteria listed in order of weight, used to formulate the Top 10 Greenest States in the Business Facilities Rankings Report 2008: i)Total Pollution Released by Pounds of Toxins; ii) Financial incentives for Energy Efficiency; iii) Financial Incentives for Renewable Energy; iv) Rules, Regulations, and Policies for Renewable Energy; v) Rules, Regulations, and Policies for Energy Efficiency; vi) Number of LEED-certified Buildings; vii) Number of Hazardous Waste Sites by State; viii) Total Air Emissions; ix) Percentage of People who Use Public Transportation. And also criteria equally weighted categories used to formulate America's Greenest States by Forbes Magazine: i)Carbon footprint; ii) Air quality; iii) Water quality; iv) Hazardous waste management; v) Policy initiatives; vi) Energy consumption. Finally, the states included in the top 15 of the two lists are included as green states in this study. They analyse US firms with 100 or more employees which had CEO pay and bonus records available. CEO base pay and bonuses data is collected from Hoover's (2008) database. The green states were identified based on Forbes listing of green states and 2008 Business Facilities Rankings Report. These states were also members of the Clean Energy States Alliance. Only the states included in the top 15 of the two lists were included as green states in this study. Their findings support a negative relationship between green management practices and CEO base pay. However, there is not any significant relationship between green management practices and CEO bonuses although the relationship is negative.

(Hourneaux et al. 2014)

The paper explores the use of Environmental Performance Indicators (EPIs) by industrial firms and to find out differences in the use of these indicators based on firms

characteristics. To define environmental profile, they adapted nine aspects from GRI report which are, i) Materials, ii) Energy, iii) Water; iv) Biodiversity, v) Emissions, effluents, waste; vi)Environmental aspects; vii) Environmental conformity; viii) Transport; ix) General environmental issues. Using factor analysis, they classify these nine aspects into two main groups, i.e. i) Production Direct Costs which includes Energy, Materials and Water ; ii) indirect costs and external influences which includes the remaining aspects. They analyse data for 149 firms in industrial sector in Sao Paulo State, Brazil in 2010. They send online questionnaires to the Board of Social Responsibility from CIESP. They also divide firms into small and large firms based on criteria determined by Brazilian Central Bank (BACEN).Their findings present that large firms will have a higher degree of use of EPIs than small firms. In addition, EPIs related to costs in production process have a higher degree of use by firms than other factors.

(Lewis et al. 2014)

The paper examines whether CEO characteristics such as education and tenure will influence firms' likelihood to voluntarily disclose environmental information. To define voluntary disclosing environmental information, they consider whether the firm responded publicly to the Carbon Disclosure Project. They analyse 589 US firms from 2002 to 2008. The main sample is collected from the Carbon Disclosure Project (CDP).They collect educational background and CEO tenure measures came from BoardEx. Where necessary, data are supplemented with Business Week's Executive Profile and Biography and company annual reports. Firms with CEOs who have MBA degrees are significantly more likely to disclose than are other firms. Conversely, we find that that firms led by CEOs with legal educations are more likely to resist pressures to disclose. Finally, we find that firms led by newly appointed CEOs are also significantly more likely to acquiesce.

(Pintea et al. 2014)

This paper analyses the existence of a connection among corporate environmental performance and financial position and performance of a company in developing countries such as Romania. To define environmental profile, they use CO_2 emissions. They analyse 14 Romanian firms from 2005 to 2010.They also compare the results in two time periods: the period of 2005 to 2007 before the financial crises and the period of 2008 to 2010 as the period of financial crises. The data is obtained from the site of BSE (Bucharest Stock Exchange), The National Pollutant Release, and Transfer Register. The study concludes that financial performance is not associated with environmental performance. The attitude of companies towards their performance is different, so we cannot sustain for sure whether or not the crisis has affected the relationship between environmental performance and the independent variables studied.

(Post et al. 2014)

This paper examines whether the presence of women and of independent directors on boards of directors is associated with higher corporate environmental performance. They measure two variables in relation to environmental profile; namely, corporate environmental performance and renewable energy alliance formation. For each firm in the sample, they aggregate, the KLD Environmental Strengths scores on an annual basis and calculate corporate environmental performance. They analyse the content of all alliance formation announcements to identify alliance for renewable energy technology for each firm. Then for each firm, they count the number of renewable alliance that the firm engaged in on a yearly basis. They analyse a sample of 36 publicly traded oil and gas firms headquartered in the US that were listed on the 2009 Forbes.com Special Report, The Global 2000. They obtain information for environmental performance from KLD, announcement regarding renewable energy alliance from the Lexis-Nexis search and women directors and independent directors from Bloomberg Research and corporate websites. Their findings confirm that increasing the number of female directors on the board lead to increasing the likelihood of engaging in a renewable energy alliance. The representations of independent directors on a board also increase the likelihood of engaging in a renewable energy alliance. Moreover, the renewable energy alliance

mediates the positive relationship between female board representation on the board and corporate environmental performance. The renewable energy alliance mediates the positive relationship between independent director representation on the board and corporate environmental performance.

(Qi et al. 2014)

The paper examines the direct effect of industrial Environmental Performance on Financial Performance and the indirect effects of industrial munificence and resource slack on the Environmental Performance-Performance link in Chinese industry. To define environmental profile, they use the industry environmental emission intensity (SO2E)as a proxy variable for measuring each industrial environmental performance. They use the presence of munificence (Munificence) in industry environments in terms of shipment value growth rate. They analyse data on all Chinese industrial sectors, including mining, manufacturing, electricity, gas and water at the two-digit SIC level. They collect environmental emissions and financial data from the China Economic Information Network database (EIN) from 1990 to 2010.Their findings confirm that SO2E positively correlated with financial performance of firms measured by ROA. In addition, SO2E does not have positive influence on ROA is not positive where environmental munificence is high.

(Tao & Zhang 2014)

The study examines the relationship between environmental performance and financial performance of heavy polluting industries. To define environmental profile, they define indicator system of environmental performance and then weight each index in the index system. The first level indicators are: i) resource input, ii) pollutants emission, iii) environmental investment, iv) environmental management. They analyse 84 A-share listed firms in Shenzhen and Shanghai stock markets of eight heavy polluting industries who disclosed Social Responsibility Reports from 2009 to 2011. They collect data to measure environmental performance from annual reports and social responsibility

reports are mainly from Sina and Juchao network. If data is not available in both annual reports and social responsibility reports, they collect data from the state environmental protection administration and the local environmental protection agency. Corporate financial data are primarily from GTA database. The results show that, there is no correlation between environmental performance of listed firms and corporate financial performance for the year, but there is a positive correlation between environmental performance of listed firms and corporate financial performance of next year.

(Zou et al. 2014)

The paper investigates whether firms use environmental performance as a criterion in incentive schemes for top executives in China. To define environmental profile, they develop a measure of environmental performance (EP) using the information about country-level, local-government, or third-party awards, social environmental lawsuits, and environmental violation disclosures, which are strong indicators of environmental performance. Each item with a score is multiplied by a weight constructed according to the degree of its influence and severity. Finally, the environmental performance (EP) is the sum of weighted score of environmental behaviours. Positive and Negative EP, are employed, defined as the summed weighted score of positive and negative environmental behaviours respectively. They analyse the manufacturing firms listed in the Stock "A" markets of the Shanghai and Shenzhen stock exchanges in China. These data for the sample firms are collected from the China Stock Market and Accounting Research (CSMAR) financial database. Environmental data is extracted using content analysis from annual reports and separate China Security and Regulations (CSR) reports from the websites of the Shanghai and Shenzhen stock exchanges. The information on environmental violation events (EVEs) and environmental awards is confirmed and complemented by the websites of government offices at different levels and by the media. The sampled firms and relevant information used in calculating HHI are derived from the Annual Industrial Survey Database of the Chinese National Bureau of Statistics (CNBS)which contains the most comprehensive information about domestic and foreign-owned firms in China. Their findings confirm a positive association between top

executives' compensation and environmental performance. Moreover, environmental performance has less impact on top executives' pay as the presence of independent directors on boards increases. The association between environmental performance and top executives' compensation is stronger in firms with larger boards. The greater the equity held by directors on the board, the weaker the relationship between top executives' pay and environmental performance. CEO-chairperson duality strengthened the relationship between top executives' compensation and environmental performance. In addition, it is shown that both positive and negative environmental behaviours are significant and positively related to top executives' compensation.

3.3 Discussion on dimensions of Comparisons

In section 3.2 a review of studies examining the link between EP and FP is presented. For each study the following set of aspects are discussed: the aim of study, the definition of EP, characteristics of sample and data sources and finally the findings in relation to EP and FP. In this section, in contrast to the specific reviews of individual papers, the focus is in presenting and discussing the patterns we can see among studies namely, data-related characteristics, EP, FP, findings and endogeneity.

3.3.1 Datasets

Once a researcher formulates a research question, a set of decisions need to be made with respect to the research design including the one about data collection. Research in business and organisational studies employs various types of data sources and data collection methods. Respectively, researchers do not rely on a single source of data and usually use variety of data sources and data collection methods in investigating the relationship between EP and FP.

Figure 3-1 presents the three main data sources identified within the related studies in this literature survey, namely primary data source, secondary data source and mixed data which is the combination of primary and secondary data sources.

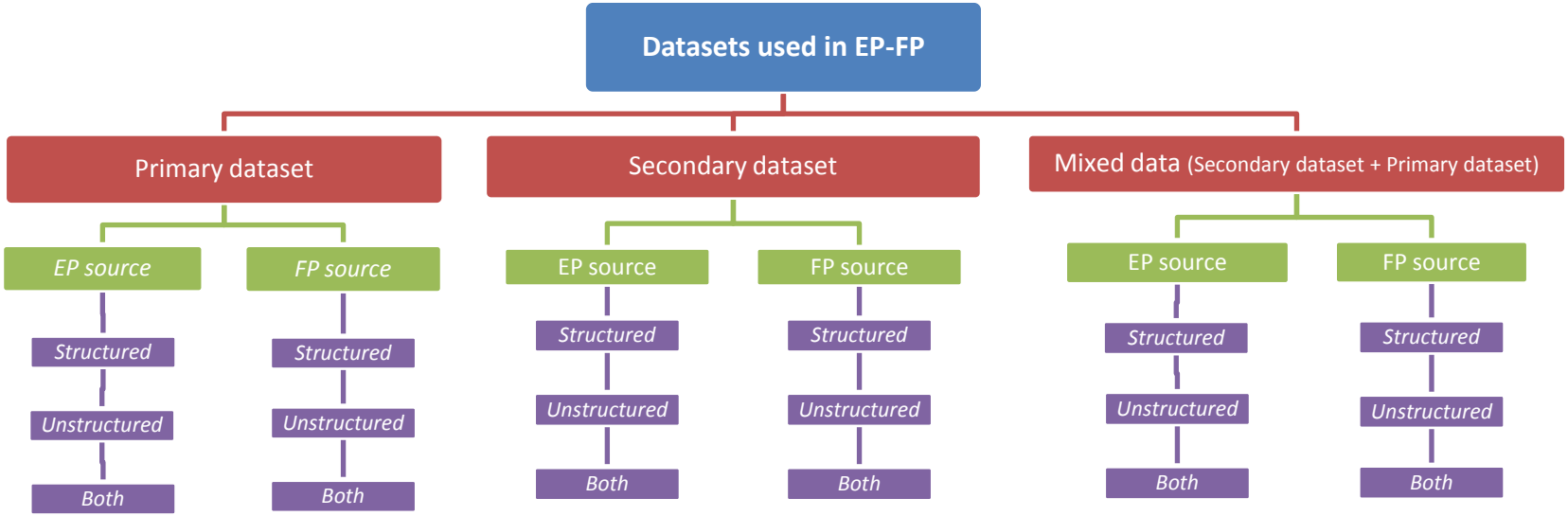

Figure 3-1. Identified data sources within the reviewed studies in relation to EP-FP

Primary data

As shown in Table 3-3, the list of the relevant literature and dataset characteristics is presented. These studies use the primary data which is mainly collected by questionnaire. We believe that the main justification for using primary data is that these studies are conducted in countries with limitation of data availability, i.e. Canada [2010-3[2012-5], the Netherlands [2012-13], OECD countries [2009-4][2011-6] and Europe [2009-3]. Another possible reason is that they are looking on a specific sector such as SMEs in [2012-13]. However, the majority of studies focus on manufacturing firms because of their social and environmental effects which some of their operations have on the climate change and people. In addition, these firms are more committed to the regulations and willing to release the relevant information.

Paper No.	Sample size	Country coverage	Sector	Measurement of construct
[2009-3]	101	Europe	Manufacturing, Services, other sectors	Measurement scale [1 to 5]
[2009-5]	240	Spain	Hotel	Measurement scale [1 to 7]
[2009-4]	4144	OECD	Manufacturing	Measurement scale [0 to 1]
[2010-3]	303	Canada	Manufacturing	Measurement scale [1 to 7]
[2011-6]	4144	OECD	Manufacturing	Measurement scale [0 to 1]
[2012-13]	689	the Netherlands	SMEs	Measurement scale [0 to 1]
[2012-5]	319	Canada	Manufacturing	Measurement scale [1 to 5]

Table 3-3. Overview of dataset characteristics in studies using primary dataset

Furthermore, using questionnaire causes that both EP and FP are measured via perceptual instrument. In addition, the locality nature of primary data prevents generalisability and further analysis.

Secondary data

A large number of studies have used datasets which have been initially collected for other purposes. This type of dataset is usually known as a secondary dataset. In this paper, we

consider firms' webpages, annual reports or other type of corporate reports as a secondary dataset.

To this end, we map the main variables of each studies to the relevant data sources and then determine whether studies use structured, unstructured or both type of structured and unstructured data sources. The main justification behind this assumption is that a structured data source provides quantified variables for the research but unstructured does not. Instead, a mechanism is required to extract/generate variables from unstructured data sources, which is usually content analysis or manual search. Once a data source contains both structured and unstructured data (e.g. Carbon Disclosure Project (CDP)), we consider whether an EP variable belongs to which part of a data source. In following, we discuss FP and EP data sources separately. Table 3-4 presents an overview of studies using secondary datasets.

FP Profile data sources

There are some data repository and research platforms, which collect specific historical data for a specific region (e.g. North America), or a country, (e.g. UK or Germany) from various independent sources. Data comes from these kind of data services is usually structured. Data validation, integrity and consistency of data allow academic and quantitative researcher to access to bias-free information. Access to this type of data allow researcher to replicate the analysis of previous studies in order to evaluate and compare their findings.

Financial performance reporting is relatively well established. Companies are required to submit their financial performance reports based on the financial standards set out in the country /region at the end of each year. There are various sources to access to such financial information such as their webpages, their annual financial reports, and corporate social responsibility reports among others. Therefore, some studies extract financial profile variables from such sources using either content analysis (e.g. [2014-1]) or manual search (e.g. [2014-3]). In addition, depends on the selected sample, some studies first rely on structured data sources to get data and then attempts to obtain the

unreported data from unstructured sources, or sometimes use unstructured data sources for cross checking purposes. Studies using (partially) unstructured data could be criticised in terms of evaluating source of information, data extraction methodology, difficulties in repeating the same analyse, access to historical data and consequently the impacts of data errors on the results of analysis.

EP Profile data sources

There is a great variability in environmental profiles' data sources. Each source of environmental data contains different variables due to differences in data collection, measurement and reporting. This makes it difficult to compare data.

Another difficulty is that a number of studies use firms' webpages and various corporate reporting as a source of environmental information. They use either content analysis (e.g. [2011-3]) or manual search (e.g. [2014-10]) to extract the needed information.

Those studies that use structured EP data sources; they are focusing on industrial sectors, manufacturing or energy intense sectors. They are mainly using panel data for their analysis.

Considering the country coverage of studies, we could assume that studies focused on a specific country like Japan or the US are more likely to collect and report firms' environmental data. For example; in the case of Japan, the focus is on manufacturing firms and there are two main sources of environmental data which are the Japanese Ministry of the Environment and Nihon Keizai Shimbun who develop Nikkei Environmental Management Survey. As a result, there is a potential of research based on the available structured data for both EP and FP in Japan.

Recently, 4 studies analyse a sample of Chinese firms which mainly using unstructured datasets such as social responsibility reports, annual reports, and websites of government offices. There must be some reasons like geographical expansion or business model or simply not publicly environmental data, which lead these studies to collect data themselves [2013-4][2014-9][2014-10][2014-11].

In the case of research on a range of firms from different countries, it is more likely to collect environmental data from structured data sources, while researchers need to collect data from unstructured sources for Asian countries.

There are 22 out of 60 studies using a sample of US firms. The KLD, EPA and IRRC Corporate Environmental Profile are the structured datasets that widely have been used by these studies.

Event studies are a subset of studies which are using secondary datasets [2005-4][2008-6][2010-4][2010-5][2011-4]. As a measure of financial profile, stock return has been used to measure the market reaction to the announcement of environmental performance. In all studies, stock return is obtained from structured dataset. In the collection of announcement of environmental performance, some studies use a specific data source to collect data (e.g. collect environmental incidence information from GES in [2010-5]), while others search various keywords and expression on different sources. The main point is that time; event window; and space are important factors in event studies.

Paper No.	*Dataset*	*Financial Profile*	*Environmental Profile*	*Year*	*Sample size*	*Sector*	*country/ region*	*Replicability*	*FP data sources* (Structured/ Unstructured/ Both)	*EP data sources* (Structured/ Unstructured/ Both)
2014-1	GRI	CSR strategy, CSR committee	SRQ	2010	113		Asia-Pacific	No	Unstructured	Unstructured
	AR	Board composition, firm size, board independence, gender diversity,	SRQ							
	CR	CSR strategy, CSR committee	SRQ							
2014-2	Unknown	ROCE, Sales growth		2010	37	Manufacturing	Sweden, India, China	No	Unstructured	Structured
	GRI		Environmental information, Supply chain management, Environmental standard for suppliers, Environmental risk analysis, Other EMPs (operational, tactical, strategic and total EMP, recycling, waste reduction, remanufacturing, environmental design, specific design targets/goals, surveillance of market)							
2014-3	FW	firm size= log(Total Assets), ROA, Growth opportunities, Concentration (Herfindahl index)		2008-2010	1590		International firms	No	Unstructured	Structured
	SDD		Integrated sustainability and financial reporting							
2014-4	ForbesGS/ BF RR		Green management	2008		semiconductor, energy and	US firms	No	Structured	Structured

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
	Hoover's	CEO base pay, CEO bonuses				utilities, telecommunication equipment, chemicals, computer software, metals and mining, apparel retail, telecommunication services, consumer services, restaurant, and agriculture industries				
2014-6	CDP		The firm responded publicly to the Carbon Disclosure Project	2002-2008	589		US	No	Unstructured	Structured
	BoardEx/ AR/ BW EPB	CEO Tenure (New CEO), CEO educational degree (MBA, Legal degree), New CEO								
2014-7	BSE	Expenditure, Income, ROA, ROE, Total Assets, Profit, Equity		2005-2010	14		Romania	Yes	Structured	Structured
	NPRTR		CO2 emissions							
2014-8	KLD		Corporate environmental performance (Based on KLD)	2004-2008	36	Oil and Gas	US	No	Unstructured	Both
	Lexis-Nexis search engine		Renewable energy alliance formation							
	Bloomberg Research / FW	#female directors, #independent directors								

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
2014-9	EIN	ROA	Industry environmental emission intensity (SO2E), Environmental munificence (= industry environments in terms of shipment value growth)	1990-2010	39	Industrial	China	Yes	Structured	Structured
	China ISY		Industry environmental emission intensity (SO2E), Environmental munificence (= industry environments in terms of shipment value growth)							
2014-10	GTA database	Tobin's Q		2009-2011	84	Heavy polluting industries	China	No	Structured	Unstructured
	AR/ SRR/ SEPA/ Local EPA		Environmental performance							
2014-11	CSMAR	Compensation, Director independence, board size		2008-2010	687	Manufacturing	China	No	Structured	Unstructured
	AR/ SCSRR/ GovWeb		EP (overall Environmental Performance), Positive EP (sum of weighted score of positive environmental behaviour), Negative EP (sum of weighted score of negative environmental behaviour)							
2013-1	TEKES		successful and unsuccessful innovators, green innovators, Preceding period (Pre), development period (Dev), exploitation period (Post)	2002-2010	128		Finland	No	Structured	Structured
	PTR	Sales growth, Rate of operating earnings, ROA, Equity ratio								

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
	FinnishNBPR	Technology-related IPRs, Market-related IPRs								
2013-2	RDS-JapanME		EE_{co2} = sales/ (CO_2 emissions)	2006-2008, 2001-2008	758+ 2498	Manufacturing	Japan	Yes	Structured	Structured
	NEEDS	ROA, ROS, Capital turnover								
	PRTR		EE_{toxic} = sales/Integerated risk score for PRTR emissions							
2013-3	FW/ AR		EDS= GRI-based environmental disclosure score and proxies for environmental disclosure quality	2005-2011	529	Environmentally sensitive	Malaysia	No	Structured	Unstructured
	Datastream	%Independent directors, %Independent directors on the Audit committee, Existing audit committee, Managerial ownership, institutional ownership, Changes in the management, Firms is cross-listed, Stock price, MBV=Market value scaled by Book value								
2013-4	CSMAR	ROE, Ownership		2006-2008	2360	Manufacturing	China	No	Structured	Unstructured
	AR		Environmental Information Disclosure (EID)							
2013-5	DJSWI	stock price behaviour, stock return	DJSI (DJ Sustainability Index), CO2 (concentration of CO2 in the atmosphere)	1999-2011	>300	financial, industrial, oil and gas, consumer goods and services sectors		No	Structured	Structured

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
2012-1	AR	ROA, ROE		2006-2007	89			No	Unstructured	Unstructured
	SR		Variation (increase or decrease) in CO2 emissions 2006-2007							
2012-2	Worldscope	Sales/revenue growth, ROA, Profit before tax (PBT), Cash flows from operating activities (CFO)		2006-2010	100			No	Structured	Unstructured
	GRI/ FW		The Global most sustainable firms							
2012-3	Destatis	GVA	Environmental expenditures, Environmental investment, Energy expenditures	1996-2002		Manufacturing	Germany	No	Structured	Structured
2012-4	KLD		net KLD score (=aggregate the strengths and weaknesses ratings from KLD)	1998-2006	1214		US	No	Structured	Structured
	COMPUSTAT	ROA, Net income								
2012-6	GHG Database		GHG emissions	2007	1089	Manufacturing	Japan	Yes	Structured	Structured
	NEEDS FinancialQUEST/ NEEDS-CAED/ Ministry of Finance	Profitability = after-tax cash flow								
2012-7	COMPUSTAT	Firm size (firm's sales), ROA		2007-2009			US	No	Structured	Unstructured
	CER-ResponsibilityReports.com/ CER-FW/ CER-PR		Firm's EM activity							

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
2012-8	CreditInfo	ROA, ROE		2004-2008	1176		Czech Republic	No	Structured	Structured
	www.irz.cz		Environmental performance =(absolute amount of emission for pollution J)/(reporting threshold for pollution J), if emissions are higher than threshold							
2012-9	AR/ 2009 corporate governance reports	Revenues ($Million)		2010	54	Petroleum		No	Unstructured	Unstructured
	SR-RobertEC		Environmental reporting							
2012-10	KLD		Environmental concerns, Environmental strengths	1991-2007	17,465			No	Structured	Structured
	COMPUSTAT	ROA, Tobin's Q								
2012-11	NEEDS FinancialQuest	Tobin's Q		2006-2008	641	Manufacturing	Japan	No	Structured	Structured
	Japanese Ministry of the Environment		Carbon dioxide productivity							
2012-12	KLD		Environmental strengths, Environmental concerns	1997-2005	313	Primary and manufacturing	US (S&P500)	Yes	Structured	Structured
	RiskMetrics	Board Independence, Board size, Board diversity								
	Thomson/Reuters	Shareholder activism, Shareholder concentration								
	Execucomp	CEO salary, CEO bonus								
2011-2	Gov-Score data	Gov-Score		2003-2005		Major emitter of Toxic Emissions	US	No	Structured	Unstructured
	FW/ ER		Environmental disclosure, Risk-related metric (RRR)							

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
2011-3	KLD		Total environmental strengths	2003-2004			US	No	Structured	Structured
	Board Analyst	#independent director, CEO Duality, director appointed after CEO, CEO-director ownership, insider-director ownership, outsider-director ownership, Board size, multiple directorships, active CEOs, law experts, board tenure								
2011-4	COMUSTAT	CAR		1993-2008	117		US	No	Structured	Unstructured
	EPA CLP/ Ceres/ Factive/ CRSP/ Lexis-Nexis Environmental		Firms' announcing their participation in one of two voluntary environmental programs: the EPA's Climate Leaders (CL) program and Ceres							
2011-5	NEEDS	ROE, ROA, ROI, ROIC, ROS, Tobin's q-1, Ln(Tobin's q)		2004-2008	268	Manufacturing	Japan	Yes	Structured	Structured
	Toyo Keizai CSR		Waste, Greenhouse gas emissions							
2011-7	KLD		KLD strengths, KLD concerns, Total KLD = KLD strengths-KLD concerns	2006-2007	78	Electronic and Chemical		No	Unstructured	Structured
	Dun & Bradstreet/ Reuters/ Lexus Nexus Academic/ FW	Gender, Age, Western European education, Educational attainment								

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
	CIC-BW	Insider/outsider directors								
2011-8	COMPUSTAT	ROS			53	Chemical manufacturing	US	No	Structured	Structured
	EPA PCS/ NPDES		The permitted waste water discharge limits							
2010-1	ASPEKT	Revenue, Costs, Profit, Operating profitability		1996-1998	429		Czech Republic	No	Structured	Structured
	REZZO-1 database		Air emissions (carbon monoxide, sulphur dioxide, particulate matter, nitrous oxides)							
2010-2	NEEDS QIT	Market value (intangible assets), Replacement costs, Tobin's Q		2003-2004	804	Manufacturing	Japan	No	Structured	Structured
	Japanese Ministry of the Environment		Toxic chemical data							
	Variuos DS		Risk information (Carcinogenicity, Chemical pollution)							
	Nihon Keizai Shimbun		Nikkei index							
2010-4	Unknown	Abnormal return (a linear relationship between the return on a stock and the market return)		2004-2006	780			No	Unstructured	Unstructured

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
	major business wire services, the ten most widely circulated US daily newspaper, The leading European business daily, Dow Jones World Sustainability Index (DJSI World)		417 announcements of corporate Environmental Initiatives (CEIs), 363 announcements of Environmental Awards and Certifications (EACs), CEIs subcategories: Environmental business strategies, Environmental philanthropy, Voluntary emission reductions, Eco-friendly products, Renewable energy, Recycling, Miscellaneous, EACs subcategories: ISO 14001, LEED, award categories (federal, state or local government, non-government)							
2010-5	GES		Environmental incidents	2003-2006	74		International firms	No	Structured	Structured
	Datastream	Firm value								
2010-6	FS	Firm size(log(Total Assets)), Industry membership, profitability(Return on Equity), quotation on the Stock Market, foreign ownership		2002-2004	109		Portugal	No	Unstructured	Unstructured
	AR		Environmental Disclosure Index (EDI)							
2010-7	CDP		CDLI	2008	283		Global Equity Index	No	Both	Unstructured
	FW/ Forbes website/ Spencer & Stuart indices	% Independent directors, CEO duality, Diversity,								
2010-8	EPA PCS		Permitted discharge limits					Yes	Structured	Structured

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
	COMPUSTAT	Tobin's Q								
2010-9	COMPUSTAT/ Worldscope Disclosure/ BankOne	Tobin's Q		1992-2003	3697		US	No	Structured	Structured
	KLD		Overall sustainability performance index comprising all KLD strengths and concerns							
2009-1	Execucomp	CEO total pay		1997-2003	469		US	No	Structured	Structured
	SEC		Environmental governance							
	EPA TRI		Pollution prevention measure, end-of-pipe pollution control							
2009-2	Management Today's BMAC survey	Tobin's Q, ROA	corporate environmental policy, Environmental reporting	1994-2000	227		UK	No	Structured	Structured
2008-1	Execucomp	CEO compensation		1996	172		US (S&P500)	Yes	Structured	Structured
	IRRC CEP		IRRC spill index, IRRC compliance index, emission index							
2008-2	KLD		a sub-index of environmental strengths, a sub-index of environmental concerns, a global environmental index, Environmental Leaders, Environmental Laggards, dirtier service industries, cleaner service industries	2004	12228	Service sector		Yes	Structured	Structured
	Thomson Baseline database	NPM								

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
2008-4	EPA TRI/ KLD		Environmental Risk management	2000	267		US (S&P500)	No	Structured	Structured
	Research Insight	Beta (covariance of the market's returns)								
	COMPUSTAT	Tax shield from debt, Beta (covariance of the market's returns), Dispersed share ownership, Percentage of institutional shareholders, Cost of debt capital, Cost of equity capital, Weighted average cost of capital								
2008-5	CDP		Disclosing information about climate change through the Carbon Disclosure Project (CDP)	2007			US (S&P500)	Yes	Structured	Structured
	COMPUSTAT	Tobin's Q, Leverage, Firm size (=Ln(Total Assets)), Foreign sale, profit								
2008-6	Datastream	Stock price		1998-2006	69		Japan	Yes	Structured	Structured
	Nikkei EMR		Announcement of Nikkei Environmental Management Ranking survey							
2007-1	AMADEUS/ FS/ Corporate Disclosure	Growth of profit before tax		1998-2004	110		Europe	No	Both	Structured
	DJSI		CSR = Firms belong to Dow Jones Sustainability Index (DJSI)							

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
	DJGI		non CSR = Firms belong to Dow Jones Global Index (DJGI) but not on the DJSI							
2007-2	Nikkei EMR		Environmental performance score	2002-2003	121	Manufacturing	Japan	No	Both	Structured
	FR/ Kaisha Shikiho/ Nikkei Financial Data CD-ROM/ FR	ROA, Tobin's Q-1, earning per share								
2006-1	PIRC ER		DISCLOSE, QUALITY	1999-2002	447		UK	No	Structured	Structured
	Datastream	Firm size (Ln(Total Assets), share ownership, ROTA (return on Total Assets), leverage, NONEXEC (the number of non-executive directors)								
2006-2	Nihon Keizai Shimbun		Overall environmental management performance	1999	400		Japan	No	Structured	Structured
	Toyo Keizai Shinpo	Firm size(total employment),Total factor productivity (TFP), The ratio of debt assets, Marketing intensity,Avg. age of employees								
2005-1	Datastream	Market return, Leverage		1992-1998	55	non-financial	Germany	No	Structured	Unstructured
	AR	Market return, Leverage	Environmental disclosure quality							
	ER-Antwerp University library		Environmental disclosure quality							
2005-2	Datastream/ FAME	Tobin's Q, ROA, ROS		1994-2000	227		UK	No	Structured	Structured

Paper No.	Dataset	Financial Profile	Environmental Profile	Year	Sample size	Sector	country/ region	Replicability	FP data sources (Structured/ Unstructured/ Both)	EP data sources (Structured/ Unstructured/ Both)
	Management Today's Survey of BMAC		The community and environmental responsibility (CER) score							
2005-4	Green Rating Project of CSE		the announcement (event) of environmental performance		50	Pulp and paper, auto firms, Chlor alkali firms	India	No	Structured	Unstructured
	PROWESS CMIE/ BSE "Sensex"	Average cumulative abnormal return								
2005-5	Trust Database of Bonnier-Findata	net income		2000			Sweden	No	Unstructured	Structured
	CC, AB		Environmental Performance Index							
	FS	net income								
2005-7	FS	ROCE, ROE, ROS			571	Pulp and paper-manufacturing sector	Germany, Italy, the Netherlands, the UK	No	Unstructured	Structured
	Pollutant release and transfer registers (e.g. the Dutch Emissions Register for Industry (ER-I), EPA TRI, The UK Pollution Inventory)		Emission of chemical oxygen demand per output COD), Emission of sulphur dioxide per unit of output (SO2), Emission of nitrogenous oxides per unit of output (Nox), Total energy input, Total water input, **inputs-based index, outputs-based index**							
2004-1	CEPD		Environmental Performance (Toxic waste recycled /total toxic waste generated)	1994	198		US (S&P500)	Yes	Structured	Structured
	COMPUSTAT	Industry-adjusted annual stock return								
2004-2	10-Ks	Market value		1989-2000	29	Pulp and paper		Yes	Structured	Structured

Paper No.	*Dataset*	*Financial Profile*	*Environmental Profile*	*Year*	*Sample size*	*Sector*	*country/ region*	*Replicability*	*FP data sources* (Structured/ Unstructured/ Both)	*EP data sources* (Structured/ Unstructured/ Both)
	EPA PCS/ EPA TRI		ECE (Environmental Capital Expenditure), EP (TRI)= the release and transfer of toxic chemicals from manufacturing facilities, EP(BOD)= the ratio of the sum of the BOD discharges across the firm's mills divided by the sum of mill BOD discharge limits. POLLUTE= Median (EP(TRI) or EP(BOD))							
2004-3	CEPD		IRRC Compliance Index	1996-1998	24	Electrical industry	US (S&P500)	Yes	Structured	Structured
	The Summit Investment Partnership	Market value								

Table 3-4. Overview of dataset characteristics in studies using secondary dataset

Mixed data (Secondary dataset and Primary dataset)

The last set of studies is using both primary and secondary data sources to obtain variables [2005-6][2005-3][2008-3][2011-1][2014-5]. Table 3-5 presents an overview of dataset characteristics. All studies are using secondary datasets for FP except [2005-6] who wants to know whether the environmental quality manager or the plant manager had a portion of salary tied to environmental performance or not. Moreover, except [2005-6] who uses EPA TRI for EP, other studies use questionnaire to collect the necessary data to measure EP. So far, all of them use measurement scale to quantify the perception of participants. The reason may be due to the selected sample from specific country (countries) for a specific sector. In addition, we can see that all of them just analyse one year, it is not panel data.

Paper No.	Sample size	Sector	Country coverage	Year	EP data source(s)	FP data source(s)
[2014-5]	149	Industrial sector	Brazil	2010	**Structured:** Questionnaire (7-points scale)	**Structured:** Brazilian Central Bank (BACEN) database
[2011-1]	174	Carbon and energy-intense industries	EU, North America, Japan, Rest of the World	2007	**Structured:**Questionnaire, Cross-checked with: CDP, Sustainable Asset Management, Official firms' reports	**Structured**: COMPUSTAT
[2008-3]	60	Manufacturing firms (the chemical and paints industry group, the automobile and tyre group, and breweries)	Nageria	[1997-2006]	**Structured**: Questionnaire	**Structured:** Financial statements of firms, questionnaire
[2005-3]	186	Chemical products, electronic and electrical equipment and furniture and fixtures industries	Spain	2002	**Structured:** Questionnaire (But they use various scales of measurement like 1 to 6, 1 to 5)	**Structured:** Dun& Bradstreet 2002 database
[2005-6]	169	Electronic plants	US	1999	**Structured**: EPA TRI	**Structured**: Survey

Table 3-5. Overview of dataset characteristics in studies using mixed dataset

3.3.2 EP variables

EP variables vary in previous studies due to different data availability and relatively lack of standardise environmental reporting. EP is multidimensional and as it is shown in Figure

3-2, we can distinguish between three concepts, which are Environmental Management, Environmental Performance and Environmental Disclosure.

Environmental Management addresses a firm's attitudes and objectives towards environmental responsibility as well as environmental management structure and processes (Schultze & Trommer 2012). In this category, variables mostly refer to environmental strategy, integration of environmental issues into strategic planning processes, environmental practices, process-driven initiatives, product-driven management systems, ISO 14001 certification, environmental management system (EMS) adoption, and participation in voluntary programs (Molina-Azorín et al., 2009)(Schultze&Trommer, 2012).

Environmental performance is the outcome of a firm's strategic activities that manage (or not) its impact on the natural environment (Walls et al. 2011). Environmental performance evaluates environmental impacts in physical and monetary terms (Albertini 2013). This group comprises of many variables, which could be categorise as input-based (e.g. resource consumption, total energy input) and output-based variables (e.g. GHG emissions, waste). Following this definition, we can clearly notice that there is a misunderstanding between environmental management and environmental performance. For example, a number of studies use KLD scores (usually KLD environmental strengths, KLD environmental concerns) as environmental performance. While by considering the variables, we can conclude that they are mainly targeting environmental practices. Therefore, in this study, we consider KLD measures as part of environmental management category. The breakdown of EP variables in studies into input-based and output-based variables is presented in Figure 3-2.The number of studies that employ each FP measure is mentioned in front of them. We can see that CO_2 emissions and GHG emissions are the most popular FP measures.

Environmental Disclosure is defined as disclosures that describes the impact firm activities have on the physical or natural environment in which they operate (Wilmshurst & Frost 2000). Albertini (2013, p.435) summarises the variables mostly refer to them as environmental disclosure in the previous studies, namely; (i) Information releases regarding toxic emissions; (ii) Environmental awards; (iii) Environmental accidents and

crises, (iv) Environmental investment announcement. In total 17 out of 72 studies use environmental disclosure variables. After careful consideration, we specify a category of variables, which are trying to capture the quality of released information rather than releasing the information regarding the toxic emissions. Therefore, we introduce new category of environmental disclosure variables which is called “environmental disclosure quality”. The breakdown of the studies in the above-mentioned categories is presented in Figure 3-2.

3.3.3 FP variables

Previous studies employ variety of FP variables to examine the relationship between EP and FP. One of the important questions is that how the selected FP variable might affect analysing the relationship between EP and FP.

Overall, we can classify the FP variables into two major groups, namely, perceptual and quantitative/ quantified measures. Perceptual measures are those obtained through questionnaire and it is likely to present the participants’ points of view about financial performance of their firms. In contrast, quantitative measures are presenting numeric information about financial profile. Although, most of the reported research show that the FP indicators are correlated and dependent on each other to some degree and no preference is given regarding the FP indicators. Following (Albertini 2013)(Endrikat et al. 2014) we can distinguish between accounting-based and market-based measures which are measuring profitability and investment respectively. In contrast to accounting-based measures which are backward-looking, market-based measures have forward-looking aspect and they are mainly concerning about the firm’s future performance which has its basis on previous or current performance (Al-Matari et al. 2014). An alternative approach to classify FP variables is to categorise them to short-term and long-term measurement, which could possibly help to explain whether improving environmental profile provides firms with short-term or long-term financial improvement. Furthermore, FP involves organisational aspects measured by other indicators rather than accounting-based or market-based indexes. We define organisational-based measures as a set of firm characteristics such as firm size (Cole et al. 2006) and board characteristics such as

number of independent directors (Post et al. 2014)and CEO characteristics such as CEO compensation (Goktan 2014). Figure 3-3 presents the breakdown of FP variables. 21 studies use ROA as FP variables, which show that around 30% of studies have concern more on accounting-based measure and profitability of firms on the short term in the past years. Tobin's Q as a market-based measure is used in 13 studies.

It worth mentioning that using variety of FP variables completely depends on the context of examined hypotheses in each study. This could be an important point to differentiate the findings of studies. In addition, sometimes FP variables such as firm size is used as main variables in the analysis while in most cases firm size is consider as a control variable. It is also important to consider how these FP variables are measured. For example, 7 studies use firm size as a FP variable. It is measured as Ln(Total Assets) in [2006-1][2008-5][2010-6][2014-3], but is measured as total employment in [2006-2][2012-13] or as a score of total assets in [2014-1].

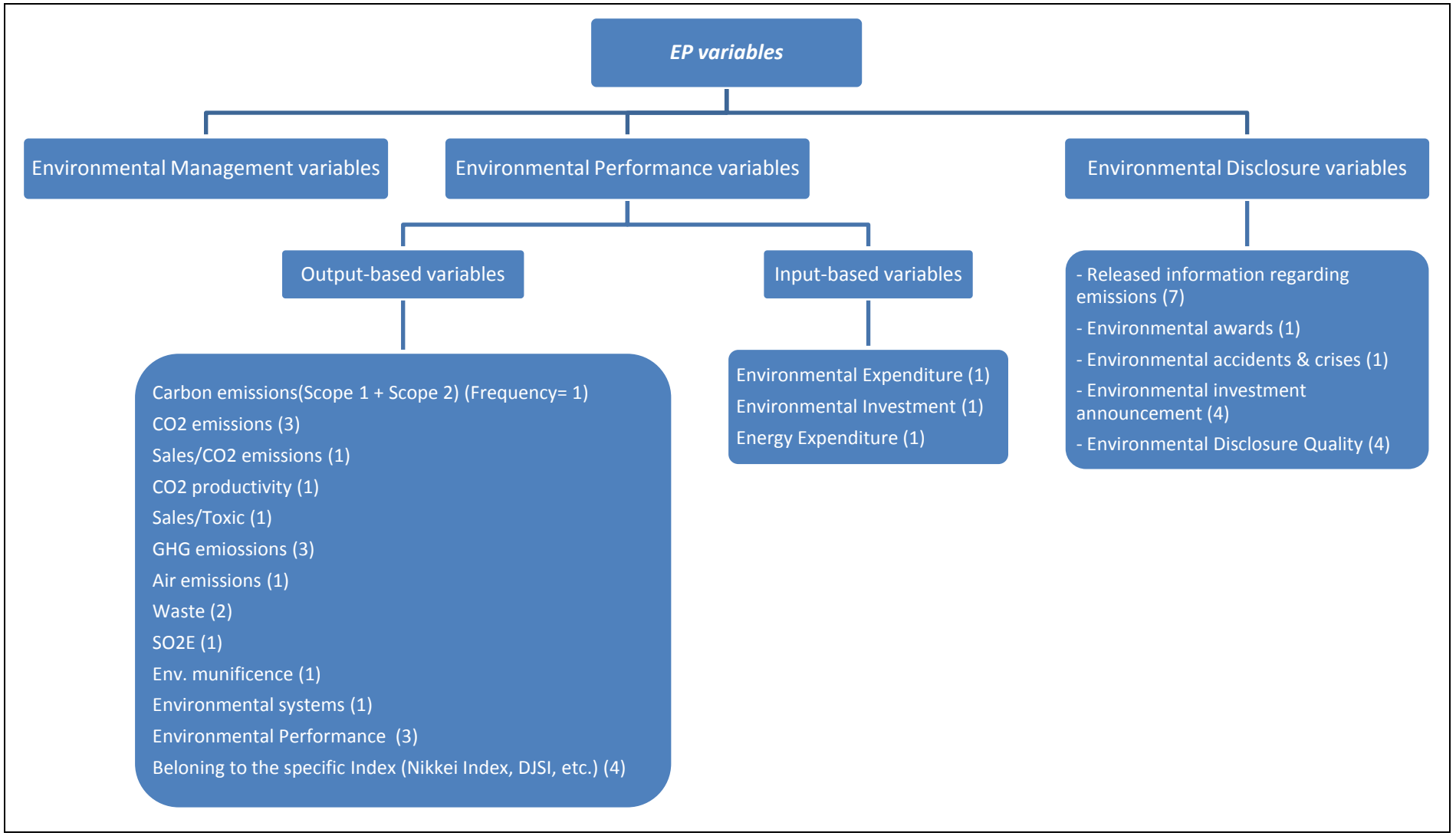

Figure 3-2. EP variables with their frequency

Accounting-based measures	total
ROA	21
ROE	9
ROS	6
Firm size	5
Leverage	4
ROCE	2
Revenue	2
Total Assets	1
Operating earning	1
Capital turnover	1
ROI	1
ROIC	1
Costs	1
Operating profitability	1
Replacement costs	1
Net Profit Margin	1
Fines &Penalties	1
Earnings per share	1

Panel A.
Accounting-based measures

Market-based measures	total
Tobin's Q	13
Profit	4
Stock return	5
Market value	3
Sales growth	2
Net income	2
Growth opportunities	1
Stock price behaviour	1
Sales/revenue growth	1
Profit before tax (PBT)	1
Cash flow from operating activities	1
GVA	1
Firm's sales	1
Quotation on the stock market	1
Foreign sale	1
Stock price	1
Growth of profit before tax	1
Market return	1

Panel B.
Market-based measures

Organisational-based measures	total
Board characteristics	31
CEO characteristics	14
Ownership	6
Firm characteristics	3

Panel C.
Organisational-based measures

Figure 3-3. List of FP variables and their frequency

3.3.4 Findings

While 46 studies examines various hypothesis on the link from EP to FP and they try to answer the question whether it pays to be green, 21 studies analyse the possibility of the link from FP to EP which is supported by the slack theory formally stated by (Waddock & Graves 1998).According to the slack theory, the superior FP results in available resources (slacks) that allow firms to invest in environmental activities and management. In addition, there are 6 studies analysing both directions. Figure 3-4 shows the distribution of direction of analysis in the reviewed studies in this research.

The majority of studies (83%) examine more than one hypothesis. They predict positive, negative, not significant or curvilinear between dependent and explanatory variables. However, not all studies confirm all the predicted signs for their hypothesis. Only 41% of studies achieve the same results as they predict in their hypotheses. Table3-6 shows the findings of studies.

The analyses of 5 studies are mainly focused in the comparison of financial performance of two groups of firms such as green management firms vs. Non-green management firms [2014-4]; socially responsible vs. socially irresponsible firms [2007-1]; firms belonging to DJSI vs. DJGI 2013-5]; the Global most sustainable firms [2012-2] or DJSI firms [2013-5].

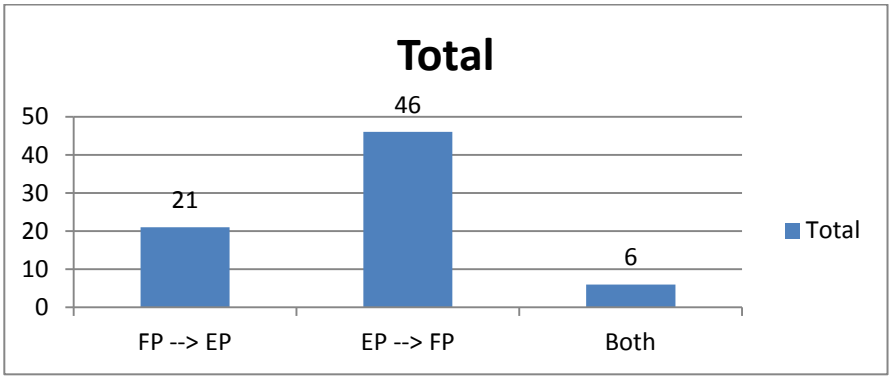

Figure 3-4.Distribution of EP-FP analysis directions

3.3.5 Endogeneity

Researchers are interested in causal relationships between EP and FP. They are using observational data which could be correlated with unseen error term. Therefore, Endogeneity is an important issue which could affect the research findings directly (Bascle 2008). Endogeneity occurs in cases where the independent variable in a regression model is associated with the error term or some kind of causality between dependent and independent variables. Table 3-6 presents whether studies considering endogeneity in their research. As we discuss the direction of analysis between FP and EP in section 3.3.4, it is important to consider whether studies control for endogeneity which is referred as a moderation effect on the study findings. As far as we consider, around 50% of studies do not check endogeneity. Those studies used questionnaire or have analysis for only one year are among this group of studies. Other studies either deal with endogeneity by using lagged data in 23 studies, fixed-term effect model in 9 studies or instrumental variables in 3 studies.

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2014-1	Board size Board independence A greater proportion of female directors Existence of CSR committee	SRQ SRQ SRQ SRQ	- + + +	+ - - +	2	No
2014-2	Environmental information Supply chain management Environmental standard for suppliers Environmental risk analysis other EMPs	Sales growth Sales growth Sales growth Sales growth ROCE/ Sales growth	+ + + + +	- - - - not correlated	1	No
2014-3	Integrated sustainability and financial reporting Integrated sustainability and financial reporting	firm size/ ROA/ level of concentration Business sector/ firms' growth opportunities	+ +	+ -	1	No
2014-4	Green management Green management	CEO base pay CEO bonuses	- -	+ - but notsignificant	1	No
2014-5	Firm size Environmental Performance Indicator	Environmental Performance Indicator Production direct costs	+ +	+ +	1,2	No
2014-6	CEO MBA degree CEO with legal degree/ CEO Tenure	The firm responded publicly to the CDP The firm responded publicly to the CDP	+ +	+ -	2	L
2014-7	Expenditure/ Income/ ROA/ ROE/ Total Assets/ Profit/ Equity	CO2 emissions	-	-	2	L
2014-8	#female directors/ #independent directors #female directors/ #independent directors	Renewable energy alliance formation Corporate environmental performance (mediated by renewable energy alliance formation)	+ +	+ +	2	L
2014-9	SO2E SO2E with high environmental munificence	ROA ROA	+ +	+ -	1	I
2014-10	Environmental performance Environmental performance	Tobin's Q Tobin's Q (t+1)	- +	- +	1	No
2014-11	EP* Director Independence EP/ EP*Board size/ EP*CEO duality/ Positive EP/ Negative EP	Compensation Compensation	+ +	- +	1	Yes

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2013-1	Sales growth in the development period	Sales growth in the preceding period	higher	higher		
	Sales growth in the exploitation period	Sales growth in the development period	higher	lower		
	Sales growth of green innovators during the exploitation period	Average sales growth in their industrial sectors	higher	higher		
	Rate of operating earnings	Differences across the Pre, Dev and Post examinations period	not significant	not significant		
	ROA	Differences across the Pre, Dev and Post examinations period	not significant	not significant		
	Equity ratio in the preceding period	Equity ratio in the development period	higher	lower		
	Equity ratio in the development period	Equity ratio in the exploitation period	higher	lower	2	No
	Efficiency-related advantage in successful innovators in the preceding period	Efficiency-related advantage in unsuccessful innovators	higher	higher		
	Efficiency-related advantage in successful innovators in the development period	Efficiency-related advantage in unsuccessful innovators	higher	higher		
	Efficiency-related, market-related, risk-related in successful innovators in the exploitation period	Efficiency-related, market-related, risk-related in unsuccessful innovators in the exploitation period	higher	higher		
2013-2	EE_{co2}	ROA	+	+		
	EE_{co2}	ROS	+	-		
	EE_{co2}	Capital turnover	insignificant	-	1	L
	EE_{toxic}	ROA/ Capital turnover	inverted U-shaped	inverted U-shaped		
	EE_{toxic}	ROS	+	+		
2013-3	Stock price/ MBV	Environmental Disclosure Score	+	+		
	Environmental Disclosure Score	%Independent directors/ %Independent directors on the Audit committee/ Existing audit committee/ Managerial ownership institutional ownership/ Changes in the management/ Firms is cross-listed	+	+	1,2	L
2013-4	ROE	EID under the voluntary regulation setting	+	+		
	ROE	EID (moderated by Ownership and stronger for non-state owned firms under the voluntary setting)	+	+		
	ROE	EID under the mandatory regulation setting	-	-	2	No
	ROE	EID (moderated by Ownership and stronger for non-state owned firms under the mandatory setting)	+	+ (weakly supported)		
2013-5	CO2	Stock price behaviour of DJSI	-	-	1	L

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2012-1	Variation in CO2 emissions 2006-2007 Variation in CO2 emissions 2006-2007	ROE (2007) ROE (2008, 2009, 2010)/ ROA (2007 -2010)	+ +	- insignificant	1	L
2012-2	The Global most sustainable firms	(higher Sales/revenue growth)/ ROA/ Profit before tax/ Cash flow from operating activities	+	+	1	No
2012-3	Environmental investment Environmental expenditure/ Energy expenditure	Production growth Production growth	+ +	+ insignificant	1	L
2012-4	ROA/ Net income	net KLD score	U-shaped	U-shaped	2	L
2012-5	GHG emissions performance Economic motivation	Financial performance GHG emissions performance	+ +	+ -	1,2	No
2012-6	GHG emissions	Profitability	+	+	1	L
2012-7	Firm size Firm profitability The focal firm size The focal firm profitability	Firm's EM activity Firm's EM activity Positive effect of a rival firm's past EM activity Positive effect of a rival firm's past EM activity	+ + - +	+ - - +	2	L
2012-8	Environmental performance Environmental performance Environmental certification	ROA (t+1)/ ROE(t+1) ROA (t+2)/ ROE(t+2) ROA/ ROE	+ + +	+ - insignificant	1	L
2012-9	Environmental reporting	revenues	+	-	1	No
2012-10	Tobin's Q ROA ROA	Environmental concerns/ Environmental strengths Environmental concerns/ Environmental strengths Environmental concerns*environmental strengths* R&D activities	- - +	- - +	2	L
2012-11	Carbon dioxide productivity	Tobin's Q	+	+	1	No
2012-12	CEO salary Shareholder activism/ Shareholder concentration Shareholder activism/ Shareholder concentration/ Board independence/ Board size/ Board diversity	Environmental strengths/ Environmental concern Environmental strengths Environmental concern	- - -	- - -	2	No

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2012-13	Firm size	environmental management practices	+	+	2	No
2011-1	Carbon intensity Carbon intensity Carbon management	ROA/ ROE Tobin's Q ROA/ ROE/ Tobin's Q	+ + -	- + -	1	L
2011-2	Risk-related metric (RRR)/ Environmental disclosure/ Environmental disclosure (in the post-SOX era)	Gov-Score	-	-	1	No
2011-3	Total environmental strengths Total environmental strengths Total environmental strengths	Independent directors/ Board size/ active CEOs/ law experts Director appointed after CEO CEO-director ownership/ insider-director ownership/ outsider-director ownership/ multiple directorships/ board tenure/ CEO Duality	+ - +	+ - -	1	I, F
2011-4	Announcing membership in EPA's Climate Leaders (CL)	Cumulative Abnormal Return	-	-	1	
2011-5	Waste Greenhouse gas emissions Greenhouse gas emissions Greenhouse gas emissions Waste- Clean industry Waste- Clean industry Greenhouse gas emissions-Clean industry Waste- Dirty industry/ Greenhouse gas emissions-Dirty industry	ROA or ROE or ROI or ROIC or ROS or Tobin's q-1 or Ln(Tobin's q) Intangible assets (Tobin's q-1 and Ln(Tobin's Q) ROS/ ROE ROA/ ROI/ ROIC ROE ROA or ROE or ROI or ROIC or ROS or Tobin's q-1 or Ln(Tobin's q) ROA or ROE or ROI or ROIC or ROS or Tobin's q-1 or Ln(Tobin's q) ROA or ROE or ROI or ROIC or ROS or Tobin's q-1 or Ln(Tobin's q)	+ + + + + + + +	- + insignificant - - insignificant - insignificant	1	F
2011-6	Environmental R&D	Business performance	+	+	1	No
2011-7	Outside directors/ three or more female directors Mean age of directors/ Educated in Western Europe/ Master degreeor above Outside directors/ three or more female directors/ Mean age of directors/ Educated in Western Europe/ Master degreeor above Outside directors/ three or more female directors/ Mean age of directors/ Educated in Western Europe/ Master degreeor above	KLD strengths KLD strengths KLD concerns Total KLD	+ + + +	+ not significant not significant not significant	2	No

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2011-8	The permitted waste water discharge limits	ROS	+	+	1	L
2010-1	Air emissions	Profitability/ Operating profitability	+	+	1	L
	Air emissions	Revenue	+	-		
	Air emissions	Costs	-	-		
2010-2	Risk information : Carcinogenicity	Replacement cost	+	+	1	L
	Risk information: Chemical pollution/ ISO 14001	Replacement cost	+	insignificant		
	Nikkei index	Replacement cost	+	-		
	Risk information : Carcinogenicity	Intangible asset	+	insignificant		
	Risk information: Chemical pollution/ ISO 14001	Intangible asset	+	insignificant		
	Risk information : Carcinogenicity	Tobin's Q	-	-		
	Nikkei index	Intangible asset	+	-		
2010-3	Environmental performance	Economic performance	+	-	1	No
	Eco control direct effect	Economic performance (with greater environmental exposure)	+	-		
	Eco control direct effect	Economic performance (with greater public visibility)	+	-		
	Eco control direct effect	Economic performance (with greater environmental concern)	+	-		
	Eco control direct effect	Economic performance (with larger size)	+	-		
	Eco control indirect effect	Economic performance (with greater environmental exposure)	+	+		
	Eco control indirect effect	Economic performance (with greater public visibility)	+	+		
	Eco control indirect effect	Economic performance (with greater environmental concern)	+	+		
	Eco control indirect effect	Economic performance (with larger size)	+	+		
2010-4	CEI announcements	Abnormal return	+	+	1	No
	Eco-friendly products	Abnormal return	+	-		
	Environmental business strategies	Abnormal return	+	-		
	Philanthropic gifts	Abnormal return	+	+		
	Voluntary emission reductions	Abnormal return	+	-		
	EAC announcements	Abnormal return	+	-		
	announcement of ISO 14001 certification	Abnormal return	+	+		
	LEED certifications (not statistically significant)	Abnormal return	+	+		
	Environmental awards- Government award	Abnormal return	+	+		
	Environmental awards-non-governmental awards	Abnormal return	+	-		

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2010-5	Environmental incidents	Firm value (firms in Europe)	-	-	1	No
2010-6	Firm size/ Quotation on the stock market	EDI	+	+	2	No
	Industry membership/ Foreign ownership/ Profitability	EDI	+	-		
2010-7	%independent directors	CDLI	+	+	2	Yes
	%independent directors (in countries developed a favourableinstitutional macro- context for CSR)	CDLI	+	-		
	%independent directors (in companies with lower environmental records & higher risk of litigation & in countries developed a favourable institutional macro- context for CSR)	CDLI	+	-		
	CEO Duality (in companies with lower environmental records & higher risk of litigation)	CDLI	-	+		
	CEO Duality ((in countries developed a favourable institutional macro- context for CSR)	CDLI	+	-		
	CEO Duality ((in countries developed a favourable institutional macro- context for CSR & higher risk of litigation in companies with lower environmental records & higher risk of litigation)	CDLI	-	+		
	Diversity (in companies with lower environmental records & higher risk of litigation & higher risk of litigation)	CDLI	+	+		
	Diversity (in countries developed a favourable institutional macro- context for CSR)	CDLI	+	+		
	Diversity (in countries developed a favourable institutional macro- context for CSR & higher risk of litigation)	CDLI	+	+		
2010-8	Permitted discharge limits	Tobin's Q	-	-	1	Yes
2010-9	Overall sustainability performance index	Tobin's Q	+	+	1	L
	Overall sustainability performance index	Tobin's Q (in Low innovation firms)	+	-		
	Overall sustainability performance index	Tobin's Q (in firms with low levels of differentiation and signalling)	-	+		

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2009-1	Pollution prevention/ End-of-pipe pollution control Environmental performance-Existing env. Governance Long-term pay	CEO total pay CEO's pay Environmental performance	+ + +	+ - +	1,2	F
2009-2	Rapid growth-financial performance Maturity-financial performance/ Revival-financial performance/ Initial growth-financial performance	Environmental Policy Environmental Policy	- +	- +	2	L
2009-3	ENVPER ENVPER	Innovation capability Resource efficiency/ Intangible assets/ Market Performance	+ +	+ -	1	No
2009-4	Profit/ COMIMG	Environmental management	+	+	2	
2009-5	hotels-competitive advantage on costs/ hotels-competitive advantage in differentiation/ IPPC law sector advantage on costs/ IPPC law sector advantage in differentiation	Financial performance	+	+	1	No
2008-1	Emission efficiency Compliance index/ Spill index Emission efficiency Compliance index/ Spill index Emission efficiency/ Compliance index/ Spill index	CEO compensation (the full sample) CEO compensation (the full sample) CEO compensation (firms with EP-pay link) CEO compensation (firms with EP-Pay link) CEO compensation (firms without EP-Pay link)	+ + + + +	- + - + -	1	No
2008-2	Environmental Leaders/ Firms in cleaner service industries/ Environmental leaders in cleaner service industries/ Service organizations with higher environmental ratings	Net profit margin	+	+	1	No
2008-3	ROTA-environmentally responsible firms Fines and Penalties-environmentally responsible firms	employee health and safety/ waste management/ community development employee health and safety/ waste management/ community development	+ +	+ +	2	No
2008-4	Environmental Risk management Environmental Risk management Environmental Risk management	Tax shield from debt/ Dispersed share ownership/ Weighted average cost of capital Beta/ Cost of debt capital/ Percentage of institutional shareholders Cost of equity capital	+ + -	+ - -	1	L

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2008-5	Tobin's Q/ Leverage/ Profit Firm size/ Foreign sale	Disclosing information through CDP Disclosing information through CDP	+ +	- +	1	No
2008-6	Announcement of Nikkei Environmental Management Ranking survey	Stock price	+	+	1	
2007-1	CSR/ non CSR CSR non CSR	Growth of profit before tax (1999-2001) Growth of profit before tax (2002-2004) Growth of profit before tax (2002-2004)	no relation direct relation no relation	no relation negative relation no relation	1	No
2007-2	Environmental performance score Tobin's q-1/ ROA	Tobin's q-1/ ROA/ Earning per share Environmental performance score	+ +	+ +	1,2	GC
2006-1	Firm size Share ownership Share ownership ROTA Leverage NONEXEC	DISCLOSE/ QUALITY DISCLOSE QUALITY DISCLOSE/ QUALITY DISCLOSE/ QUALITY DISCLOSE/ QUALITY	+ + + + + +	+ + - not significant - not significant	2	L
2006-2	The ratio of debt assets Marketing intensity/ Average age of employees/ Firm size/ Total factor productivity (TFP)	Overall environmental management performance Overall environmental management performance	+ +	- +	2	Yes
2005-1	Market return Leverage	Environmental disclosure quality Environmental disclosure quality	+ +	+ -	2	No
2005-2	The community and environmental responsibility (CER) score (in static panel data) The community and environmental responsibility (CER) score (in static panel data) The community and environmental responsibility (CER) score (in dynamic panel data) The community and environmental responsibility (CER) score (cross-section and pooled estimates)	Tobin's Q/ ROS ROA Tobin's Q/ ROA/ ROS Tobin's Q/ ROA/ ROS	+ + + +	not significant - + (very weak) +	1	L

Paper No	left	right	Predicted	Support?	1: EP-->FP 2: FP --> EP	Endogeniety
2005-3	Planning and organizational practices/ Logistics processes practices/ Product design practices/ Internal production processes practices	ROA	+	-	1	No
2005-4	The announcement (event) of environmental performance (for 0-1 day) (pulp & paper) The announcement (event) of environmental performance (for 0-5 days) (for 0-10) (pulp & paper) The announcement (event) of environmental performance (for 0-1 day)(for 0-5 days)(for 0-10) (chlor alkali) The announcement (event) of environmental performance (for 0-1 day) (for 0-5 days) or (for 0-10 days) (automobile)	Average cumulative abnormal return Average cumulative abnormal return Average cumulative abnormal return Average cumulative abnormal return	+ + + +	not significant - - & not significant +	1	No
2005-5	Environmental Performance Index	Net income	-	-	1	No
2005-6	Quality manager's salary tied to environmental performance Plant manager's salary tied to environmental performance	Toxic release index Toxic release index	+ +	- +	1	L
2005-7	Output-based index Output-based index Input-based index	ROCE/ ROE ROS ROCE/ ROE/ ROS	- or inverse U-shaped - or inverse U-shaped - or inverse U-shaped	- inverse U-shaped not significant	1	F
2004-1	Environmental performance Industry-adjusted annual stock return	Industry-adjusted annual stock return Environmental performance	+ +	+ not significant	1,2	F
2004-2	ECE (Low-polluting firms)/ ECE (High-polluting firms)/ Existence of unbooked liabilities (High-polluting firms)	Market value	+	+	1	No
2004-3	IRRC Compliance Index High (lower) IRRC Compliance Index (t)	Market Value lower (higher) Market value (t+1)	- +	+ -	1,2	No

Table 3-6. An overview of EP-FP findings, direction of tested hypotheses and endogeneity

3.4 Conclusions and Future work

Our study presents an overview of 72 empirical studies conducted on the relationships between EP and FP from 2004 to 2014. The study expands the view of this relationship from data characteristics perspective, which concentrates on the characteristics of data sample, data sources, EP profile, FP profile, finding and endogeneity. First, we provide a brief overview of each paper to cover the aim of each study, the definition of environmental profile, the full description of sample analysed and the datasets and finally the findings related to EP and FP. Then we discussed and compare data-related characteristics such as sample size, industrial sector, market index, country coverage, type of data sources for EP and FP and finally the replicability of analysis.

The findings of this study categorise the studies based on their datasets into three main categories namely, studies using primary dataset, studies using secondary datasets and those using mixed datasets. Although we acknowledge that studies using primary datasets and mixed datasets are contributing to knowledge and provide some insights into the relationship between EP and FP, they are not replicable and therefore comparable. The main reason is a lack of transparency in dataset availability and sample selection and also they are mainly looking in one year data. In terms of FP variables, this study defines FP precisely and then explores the FP variables in reviewed studies. The findings show that ROA and ROE are the most common FP variables in accounting-based group, Tobins' Q is the most common FP variable in market-based group and finally board characteristics are the most common FP variable in organisational-based group. Similarly, this study provides a concrete definition of EP and then explores the EP variables in reviewed studies.One sub category of EP variables is environmental disclosure which is well defined in Albertini (2013, p.435). In addition, after careful consideration, we specify a category of variables, which are trying to capture the quality of released information rather than releasing the information regarding the toxic emissions. Therefore, we introduce new category of environmental disclosure variables which is called "environmental disclosure quality". Environmental performance also is considered as input-based and output-based variables. The direction of analysis is mainly from EP to FP which reveals the interest of researchers on the influences of EP on FP.

The theoretical contribution of this study is enriching the domain knowledge by providing comprehensive insight to the literature examining the relationship between EP and FP. This study has shed some light on the relationship between EP and FP by focusing on the data as a unit of analysis. This study attempts to clarify the mixed results between EP and FP by providing insights into the data related problems such as unavailable data and misspecification of EP and FP variables. This study supports Lankoski (2008) argument which emphasis "A further breakthrough was the '**it depends' hypothesis** by Reinhardt (1998), recognizing that the relationship is not likely to be universally either negative or positive, but that its nature depends on the specifics of each situation.".

Another contribution of this study is to reduce the inconsistency in using terminologies. To be more specific, this study defines EN and FP and provides the classifications for each of them. This classification helps in recognising the key area that associate and affect EP-FP relationship.

One of the important contributions of this research is providing an extensive overview of the relationship between EN and FP in data level which has not been conducted yet. The researcher investigates both research streams in data level, because data is the base of any research. The main contribution of this paper is to identify issues with data collection, data characteristics and offer recommendations on both these issues.

This study focuses only on the findings which directly depict the relationship between EP and FP. The interdependencies, mediation or moderation findings need to be addressed in future research. In addition, studies employ various research methodologies such as regression analysis, fixed-effect and random-effect model and structured equation modelling. We recommend examining the influence of the research methodology and analysis method on the EP-FP relationship. Moreover, each study employs a set of control variables. The common ones are firm size, industrial sector and country. Since control variables strongly influence the results, future research is necessary to investigate the control variables. In addition, sometimes some variables like firm size are used as control variable while in other studies they are the main variables. It is obvious that each industrial sector has its own regulations in relation to EP, now the question is that "is it enough to include the firms' sector as a (control) variable to the analysis, or it would be

better to focus on specific sectors and investigate the variables which are specific to that sector?". Finally, studies rely on various theories, such as agency theory, institutional theory, resource based theory, slack resource theory. Therefore, it is recommended to examine that the EP-FP results are in response to which theories.

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Appendix A: List of abbreviations

Abbreviation	Description
AR	Annual report
BACEN	Brazilian Central Bank (BACEN) database
BF RR	Business Facilities Rankings Report
BMAC	Britain's Most Admired Companies
BSE	Bucharest Stock Exchange
BW EPB	Business Week: Executive Profile and Biography
CAR	Cumulative Abnormal Stock returns
CC,AB	CaringCompany Research, AB
CDP	Carbon Disclosure Project
CEPD	IRRC: Corporate Environmental Profiles Database
CER	Corporate environmental reports
CER-FW	Corporate environmental reports - Firms' websites
CER-PR	Corporate environmental reports - respective firms' public relations departments
China ISY	China Industrial Statistics Yearbook
CIC-BW	Business Week Online: Company Insight Centre
CNBS	The Annual Industrial Survey Database of the Chinese National Bureau of Statistics
CorporateDisclosure	Other corporate disclosure available on Internet
CR	CorporateRegister.com
CRSP	Centre for Research in Security Prices
CSMAR	The China Stock Market and Accounting Research (CSMAR) financial database
CSR	Corporate Social Responsibility
Destatis	German Federal Statistical Office (German: StatistischesBundesmat)
DJSWI	Dow Jones Sustainability World Index
EDS	Environmental Disclosure Score
EIN	China Economic Information Network database
EPA	The local environmental protection agency
EPA CLP	Environmental Protection Agency Climate Leaders Program
EPA PCS	Environmental Protection Agency Permit Compliance System
EPA TRI	Environmental Protection Agency Toxic Release Information
ER	Environmental report
FAME	Financial Analysis Made Easy
FinnishNBPR	National Board of Patents and Registration of Finland
ForbesGS	Forbes: List of Green States
FS	Firm's financial statement
FW	Firms' website
GC	Granger causality
GES	GES Alert Service
GHG	Greenhouse Gas Emissions
GovWeb	The website of government offices

Abbreviation	Description
GRI	Global Reporting Initiative
GVA	Growth of gross value added
Hoover	Hoover database
IRRC CEP	IRRC Corporate Environmental Profile
Leverage	the ratio of total debt to total assets
NEEDS	Nikkei Economic Electronic Databank System
NEEDS FinancialQUEST	Nikkei NEEDS-Financial Quest Corporate Financials Database
NEEDS QIT	Nikkei NEEDS Database (Nikkei Quick Information Technology Co. Ltd.)
NEEDS-CAD	NEEDS-the Corporate Attribute Database
Nikkei EMR	Nikkei Environmental Management Ranking survey
NPDES	National Pollutant Discharge Elimination System
NPM	Net profit margin (NPM)
NPRTR	The National Pollutant Release and Transfer Register
OECD	OECD countries (Canada, France, Germany, Hungary, Japan, Norway, US)
PIRC ER	PIRC Environmental Reporting 2000
PortugueseExame	Portuguese financial magazine Exame
PROWESS CMIE	PROWESS of Centre for Monitoring the Indian Economy
PRTR	Pollutant Release and Transfer Registration
PTR	Public Trade Register
RDS-JapanME	Reporting and disclosure system (Ministry of Environment, Japan)
ROA	Return on Assets
ROCE	Return on Capital employed
ROE	Return on Equity
ROTA=ROA	return on Total Assets
SCSRR	Separate China Security and Regulations (CSR) reports
SDD	GRI- Sustainability Disclosure Database
SEC	Proxy statement of each firm reported to Securities and Exchange Commissions
SEPA	State environmental protection administration
SIP	The Summit Investment Partnership
SR	Sustainability reports, sustainable development report and corporate social responsibility report by each firm on its website
SRQ	Sustainability Reporting Quality
SRR	Social responsibility reports
SR-RobertEC	The 2010 Sustainability Reporting of the Wolrd's Largest Petroleum Refining Companies published by Roberts Environmental Centre
TEKES	Finnish Funding Agency for Technology and Innovation
Toyo Keizai CSR	Corporate Social Responsibility Database (by Toyo Keiai)
Various DS	The Ministry of Labour in Japan/ The American Conference of Governmental Industrial Hygienists/ The International Agency for Research on Cancer/ The European Union, The US Environmental Protection Agency/ The US National Toxicology Program, Japan Society for Occupational Health
Worldscope	Thomson financial Worldscope
www.irz.cz	the integrated register of pollutant emissions (www.irz.cz)

Chapter 4 Literature Review on Social Network Profile and Financial Profile

Abstract

In organisational studies, social network is generally regarded as a source that provides resources and information for firms. There is consensus that directors' social network has significant effect on the firms' financial profiles. There are a growing number of empirical studies investigating these effects on various aspects of financial profile. These studies use various data samples with different characteristics, different definitions of social network and a diverse set of social network metrics as well as a wide range of financial variables. All of these are essential determinants that have direct impacts on the findings in each study. Before comparing these findings it is essential to undertake an in-depth literature review on the basis of these determinants. An overview of 21 studies published between 2004 and 2014 is presented in four main categories: data-related characteristics, social network profile, financial profile and findings and endogeneity. The findings of this study reveals that researchers need to consider the effects of data quality, data sources, data collection method and other data sample characteristics on the results. In addition, the review suggests that researchers should pay attention to the definition of social network and selecting social network metrics by referring to the social network theory. This paper contributes to the understanding of the relationship between social network and financial profile in future research.

Keywords: social network profile, financial profile, data characteristics

4.1 Overview

In organisational context, social network could be formed between directors and also collectively between boards of directors which is called board interlocks. Research using board interlock developed in 1970s and 1980s and with the increase of interest on the inter-organisational relationships, it became even more popular in 1990s (Mizruchi 1996). Consequently, the impact of social networks of directors on financial profile has emerged as a stream of research.

Like other studies, all empirical studies considering the social network influences on financial profile of firms position their research on the basis of the existing studies and concepts that support the study requirements. They usually compare the results of the relevant studies in such a way as to support their hypotheses. However, it is important to consider to what extend the results of various studies are comparable. Although the basis of all studies' results is data, less is known about data characteristics. Studies are using variety of data sources for both social network and financial profile. It is very likely that data source characteristics and the data collection methodology influence the results. Data source could be structured, unstructured or semi-structured. The unstructured or semi-structured data needs to be processed and converted to suitable format for analysis. Moreover, data sample characteristics make comparisons of studies difficult. Each study has a data sample with specific sample size, industry sector, country coverage, time span and market index.

In addition, these studies define social network in various ways such as between directors (e.g. (Brown et al. 2012), between boards of directors (e.g. (Larcker et al. 2013), or even as belonging to the group with specific characteristics (e.g. (Kim 2005)). Consequently, the definition of social network has direct effect on the social network metrics. Moreover, studies employ various set of social network measure to present the position and behaviour of directors/firms in the network. On the other hand, financial profile of firms is relatively well established but covers a wide range of variables. Finally, Studies employ various financial variables which make the comparison of studies more complicated.

The current study aims at providing insight into the relationship between social network and financial profile of firms by examining the influence of data-related characteristics, social network profile and financial profile. The unit of analysis in this research is data. Therefore, the focus is on the dataset characteristics, data sample characteristics, social network variables, financial profile variables, endogeneity and findings.

This study attempts to conceptualise the studies by describing the hypotheses, defining terms and clarifying the assumptions and limitations (Rocco & Plakhotnik 2009). First, we define both social network profile and financial profile domains. The summary of each study is presented to clarify the area of investigation, the definition of social network

profile, the data sample characteristics and findings. Then attempt is made to recognise the similarities between studies in this research stream in terms of data set characteristics, social network profile, financial profile and findings. Part of the literature review outcome is expected to provide statistics on how often variables from each domain are used.

Additionally, with its focus on social network profile, this review goes beyond existing reviews to investigate their definition of social network, the key components of social networks and the metrics they used to measure the characteristics of directors/board in relation to the entire structure of social network rather than individual influences.

The Financial Profile (FP) of a firm captures its financial and organisational characteristics. By definition, FP is multidimensional and for the purposes of this paper, three dimensions are distinguished, namely: market-based, accounting-based and organisational-based. Accounting-based indicators measure profitability and are mainly backward-looking (Al-Matari et al. 2014). Return on Assets (ROA) and Return on Equity (ROE) are examples of accounting-based indicators (Al-Matari et al. 2014). Market-based measures have forward-looking aspects and are mainly concerned with the firm's future performance and investment that has its basis in previous or current performance (Al-Matari et al. 2014). Tobin's Q and market-to-book value are examples of market-based indicators (Al-Matari et al. 2014). Furthermore, FP involves organisational aspects measured by other indicators rather than accounting-based or market-based indexes. We define organisational-based measures as a set of firm characteristics such as corporate governance index (Subrahmanyam 2008) and board characteristics such as director selection (Fracassi & Tate 2012)(Qi 2011) and CEO compensation (Renneboog & Zhao 2011).

The social network profile (SN) of a firm describes the position and behavioural characteristics of a firm in relation to other firms in the network. The focus of this paper is on two aspects of social network profile which are (i) social network definition, and (ii) social network metrics.

Initially social network needs to be defined. According to social network theory, defining social network requires the precise definition of the nodes and the links between them

(Shahgholian et al. 2015). For example, Larcker et al. (2013) define social network as where nodes are firms and links are formed when two firms share at least one board member. Social network could be defined in terms of director level or board level (Shahgholian et al. 2015). In addition, some studies define social network as directors belonging to specific groups such as Elite school network (Kim 2005). Then, social network metrics are calculated to define the position and behaviour of nodes (directors or firms) in the network. Studies typically use social network centrality metrics. However, it is important to distinguish between measures such as degree, betweenness, closeness and eigenvector (Shahgholian et al. 2015).

This paper makes several contributions. To begin with, in other research fields like the relationship between environmental Profile (EP) and Financial Profile (FP), a number of comparative studies have been carried out to review the EP-FP literature and provide insights on the relationship between EP and FP, understand the determinants of the relationship and identify gaps and opportunities for further research. These comparative studies have employed narrative reviews (Ambec & Lanoie 2008), vote counting (Margolis & Walsh 2001)and meta-analysis (Allouche & Laroche 2005)(Margolis et al. 2009(Dixon-Fowler et al. 2013)(Albertini 2013)(Endrikat et al. 2014).Unlike other research fields, there is not any comparative study to review the relationship between SN and FP. To the best of our knowledge, there is a study conducted by Jackson (2010) which provides an overview of research on social networks and their role in shaping behaviour and economic outcomes. The focus of Jackson (2010) is on highlighting the research on SN and various aspects of FP as well as providing some research background on SN. To this end, the current study is the first in examining the determinants of the relationship between SN and FP with the focus on data. Datasets as the basis of any research is one of these factors. This paper contributes to informing researchers of possible further analysis in terms of the appropriateness of the datasets used or the research methodology adopted for extracting the variables. Secondly, in relation to the variables, the paper contributes in identifying the variables chosen to describe each one of the profiles and highlights possible inconsistencies and overlaps in the literature e.g., different names used for the same variable or same name used for different variables. This contribution facilitates the interpretation and comparison between the different approaches and

results. Together, all the above, provide a basis for future research and contribute to the development of the link between SN and FP. Researchers can draw from our analysis and highlighted factors to conduct future research. Our research could be a guideline for practitioners to identify challenges and opportunities in relation to existing or social networks, or in building new ones and investigating their impacts on firm financial profile.

The remainder of the paper is organised as follows. Section 4.2 describes the research method. Section 4.3 reviews the studies that have analysed the relationship between SN and FP from 2004 to 2014. Section 4.4 is the discussion on each dimension of comparison table. Section 4.5 concludes a discussion of the results, implications and possible directions for future research.

4.2 Research method

In this section, first the scope of the literature review and the criteria applied to identify the 21 relevant articles published from 2004 to 2014 are described. Then, the dimensions of comparisons are explained.

4.2.1 Methodology: Study selection and inclusion criteria

To ensure a high-quality literature review, this study follows the guidelines by (Webster & Watson 2002). They assume that the major contributions in a research field are primarily found in high reputation journals. In order to construct a comprehensive study sample, first we conducted a systematic search in the multidisciplinary journals including management, accounting, marketing and finance from 2004 to 2014. In our initial search, we use different combinations of keywords for the correlation between SN and FP indicators including "board interlocks", "social network", "board connections", "financial performance", "corporate governance", "profitability". In the next stage, we manually search the reference lists of each study which were collected previously. The non-empirical studies such as (Granovetter 2005)(Harris & Helfat 2007)(Hambrick et al. 2008)(Ahuja et al. 2012) are not included in our sample. The final sample comprises 21 studies. Table 4-1 presents the list of studies categorised by the year of study.

4.2.2 Define the dimensions of the comparison table

Each study is carefully examined to identify the relationships between SN and FP and factors that could influence this relationship. Datasets as the root of examined variables could have a high potential of influencing the results. Therefore, this study attempts to examine the datasets in full details such as datasets, SN variables and their data sources, FP variables and their data sources, time span of analysis, sample size, sector, country/region coverage, type of datasets for both SN and FP which could be structured, unstructured or both. Structured data is described as set of information organised into a well-structured format where the schema of the data is defined in advance, this could be relational database, or any other forms of data tables which has the advantage of being easily stored, queried and analysed. On the other hand, unstructured data is the opposite of structured data; it has no schema that defines the form, the characteristics, and the structure of data. Because of the nature and the free structure makes working on this kind of data very challenging (Hadzic et al. 2011, p.4 ;7).

The type of FP variables is examined as well which could be accounting-based, market-base and organisational-based. The social network profile of studies also investigated in terms of social network definition and social network metrics. Moreover, findings of each paper are listed in the format of dependent variables, explanatory variables, predicted results and the obtained results after analysis. Finally, considering endogeneity and the way of dealing with this is presented as well. Table 4-1 lists the studies included in the review.

Year			Total
2005	**[2005-1]:** (Kim 2005)		1
2006			0
2007			0
2008	**[2008-1]:** (McDonald et al. 2008);	**[2008-2]:** (Subrahmanyam 2008)	2
2009	**[2009-1]:** (Barnea & Guedj 2009); **[2009-3]:** (Hwang & Kim 2009);	**[2009-2]:** (Bizjak et al. 2009); **[2009-4]:** (Kuhnen 2009)	4
2010	**[2010-1]:** (Crespí-Cladera & Pascual-Fuster 2010)		1
2011	**[2011-1]:** (Mizruchi et al. 2011); **[2011-3]:** (Qi 2011);	**[2011-2]:** (Pombo & Gutiérrez 2011); **[2011-4]:** (Renneboog & Zhao 2011)	4
2012	**[2012-1]:** (Brown et al. 2012); **[2012-3]:** (Engelberg et al. 2012); **[2012-5]:**(Horton et al. 2012)	**[2012-2]:** (Cai & Sevilir 2012); **[2012-4]:**(Fracassi& Tate 2012);	5
2013	**[2013-1]:** (Chiu et al. 2013);	**[2013-2]:** (Larcker et al. 2013)	2
2014	**[2014-1]:**(Fogel et al. 2014);	**[2014:2]:** (Fracassi 2014)	2
Total			21

Table 4-1. List of studies included in this review

4.3 Literature Review

The overview of selected studies is presented in this section. For each paper we provide the main aim of the study, the definition of the social network profile of firms, the characteristics of sample of firms and the data sources used in the study and finally the findings of each paper in relation to social network profile and financial profile of firms.

(Kim 2005)

The paper is one of the earlier studies and explores the effects of social network characteristics of board of directors on firm performance based on theory previously suggested on the role of boards in large corporations (Johnson 1996).

To define the social ties between directors, the paper uses three types of links, namely family ties, elite school ties and membership in external economic associations. On the basis of these, they define two social network profile characteristics namely, board network density and board external social capital. The board external social capital

consists of two characteristics, namely degree of graduates from Seoul National University and degree of membership to external economic associations.

The paper analyses 199 large publicly traded Korean Chaebolcorporations from 1990 to 1999. The family ties are obtained from the Chaebol Chong-soo-dle. The elite school ties and membership in external economic associations are obtained from the Directory of Corporate Management and financial performance data are obtained from the Annual Report of Listed Companies. Both of these datasets are published by the Korea Listed Companies Association. The findings show a positive relationship between board network density and firm performance and a negative relationship between the square of board network density and firm performance. The findings suggest that a moderate level of density can be beneficial bit high levels of density create agency problems. Furthermore, the findings show a positive relationship between elite school network degree and firm performance but fail to show evidence that there is a positive or negative relationship between the membership to external economic association network degree and firm performance.

(McDonald et al. 2008)

The paper examines how corporate governance factors influence the external advice-seeking behaviour of CEOs and how these networking behaviours relate to firm performance. This work extends previous work that examined how the corporate governance factors affect company responses to poor performance (McDonald & Westphal 2003).

The social network profile characteristics that are used in this paper have been collected manually through a questionnaire and they relate to ties between CEOs and external advisors (friendship tie or acquaintance tie) and so-called functional background ties between the CEOs and external advisors. The functional background ties were coded in three categories: output-related, throughput-related and peripheral functions. On the basis of these, for each CEO, they defined four metrics: number of friends, number of acquaintances, number of advisors with shared functional background and number of advisors with different functional background.

They selected 600 firms randomly from the Forbes listing of the largest US industrial and service firms in year 1999. Data on the social ties were collected through questionnaires to the CEOs in January 1998 and January 1999 and the dataset obtained was for 225 of these firms. Financial profile characteristics were collected from COMPUSTAT and Thomson Financial. Director characteristics were collected from the S&P Register of Corporations, Directors, and Executives, the Dun & Bradstreet Reference Book of Corporate Management, and the Who's Who in Finance and Industry.

They have extensively tested for a number of hypotheses and their findings are as follows:

- The level of CEO stock ownership is positively related to the level of a CEO's advice seeking directed toward the executives of other firms who have functional background of the CEO.
- The level of CEO performance-contingent compensation is positively related to a CEO's advice seeking directed toward executives of other firms who are not friends of CEO as well as to CEO advice seeking directed toward the executives of other firms who have backgrounds that are different from the CEO's background.
- Board monitoring is positively related to the level of the CEO's advice seeking directed toward executives of other firms who are not friends of the CEO, as well as tothe level of his or her seeking of advice from the executives that are different from the functional background of the CEO.
- The relationship between a board's monitoring and the level of a CEO's advice seeking directed toward executives of other firms who have backgrounds that are different from the CEO's background is also significantly more positive to the extent that outside directors have prior executive experience.

(Subrahmanyam 2008)

The paper investigates the association between corporate governance and firm value to the board's social network. The definition for a social network between the CEO and members of the board is rather simplistic and more emphasis is placed on the analysis of board characteristics in relation to financial characteristics.

The social ties that have been used in this paper to define the social network of the CEO with the other board members are based on “board membership” and “immediate family” ties. On the basis of these and other director characteristics, the paper defines a number of variables used for the analysis and which they relate to board characteristics. These are: AGEDIFF is the absolute value of the difference between the age of the CEO and the average age of the other board members; EXEC is the number of other board members who also are CEOs; INTGEN is obtained from interacting a dummy for whether the CEO is a female with the number of female board members; RELATIVE is the number of board members who are immediate relatives of the CEO; ETHN is the proportion of directors that declare themselves as Caucasian.

The paper analyses the US data for year 2005. Data on the characteristics of board members is obtained from RiskMetrics database, the governance index from Andrew Metrick’s website and compensation and shareholding data from Execucomp.

The analysis consists of a series of cross-sectional regressions for the governance index, Tobin’s q and executive compensation. For the governance index, AGEDIFF and EXEC are significant determinants, ETHN is strongly significant, and EXEC is marginally significant. For Tobin’s q, ETHN has a significantly positive impact on q. Finally, for executive compensation, higher values of EXEC imply higher compensation, AGEDIFF is negatively related to compensation, ETHN is negatively related to compensation and non-Caucasian (or minority) representation on the board implies lower compensation.

(Barnea & Guedj 2009)

The paper examines the relationship between the social networks of directors and their impact on the decision making of companies in areas such as CEO pay, CEO turnover, etc. They introduce the so-called reputation hypothesis – “when directors are not connected they build their reputation by providing superior monitoring but when they are highly connected they provide soft monitoring”.

The social network profile characteristics include the director network interlocks and the firm-level metrics. For the director network they define the following metrics: degree,

eigenvector (they call it closeness) and betweenness. At the firm level, they define the same metrics by averaging the corresponding director-level scores across all directors in each firm.

They paper analyses the director's dataset for all firms in the S&P1500 from 1996 to 2004. The data on directors' characteristics and corporate governance variables are collected from the RiskMetrics dataset, CEO compensation from Execucomp and firm characteristics from COMPUSTAT and CRSP.

The findings show that when the firms are better connected (higher average eigenvector) then the CEOs get a higher compensation (CEO salary or CEO total compensation). This implies that directors are less strict with the CEO when their reputation is already well established. On the other hand, when the level of connectivity is lower, the board is strict and provide superior monitoring. In addition, when firms are highly connected, forced CEO turnover is less likely to occur. Finally, the well-connected directors (degree) are more likely to be awarded new directorships.

(Bizjak et al. 2009)

The paper examines the role of board connections in relation to the practice of backdating stock options and how this relates to firms from across a wide range of industries.

To define social network profile characteristics include board interlocks, joint degree and backdating interlock. The board interlock is defined where two firms share a common board member in a year. The backdating interlock considers the directors that have been involved previously with companies that have been identified as been involved in backdating stock options. Finally, joint degree relates to the number of common board members between each pair of firms.

They analyse stock option grants from Thomson Financial Insider Filing database from January 1996 to August 2002. The additional information on stock-return data is collected

from CRSP, financial data from COMPUSTAT, director data from Compact Disclosure database and executive data form Execucomp database.

The findings confirm the positive association between the likelihood that a firm begins backdating option grants and having a board member who sits on the board of another firm that is already identified as backdating option grants. In addition, board link and firm size are associated with the probability of initiating backdating. However, they could not find any evidence that the incidence of backdating is higher for interlocks based on new directors relative to the incidence based on existing linkage.

(Hwang & Kim, 2009)

The paper examines the impact of social ties between CEOs and directors on the way the board of directors' monitors and discipline the CEO.

To define the social ties, the paper uses social network profile characteristics such as regional origin, mutual alma matter (as a sense of group belonging through artefacts like alumni networks, newsletters, donations or college sports events), military service, academic discipline and university ties. On the basis of these, they extended the definition of "independent director" to include social ties with the CEO and the firm i.e., "socially independent director". Their analysis also considered "conventional ties" and defined "conventionally independent director" if he or she has neither financial nor familial ties to the CEO or the firm.

The paper analyses the Fortune 100 firms from 1996 to 2005 and their director information based on the RiskMetrics Directors database. The social ties information is collected manually from the Marquis Who's Who database and Notable Names database, conventional ties information from the RISKMETRICS Directors database, the SIC code of the firms from the CRSP, the CEO-award information from the Business Week and Execucomp database and finally, the firm operational performance data from COMPUSTAT.

The findings show that CEOs over time employ socially dependent directors and that there is a positive correlation between socially dependent boards and the CEO compensation (salary + bonus and total compensation). In relation to the conventionally dependent boards, this correlation is much weaker and negative which could affect the board's monitoring capacity. Also, a positive correlation is found between socially dependent boards and CEO power and influence expressed through the negative correlation between socially dependent boards and the CEO turnover to performance (ROA, ROS and ROE) sensitivity, and, a negative correlation between socially dependent boards and compensation to performance sensitivity. These correlations are weaker in the presence of social ties as opposed to conventional ties which shows that social ties allow CEOs to influence the monitoring effectiveness of boards e.g., in order to increase their bonuses.

(Kuhnen, 2009)

The paper examines the effects of business connections between board of directors and advisory firms in the mutual fund industry and especially, in relation to the welfare of the fund investors.

The social ties between directors and advisory firms are based on links when directors sit on fund boards and advisory firms manage those funds. On the basis of the director-advisor network, the social network profile characteristics that are used include: degree, joint degree and influence. Joint degree of an advisor-director pair is the number of ties between them and it captures the number of interactions between them. The influence of an advisory firm over a director is defined as the joint degree over the degree of the director and essentially, it measures the important of the director's ties to that particular advisor in relation to his ties to all other advisors in the network.

The data set comprises of information about advisory contracts for all US mutual funds from 1993 to 2002. It is based on Form N-SAR B and Form N-30D that mutual funds submit to the SEC (Edgar) and includes information on the fund directors as well as

contractual and reimbursement information. The fund information is obtained from the from CRSP mutual funds database.

The findings show that the social ties between directors and advisors (advisor-board connections) influence who wins the contract (advisor selection) and who participates in the fund board. In addition, the findings show that the positive association between advisor-board connections and expenses ratios and advisory fees. Finally, the association between advisor-board connections and reimbursements or fund returns is not proven either way.

(Crespí-Cladera & Pascual-Fuster 2010)

The paper examines the role of social networks among board directors in determining executive directors' compensation.

To define social ties on firm level, they count the number of firm-interlocked executive directors who sited in another board as outside director while an executive director of that firm is also an outside director of the firm.

The paper analyses all firms listed on Spanish Stock Exchange from 2004 to 2008. The main source of information on executives' and directors' pay is collected from Corporate Governance Annual Report available at the Spanish securities commission CNMV website. Data on financial and performance obtains from Thomson Financial Database, data on board executive compensation from annual stock returns data.

The findings show the positive association between executive directors' network measured by closeness and executive pay.They examines whether executive director's compensation is different for management-controlled firms and owner-controlled firm. The network closeness of the executive directors of management-controlled firms is more relevant explaining their compensation in compare to that of owner-controlled firms. Management-controlled firms provide even higher compensation to board executive directors with higher closeness measures and this higher compensation is negatively related to future performance when ROA is used as a performance measure. Ownership

and corporate governance practices has lower future return when ROA is the measure, while there is not any statistically significant relationship when the stock return is the performance measure.

(Mizruchi et al. 2011)

The paper investigates the effects of job performance, social network structure and social network ties on the performance benefits and rewards.

To define social ties, they distinguish social networks based on collegial relations from those based on authority. “Information networks” involves the quest for information about clients, projects and company capabilities which consists of two main groups: product specialist and banker’s superiors. ”Approval networks” involves a quest for support, such as finding those individuals who can give the authority for an employee to perform certain functions. Those in this network are banker’s immediate superior as well as those above him in the hierarchy.

They analyse 80 bankers in the global relationship banking unit of a major multinational financial corporation that they called “UniBank”. All information on bankers’ deal with their customers and network data are derived from two round interviews. Other individual-level data collects from bank’s employee database. In order to check bankers’ educational background in bachelor’s, business or law degree, they uses a list of elite schools identified by(Useem & Karabel 1986).

The findings highlight the differences between information networks and approval network. The findings show that bankers receive higher bonuses when they are in low level of density information network or when they have stronger ties to others in their information network. They report that the combination of strong tie and sparse information network has great influence of the size of the banker bonus.

On the other hand, their analysis was not agreed with their hypotheses involving approval network. They could not confirm bankers would receive higher bonuses when they are in approval network consisted of strong ties. Their analysis, in addition, could not confirm

either positive or negative effect of network density on bonus size. Their further analysis indicates the curvilinear association between approval network density with bonus size. However, the findings reveal that the combination of strong social ties and high density in their approval network would have positive effect on bonus size.

(Pombo & Gutiérrez 2011)

The paper examines the relation of board structure through appointments of outside directors and the role of busy directors on firm performance.

To define links between firms, they define four types of interlocking variables. The first are pure interlocks within or outside the business group relative to board size. The second type is busy directors who hold two or more seats. They are either insiders or outsiders. The third one is the CEO interlocks and fourth type is the family relations.

They analyse all listed firms and privately held firms from Colombian business groups from 1996 to 2006. The financial information and other variables are mainly collected from the National Equity-Issuer Registry Forms filed by Colombia's Financial Superintendence (SFIN). Additional information is obtained from the Colombian Confederation of Chambers of Commerce, the Colombian Stock Exchange, BPR-benchmark (traded as ISI-Emerging Markets) and firm's ownership data was borrowed and updated from (Gutiérrez & Pombo 2009).

The findings show that director interlocking within affiliated firms is a fact that shapes board structure and influences its controlling role over firm performance. When the firm's CEO is a member of the foundingfamily, [Family-CEO], firm's ROA decreases by 2.5% on average. Family member who are active directors have a positive effect through better monitoring. Overall directorate reputation increases firm performance by 0.9% if a company's board members raise the number of external appointments by 10%. In addition, an over-committed director loses a leadership controlling role because too many active appointments imply a rent-seeking behaviour. Outsider busy directors matter in forming more professional directorates and controlling the quality of a firm's investment projects and funding sources.

(Qi 2011)

The paper explores the role of board interlocks on director appointments and firm value. It claims to be the first study that examines the dynamic relationship between these factors.

To define the social ties between directors, social network profile characteristics are used such as friendships and college mates and also assumed that these are usually formed over the director's lifetime. For the "friend" tie, the "seating on the same board" is used as a proxy and on the basis of this, the "friend of a friend" and the "peer referral" social ties between directors are defined. These social ties were used to describe directors in the board interlock network between firms.

Two datasets are analysed, one for the US and one for China. For the US, all S&P 1500 firms from 1996 to 2006 are analysed using director information from the RiskMetrics and the Execucomp datasets. For financial data in relation to firms COMPUSTAT is used. For the China dataset, the CSMAR database is used which provides the Chinese counterparts of RiskMetrics, COMPUSTAT and Execucomp.

The findings show that director appointments are highly influenced by the "peer referral" and "friend of a friend" social ties between the director and the board. The relationship between the board interlock network and the value of the firm are examined and it has been shown that the board interlock impacts positively on the firm value (increase) post-SOX whereas impacts negatively the value pre-SOX.

(Renneboog & Zhao 2011)

The paper explores the relation between CEO compensation and social networks of executive and non-executive directors.

The basic social network profile has two networks: board interlock and director interlock. For each of these networks, they calculate the degree, eigenvector, closeness and

betweenness for board networks. Based on previous literature, they associate the degree and eigenvector metrics (called direct centrality measures) of director interlock network with managerial influence. They also associate the closeness and betweenness metrics (called indirect centrality measures) of director interlock network with information access.

The dataset consists of UK companies from 1996 to 2007 which were listed on the London Stock Exchange and belonging to one the following indices: FTSE 100, FTSE 250, FTSE Small Cap, FTSE Fledgling and FTSE AIM. Remuneration data and detailed Board information is taken from BoardEx, remuneration data from Manifest and ownership data from Thomson Financial and PricewaterhouseCoopers. Finally, sector categorization, accounting information, stock performance and volatility are gathered from Datastream Advance.

In the director interlock network, the degree of CEOs is positively associated with the total CEO compensation. Similarly, normalised closeness of CEOs is positively associated with the total CEO compensation. In the board interlock network, the company degree is positively associated with the total CEO compensation whereas company closeness is negatively associated with the total CEO compensation.

(Brown et al. 2012)

The paper presents the findings on the impact of CEO networking on compensation arrangement.

They define CEO's social network as direct ties developed by the CEO during her life. They measured the total number of contacts with whom the CEO is acquainted, through her current and past employment, her education, and other types of social activities (golf clubs, charity organisations, etc.)

They analyse CEO data from more than 1000 US firms. All CEO data is for the 2005 fiscal year. CEO networking, age and tenure data are collected from BoardEx. All data for compensation was collected from Execucomp, all other accounting and market data from CRSP dataset and shareholder right index (g-index) from RiskMetrics database.

The findings discuss that in order to understand the compensation setting process better, it is important to measure the CEO power in the managerial labour market and not only within the firm.

They show a positive relationship between the size of the social network; therefore her power in managerial labour market; and the level of total CEO pay. In addition, their research confirmed that strong shareholder's right reduce the impact of CEO power on their pay arrangement. In contrast, they reported a strong negative relationship between the size of the social network and the pay-performance sensitivity of compensation package.

(Cai & Sevilir 2012)

The paper examines board connections and M&A transactions.

To define social ties between firms, they use a current board connection between acquirer and target firms. The "first-degree connection" is the type of connection when two firms share a common director before the deal announcement. The "second-degree connection" is where one director from acquirer and one director form the target have been serving on the board of a third firm before the deal announcement.

The paper uses 1,664 US acquisitions from 1996 to 2008.They select all merger and acquisition announcement from SDC merger and acquisitions where both acquirer and target firms are listed as public firms. Financial data and daily stock return data from COMPUSTAT and CRSP respectively as well as available proxy statements from EDGAR, director data from RiskMetrics. In addition, investment banking fee data is collected manually on fairness opinions from Kisgen, Qjan, and Song.

Their findings show that acquisitions of public firms do not lead to value destruction for acquirer shareholders if the acquirer and the target have a board connection at the acquisition announcement. Their analysis on announcement returns reveals that acquirer in both first-degree and second-degree connected transactions perform better in compare with non-connected transactions. In addition, deals with a second-degree

connection are associated with greater value creation which is significantly larger than those in non-connected transactions. Their results seem robust since many factors are being controlled in the analysis. These factors include managerial quality, corporate governance and board characteristics, and other factors known to affect acquirer returns. On the other hand, neither similarity between acquirer and the target in connected transactions nor previous business relation between acquirer and the target nor acquirer acquisition experience could explain their findings.

Considering their analysis on takeover premiums, deal profitability, and transaction fees suggests that first- and second-degree board connections have different implications for an M&A transaction. It could be concluded from their analysis that first-degree connections benefit acquirers by providing access to information about the true value of the target firm, limiting competition from outside less-informed bidders, and allowing them to acquire underperforming firms at an attractive price. On the other hand, second-degree connections appear to facilitate efficient deal-making as evidenced by greater overall value creation experienced by acquirer and target shareholders at the deal announcement, and better operating performance of the combined firm after the deal completion.

(Engelberg et al. 2012)

The paper examines the personal relationships between executives and board members of a firm and their lenders.

To define social ties between individuals in firms and banks, they use three types of personal connections. “School connection” formed when two people graduate from the same educational institution within 2 years of one another. “Third-party past professional connections” formed when two people overlap through either a common past job. “Social connection” formed based on the common participation in social organizations such as charities, volunteer groups, etc.

They analyse bank loans made to publicly traded US companies from 2000 to 2007. The source of this data is Dealscan, a proprietary product from Loan Pricing Corporation. Data

on common organizations and biographical information on executive and board members required for building social network gathers from BoardEx and custom data related to biographical data on personnel from public, data on private commercial banks from Management Diagnostic Limited (MDL) and various firm level data from CRSP.

The findings indicate that by doubling the number of personal connections between a firm and its syndicate partners, the firm pays a spread over 13% less. The result show that firm-bank personal connections lead to less stringent lending terms (covenant) and those firms with the worst credit benefit the most. Furthermore, increasing the number of firm-bank personal connections increases the amount lent. Considering the credit ratings evolution for connected and unconnected firms reveals that the credit ratings of connected (unconnected) firms tend to drift upward (downward) or remain the same.The stock returns of connected borrowers are higher than those of their unconnected counterparts. Moreover, returns are predictable form a firm's personal connectedness to its syndicate members.

(Fracassi & Tate 2012)

The paper presents one of the most clear and well-articulated studies within this research stream. They explore the role of board of directors on corporate governance, policies, Firm Value, acquisitions, shareholder value.

They use biographical information for all directors in the S&P 500, S&P 400 and S&P 600 firms to build the following binary networks: Current Employment Network (directors working within same company), Past Employment Network (directors who have worked in the past in the same company), Education Network (directors who graduated one year apart from the same school) and Other Activities Network (represented through memberships in clubs, organizations or charities) which, together, form the Social Network Index (SNI). SNI is the number of connections of all four types between the outside directors and the CEO.

They analyse the S&P 1500 firms between 2000 and 2007. Their main dataset is biographical information on the directors and top five disclosed earners obtained from

BoardEx. In order to perform their analysis they merge the biographical data from BoardEx with director-, executive-, and firm-level information from various sources. They collect corporate investment measurements from SDC Platinum Mergers & Acquisitions database, firm-level financial information from COMPUSTAT, two firm-level governance measures namely GIM index and the Entrenchment index from RiskMetrics dataset.

Their findings support the hypothesis that companies with more powerful CEOs are more likely to appoint directors connected to the CEO. As a consequence, companies may suffer from weakened monitoring and undermined effective internal governance. In addition, connected independent directors cause lower firm value measured by Tobin's Q.

In addition, their findings show that companies in which a high percentage of independent directors have external network ties to the CEO make more frequent acquisitions than companies with fewer CEO-director connections. These acquisitions destroy shareholder value on average, particularly in companies that also have weak shareholder rights.

(Horton et al. 2012)

The paper examines whether a director's connectedness is associated with compensation and firm's future performance.

To define a complete interlocking directorship they include not only the direct ties between one executive or outside director and another, but also the indirect ties which are generated by a friend of a friend.

They analyse all the UK companies on the London Stock Exchange (LSE) which are listed either on the Main or the Alternative Investment Market (AIM) between 2000 and 2007. They mainly obtain executive and outside director's compensation from Hemscott and other completions from BoardEx as well as all stock market and accounting data from Datastream and Worldscope.

Their overall results show that firms compensate their executive officers according to their position in the social network and for the reciprocating resources. The network

position presented by closeness centrality is positive and significantly associated to compensation for CEO, CFO and other executives. The network position presented by brokerage has a significant positive association with compensation for CEO and CFO. However, firm does not reward other executive based on the brokerage position. In addition, for both chairman and other outside directors the network positions; measured by closeness and brokerage; are positively and significantly associated with compensation. At company level, connectedness is associated with the future operating performance measured by total stock return, market-to-book and ROA.

(Chiu et al. 2013)

The paper examines the role of board interlocks in relation with earning management contagion. Their main focus was on the key role of board monitoring over contagiousness and companies' financial report.

To define social ties between exposed and contagious firms, they define following indicators. EMLINK is a binary indicator which equals 1 if the firm has a board link to a contagious firm during the contagious period. #EMLINK measures the number of such links to contagious firms in a given year. #BOARDLINK is the number of links to other boards in general, regardless of whether the linked firms manage earnings that require subsequent restatements.

The analysed data on restatement and board links. Their dataset mainly included large firms in the S&P 1500 and approximately 400 other widely held firms. They used the US Government Accountability Office's (GAO) first release of restatement (GAO 1) from January 1, 1997 to June 30, 2002 to identify contagious firms and their contagious periods. Data for board network obtained from Risk Metrics and the fraction of institutional holdings from Thompson Financial database.

Their findings show that a firm is more likely to manage earnings during or soon after the period when it shares a common director with a firm that is managing earnings. They found that a firm linked to a non-manipulator is less likely to manage earnings. In addition, they provided evidencethat more important board positions held by the interlocked

director in the exposed or contagious firm have a stronger contagion effect. This relationship being enhanced if the links are through directors with a board chairman or accounting-relevant positions (e.g. audit committee chair or member)(Chiu et al. 2013).

(Larcker et al. 2013)

This paper investigates the board centrality influences on firm performance.

They defined undirected and unweighted boardroom network formed by shared at least one board member.

They analysed the US firms which are all publicly traded firms on the NYSE, NASDAQ and AMEX as well as private firms with annual sales exceeding $1 billion. The sample is selected from 2000 to 2007. They obtained information on firms' board of directors from the Corporate Board Member Magazine Director Database. They merged this dataset with data on firm characteristics, returns and analysts' consensus forecast from COMPUSTAT, CRSP and IBES respectively.

They found out that companies with the better-connected boards on average earn substantially higher future excess returns compared to companies with the less-connected boards. The return difference between best- versus worst- networked companies is stronger among companieswith high growth potential (young companiesor those with low book-to-market ratios) and companiesconfronting adverse circumstances. In addition, their findings presented positive association between the well-connected boards and changes in future profitability as measured by ROA. In addition, well-connected board are more likely to realise earning that exceed the consensus forecast. They confirmed their findings by checking robustness over time, across industries and against a standard set of governance controls.

(Fogel et al. 2014)

The paper investigates the power of independent directors in relation to shareholder wealth and effective monitoring.

They define social network in director level if their graduate or professional educations overlap, if they share prior or current common work experience or if they share board membership in non-profit organisation. To make the centrality measures comparable with each other and over time, they rank the raw values of each centrality measure for all individual each year and assign a percentile value, with 1 the lowest and 100 the highest, to each individual's centrality measures each year. Finally, they define apowerful independent director (PID) as an individual with at least three of the four centrality measures falling in their top quintiles of the distributions of the centrality measures.They create an indicator variable powerful independent board (PIB) for firms with a majority of independent directors and a majority of them PIDs.

They analyse over 8,000 US public and private firms from 1996 to 2010. They use BoardEx dataset to build the social network of executive and directors. They collect financial accounting data, compensation data, and additional data for directors from CRSP, Execucomp and RiskMetrics respectively.

The powerful independent directors can elevate the shareholder wealth by preventing value-destroying decisions such as merger bids and excessive free cash flow retention, by monitoring CEO performance and by linkingCEO payment to company performanceand by forcing out underperforming CEOs as well. They have confirmed that more powerful independent directors can detect managerial missteps better and consequently they can challenge a wayward CEO more effectively because they have access to information as (Granovetter 2005) argued earlier. Their findings revealed that heterogeneous director social power are economically important.

(Fracassi 2014)

In 2014, Fracassi has indicated that social networks influence the way S&P 1500 firms make corporate finance decisions.

They used biographical information for all directors in the S&P 500, S&P 400 and S&P 600 firms from 1999 to 2009. They built the following binary socio-matrix for each network type for each year: Current Employment Network (directors working within same company), Past Employment Network (directors who have worked in the past in the same company), Education Network (directors who graduated one year apart from the same school) and Other Activities Network (represented through memberships in clubs, organizations or charities). In the next step, they aggregate each network in firm-pair level which is a dummy (binary) variable with value 1 if two firms share at least one connection.Finally, they define Social Network index (SNI) as the sum of the social connectivity dummies in previous step.

They collected social network information from BoardEx as well as stock price and accounting data from CRSP dataset.

Their findings have revealed that the nearest social neighbours have the most influence on companies' policy decision making process including investment policy, R&D Ratio, the Cash Ratio and the Interest Coverage Ratio. Two firms that are socially connected with each other change their investment policies more similarly over time than two companies that are not socially connected. Firm pairs that are socially connected seem to have similar levels of capital expenditure, after accounting for firm's characteristics. In addition, more central companies measured as high degree, betweenness and eigenvector and low closeness have better financial performance measured by ROA and Tobin's Q.

4.4 Discussion on dimensions of comparisons

In the previous section a review of the studies examining the link between SN and FP was presented. For each study the following set of aspects was discussed: the aim of the study, the definition of SN, characteristics of sample and data sources and, finally, the findings in relation to SN and FP. In the next section, in contrast to the specific reviews of individual papers, the focus will be on presenting and discussing the patterns we can discern among the studies, namely, data-related characteristics, SN, FP, findings and endogeneity.

4.4.1 Dataset

Once a researcher has formulated a research question, a set of decisions needs to be made with respect to the research design, including the one about data collection. Research in business and organisational studies employs various types of data source and data-collection methods. Respectively, researchers do not rely on a single source of data and usually use a variety of data sources and data-collection methods when investigating the relationship between SN and FP. The list of abbreviations used in this section is presented in Appendix A.

Table 4-2 shows the list of datasets employed by the reviewed studies. BoardEx is used in six studies as the SN data source. There are three popular data sources for FP, namely, COMPUSTAT, CRSP and Execucomp, which are used in eight, four and five studies respectively. RiskMetircs is used as SN or FP data sources in six studies. Table 4-2 indicates that the level of data-set availability is varied, for example, COMPUSTAT, Execucomp and RiskMetircs are available on the Wharton data repository and many researchers have access to them.

Data sets	*Reference*	*SN/FP*
AndrewMetrick'	http://som.yale.edu/andrew-metrick	FP
BoardEx	https://wrds-web.wharton.upenn.edu/wrds/ds/crsp/index.cfm	SN
BoardMag	http://www.boardmag.cz/	SN
Compact D/ SEC	It is CD-ROM format	SN
COMPUSTAT	https://wrds-web.wharton.upenn.edu/wrds/ds/comp/index.cfm	FP
CONFECAMARA	http://www.chamber-commerce.net/dir/1453/The-Colombian-Confederation-of-	SN
CRSP	http://www.crsp.com/	FP
CSMAR	https://wrds-web.wharton.upenn.edu/wrds/ds/csmar/index.cfm	SN & FP
DataStream	https://forms.thomsonreuters.com/datastream/	FP
EdgarOnline	http://www.edgar-online.com/	SN
Execucomp	https://wrds-web.wharton.upenn.edu/wrds/ds/execcomp/exec.cfm	FP
GAO	http://www.gao.gov/	SN
Hemscott	www.hemscott.com	SN
LPC	https://www.loanpricing.com/products/loanconnectordealscan/	FP
Manifest	http://www.manifest.co.uk/what-we-do/data-analytics/	SN
NEI RF	https://www.superfinanciera.gov.co/web_valores/?MIval=Emisores&titulo=%27%27	FP
RiskMetrics	https://wrds-web.wharton.upenn.edu/wrds/ds/riskmetrics/index.cfm	SN & FP
SDC	http://thomsonreuters.com/en/products-services/financial/market-data/sdc-	SN
SDC Platinum	http://thomsonreuters.com/en/products-services/financial/market-data/sdc-	FP
Selected-DS	https://wrds-web.wharton.upenn.edu/wrds/ds/ibes/index.cfm	SN & FP
TF	http://thomsonreuters.com/en/products-services/financial.html	FP
Worldscope	http://extranet.datastream.com/Data/Worldscope/index.htm	FP

Table 4-2. List of data sources in reviewed studies

The study reviews a set of characteristics for datasets, which are described in Table 4-3. Table 4-4 presents a summary of data-set characteristics used in the reviewed studies. Having reviewed the data-set characteristics, it is clear that country or region of study is an important factor that can divide studies into two main categories: studies that analyse US firms and studies analysing firms from other countries. Fifteen out of twenty-one (71.42%) studies are conducted on a sample of US firms. Data availability could be an important determinant of sample selection. All studies use structured data for both SN and FP data sources, with the exception of one, namely [2009-3]. In general 5 out of 15 studies and 4 out of 15 studies use RiskMetrics and BoardEx datasets respectively as their social network dataset. Financial variables are taken from COMPUSTAT, Execucomp and CRSP in 8 out of 15 studies, 5 out of 15 and 4 out of 15 studies respectively. Another advantage of the above-mentioned datasets is that they have been available for a long time, for example, COMPUSTAT has been available from 1950, Execucomp from 1992, CRSP from 1925, BoardEx from 1999 and RiskMetrics from 1996. Consequently, this provides an opportunity for studies to analyse a panel dataset and test their hypotheses for a period of time rather than one specific year. In addition, results are biased towards the US publicly traded firms presented as the S&P1500 index.

On the other hand, 6 out of 21 (28.57%) studies analyse a non-US dataset, namely, Colombia, Spain, Korea, the UK and even a set of international firms. All of them rely on data that is available locally to the selected country or region, or they use unstructured data sources such as interviews and annual reports. In both studies performed in the UK, BoardEx is used as an SN dataset and Datastream as an FP dataset.

RiskMetrics has a specific variable called interlocking directorship, which means that a director is serving on the boards of other firms. This is used mainly by those studies that focus on board interlock rather than social ties. In addition, when some studies use RiskMetrics to build the social network and, more precisely, board interlocks, this means they have the same definition for social network. On the other hand, one-third of studies use BoardEx to build the social network. Whereas BoardEx is very well known in terms of collecting detailed information on current employment, prior employment, education and

other activities for key top executives and directors on the board, social network could be defined in various ways, which makes it difficult to compare approaches.

Replicability considers whether someone could replicate the analysis presented in a study. The following factors are important in terms of replicating the analyses of a study:

- Data-set availability;
- Whether variables belong to a specific dataset;
- Sample selection;
- Derived variables are defined precisely.

Based on the above criteria, fewer than half of the studies could be replicated (38 per cent).

Column Name	Description	Example
Paper No.	Each paper is coded and they will be used in the exchange of paper	2014-1
Paper reference	Paper reference	(Larcker et al.,
Datasets	The list of datasets which are used to extract SN and FP variables.	BoardEx
SN Profile	SN variables	Degree
FP Profile	FP variables	ROA
Time span	The time period of the selected sample	1996-2010
Sample size	The number of firms analysed in a study	1,417
Market Index		S&P1500
Country/ region	Country/ region coverage of the selected sample	US
Replicability	Whether someone could replicate the analysis	Yes/No
SN datasources	Structured/ Unstructured/ Both	Structured
FP data sources	Structured/ Unstructured/ Both	Unstructured

Table 4-3. An overview of datasets characteristics

Paper No.	Data sets	Social Network Profile	Financial Profile	Year	Sample size	Sector	Market Index	country/ region	Replicability	SN data sources (Structured/ Unstructured/ Both)	FP data sources (Structured/ Unstructured/ Both)	Endogeneity
2014-1	BoardEx	PID, PIB		1996-2010	1,417		S&P1500	US	Yes	Structured	Structured	L
	COMPUSTAT		Tobin's Q									
2014-2	BoardEx	SNI		1997-2010	2,059	All sectors except financial sector	S&P1500	US	Yes	Structured	Structured	L
	COMPUSTAT		Cash Flow ratio, Interest Coverage, R&D Ratio, Return on Assets (ROA), Tobin's Q									
2013-1	RiskMetrics/ GAO	EMLINK, #EMLINK, #BoardLinks to Earning Manipulators		1997-2002	118		S&P1500+ 400 widely held firms	US, Intl.	No	Structured	Structured	F
	COMPUSTAT/ Edgar		BoardLinks to Earning Manipulators, Board position (Board chairman, audit committee chair, audit committee member)									
2013-2	BoardMag	Board's well-connectedness		2000-2007	3896	All sectors	NYSE, NASDAQ, AMEX, PF-1B	US	Yes	Structured	Structured	L
	COMPUSTAT		Future returns, ROA									
2012-1	BoardEx	CEO network (Degree), CEO power in the managerial labour market		2005	1000			US	No	Structured	Structured	Yes
	Execucomp		CEO compensation level, pay-performance sensitivity									

Paper No.	Data sets	Social Network Profile	Financial Profile	Year	Sample size	Sector	Market Index	country/ region	Replicability	SN data sources (Structured/ Unstructured/ Both)	FP data sources (Structured/ Unstructured/ Both)	Endogeneity
2012-2	RiskMetrics/ EDGAR	First-degree connection, Second-degree connection		1996-2008	1,664		NYSE, AMEX, NAZDAQ	US	Yes	Structured	Structured	F
	CRSP		ACARs									
2012-3	SDC	School connections, third-party past professional connections		2000-2007	17,428			US	No	Structured	Structured	L
	CRSP		Stock returns									
	LPC		Loan convenant, Credit spread, Loan size, Credit rating downgrades									
2012-4	BoardEx	SNI	Director selection	2000-2007	11,468		S&P1500	US	Yes	Structured	Structured	Yes
	COMPUSTAT		Tobin's Q									
	SDC Platinum MA		Acquisitions									
2012-5	BoardEx	Executive social network, Outside directors social network, firms ' aggregated social network (Closeness, Brokerage position)	LTIP	2000-2007	3,332		LSE	UK	No	Structured	Structured	L
	DataStream/ Worldscope		Total stock return, market-to-book, ROA									
	Hemscott		Compensation									

Paper No.	Data sets	Social Network Profile	Financial Profile	Year	Sample size	Sector	Market Index	country/ region	Replicability	SN data sources (Structured/ Unstructured/ Both)	FP data sources (Structured/ Unstructured/ Both)	Endogeneity
2011-1	Interview	Information networks, Approval networks		1998-1999	80		UniBank	Intl.	No	Unstructured	Structured	L
	BankEmp		Bonus									
2011-2	CONFECAMARAS	Pure interlocks outside Business Group, Family-CEO, Family members-participants		1996-2006	351		Colombian Stock Exchange	CO	No	Structured	Structured	I
	NEI RF		ROA									
2011-3	RiskMetrics/ CSMAR	**Board interlock**(Peer, Peer referral, Friend of friend, Seating on the same board)		1996-2006	2,738		S&P1500	US, China	No	Structured	Structured	L
	COMPUSTAT/ CSMAR		Firm value									
	Execucomp/ CSMAR		Director's Total Compensation, Director appointment									
2011-4	BoardEx/ Manifest/ AR	**Board interlock**(Degree and eigenvector, closeness and betweenness), D**irector interlock** (Degree and eigenvector, closeness and betweenness)		1996-2007	1,758		LSE	UK	No	Both	Structured	I
	Datastream		Total compensation									

Paper No.	Data sets	Social Network Profile	Financial Profile	Year	Sample size	Sector	Market Index	country/ region	Replicability	SN data sources (Structured/ Unstructured/ Both)	FP data sources (Structured/ Unstructured/ Both)	Endogeneity
2010-1	AR	**Board Interlock** (Degree, Closeness, Betweenness)		2004-2008	628		Spanish Stock Exchange	Spain	Yes	Structured	Structured	L
	ASR		Executive compensation									
	TF		ROA, stock returns									
2009-1	RiskMetrics	Firm level network (Eigenvector)	Future director appointment	1996-2004	1,914		S&P1500	US	No	Structured	Structured	I, F
	COMPUSTAT		CEO pay-performance sensitivity									
	Execucomp		CEO salary, CEO compensation									
2009-2	Compact D/ SEC	**Board interlock (**Total board links, Joint degree, backdating ties)		1996-2002	25,610	Fama&French 30 industries		US	No	Structured	Structured	No
	CRSP		Backdaters									
2009-3	Selected-DS	Social ties, Socially dependent Board	Total Assets, MB, ROA, RET, ROS, ROE	1996-2005	704		Fortune 100	US	No	Unstructured	Structured	L
	RiskMetrics	Conventional ties, Conventionally Independent Board										
	Execucomp		CEO compensation (salary + bonus, total compensation)									
2009-4	EdgarOnline	Advisor-Board Level Measures (Influence, JointDegree, degree)	Director selection, Subadvisor selection	1993-2002			Mutual funds	US	Yes	Structured	Structured	No

Paper No.	Data sets	Social Network Profile	Financial Profile	Year	Sample size	Sector	Market Index	country/ region	Replicability	SN data sources (Structured/ Unstructured/ Both)	FP data sources (Structured/ Unstructured/ Both)	Endogeneity
	Annual N-SAR B		Advisory fees, Expense reimbursements									
	N-30D		Director selection, Subadvisor selection									
	CRSP		Expense ratios, Fund net returns									
2008-1	Questionnaire	CEOs' external advice seeking behaviours	Board Monitoring	1998-1999	225	Industrial & Service sector	Forbes	US	No	Structured	Structured	No
	TF		CEO Stock Ownership									
	COMPUSTAT		ROA, Market-to-Book Value									
2008-2	RiskMetrics	Board membership ties, Immediate family" ties	Tobin's Q	2005				US	No	Structured	Structured	L
	AndrewMetrick		Corporate governance index									
	Execucomp		CEO compensation									
2005-1	CGC CSD	**Board network** (Family ties, Elite school network, External economic association membership network), Board network density		1990-1999			Large Publicly traded firms	Korea	No	Structured	Unstructured	L
	AR		ROA									

Table 4-4. SN-FP dataset characteristics

Figure 4-1 presents the time-span analysis, which shows the probability of analysing a specific year within a time span. The data sample in each study covers a time span of between 1990 and 2010. There are a number of studies analysing just one year that make a pick selection in year 2005. It is clearly demonstrated that the time span from 1997 to 2007 is covered by many studies.

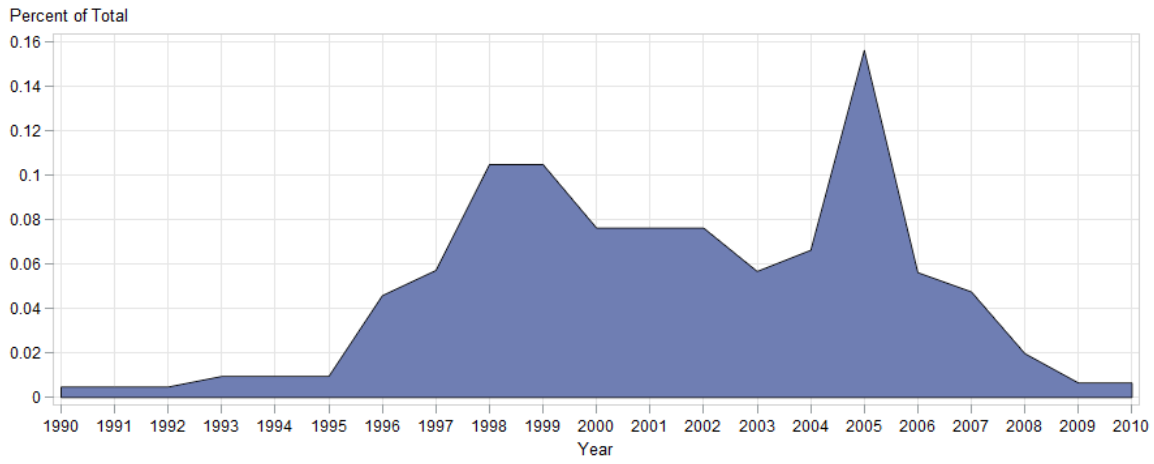

Figure4-1. Time span analysis

4.4.2 Social Network Profile

In relation to the social network profile of firms, there are two arguments that make comparisons of studies difficult. One is the definition of social network profile in each study and the second is the social network metrics employed by each study.

Social Network Profile Definition: Social network analysis uses the network theory, which includes nodes and links to represent any social network. We can differentiate between two types of node in the social networks of firms, namely, directors and firms. In addition, a variety of definitions can be used to define the links between the nodes, and the graph-based structures that are produced are often complex.

Since the focus of the social network is the relationships between nodes rather than the attributes of individual nodes, it is important to examine the definition of social network in each study. It is clear that in social network analysis, one size does not fit all. Every individual data set is a collection of different attributes. Therefore, all the above studies have customised the social network definition in such a way as to address their research

questions. Some studies limit their definition to board interlock (interlocking directorate). Alternatively, it is also possible to extend directors' networks beyond "interlock directorate" by considering informal social connections associated with directors' demographic and professional characteristics. After further review of the definition of social ties in each study, it is concluded that social ties could be formed at director (e.g. [2014-1]) or firm (board) level (e.g. [2012-1]). Table 4-5presents an overview of the social network, whether it is board interlocks or social ties and whether social ties are created at director level or board level.

Social Network metrics: Each study measures the influence of the social network using various sets of social network metrics. Social network centrality metrics are the most popular metrics, which help to identify the role of each director/firm within the social network. Social network centrality metrics are degree, closeness, betweenness and eigenvector, which measure the power of directors/firms from different perspectives (Shahgholian et al. 2015).

Table 4-5 presents the list of social network metrics employed by each study. With the exception of [2008-2], [2011-1] and [2012-3], other studies use at least one social network centrality metric. As shown in Table 4-5, degree is the most frequent social network metric, which is used in 15 studies. Eleven studies employ only degree as their measure of social network profile, because degree presents the importance of direct connections to other directors/firms in order to access direct sources of information and consequently influence or be influenced by them (Shahgholian et al. 2015).

Various combinations of social network metrics are indicated among studies, for example, using all four centrality metrics (in four studies: [2011-4][2013-2][2014-1][2014-2]); using degree, betweenness and closeness (in [2010-1]); using closeness along with brokerage (in [2012-5]); and using only eigenvector (in [2009-1]). Each study has its own justification for using a particular combination of social network centrality metrics. For example, [2011-4],[2013-2],[2014-1] and[2014-2] use all four centrality metrics. [2011-4] argues that degree and eigenvector focus on direct (local) connections and closeness, and betweenness focuses on the ability to collect information. However, [2014-2] uses degree and betweenness to capture the information flow and closeness, and eigenvector to

capture influence. On the other hand, [2013-2] and [2014-1] rely on the point that well-connectedness is multi-dimensional. Both [2010-1] and [2012-5] refer to the social network theory to use the combination of centrality metrics, and [200-1] uses eigenvector for simplicity of the exposition and for tractability.

Three studies do not use any social network centrality metrics [2008-2], [2011-1] and [2012-3], the main reason being their definitions of social network. In [2008-2] social network is defined as an internal social tie between the CEO and other board members. Therefore, the social network metrics are derived from board characteristics. In [2011-1] the social network is defined as when bankers seek either information about customers or deals or to gain support or confirmation for the deal. The means of defining eight people during their consultancy, and the method of rating their relationship to them, direct the study to use tie strengths and density instead of social network centrality metrics. In [2012-3] the existing relationships between firms and lenders are examined through three different types of relationship, namely, school connection, third-party past professional connections and social connections.

Two studies use the "joint degree" metric, which takes into account the number of common board members between each pair of firms [2009-2][2009-4].It is different to degree in the sense that it focuses on the degree between each pair of firms/director, while degree is a metric for a director/firm in relation to the whole network. In [2009-2] they not only consider the existence of board interlock between two firms, but they also use the number of common board members between each pair of firms in their analysis. In [2009-4] joint degree is used with exactly the same definition. In addition, they calculate an influence metric, which is defined as the joint degree over the degree of the director. This metric measures the importance of a director's ties to that particular director in relation to his or her overall connections to other directors in the network.

Paper No.	*Degree*	*Betweenness*	*Closeness*	*Eigenvector*	*Other metrics*	*Director/ Firm level*
2014-1	√	√	√	√		Director
2014-2	√	√	√	√		Director
2013-1	√					Firm
2013-2	√	√	√	√		Firm
2012-1	√					Director
2012-2	√					Firm
2012-3					Existing a link	Firm
2012-4	√					Director
2012-5			√		Brokerage	Both
2011-1					Density, Strength of ties	Director
2011-2	√					Both
2011-3	√					Director
2011-4	√	√	√	√		Both
2010-1	√	√	√			Director
2009-1				√		Firm
2009-2					Joint degree, Board Interlock	Firm
2009-3	√					Director
2009-4	√				Joint degree, Influence	Firm
2008-1	√					Firm
2008-2					Board characteristics	Firm
2005-1	√				Density	Firm
Total	15	5	6	5		13 firm level, 10 director level

Table 4-5. An overview of social network metrics

4.4.3 Financial Profile

Table 4-6 presents the list of FP variables and the frequency of using them in studies, which are classified into three groups: accounting-based, market-based and organisational-based.

Overall, 7 variables within the category of organisational-based are examined in 12 studies. Compensation, bonus or salary is the most frequent organisational-based variable used in the studies (10 studies).Accounting-based includes eight variables that are examined in nine studies. ROA is the most frequent variable in this group and is used

in seven studies. Market-based includes 13 variables, which are examined in 11 studies. Tobins'Q, market-to-book value and stock returns are the most frequent variables in this group, which are used in four, two and two studies respectively.

Organisational-based measures	Frequency
Compensation/ Salary/bonus	10
Director selection	4
Pay-performance	1
Board monitoring	1
CEO stock	1
CEO background	1
Corporate	1

Panel A. Organisational-based measures

Accounting-based measures	Frequency
ROA	7
Interest coverage	1
R&D ratio	1
Firm value	1
Fund net return	1
Expense	1
Expense ratio	1
Advisory fees	1

Panel B. Accounting-based measures

Market-based measures	Frequency
Tobin's Q	4
Market-to-Book value	2
Stock return	2
Board earning	1
Future return	1
Credit spread	1
Loan covenant	1
Loan size	1
Credit rating downgrades	1
Cash flow ratio	1
ACARs	1
Acquisitions	1
Backdaters	1

Panel C. Market-based measures

Table 4-6. List of FP variables and their frequency

Table 4-7 presents the list of studies and the FP variables used in each study. FP variables are classified into three groups. It is clear that studies do not specifically analyse one category of FP variables. Only two studies focus on accounting-based, five studies on market-based and six studies on organisational-based variables. Other studies test their hypotheses in relation to FP variables from different groups of FP.

Paper No.	Accounting-based	Market-based	Organisational-based
2014-1		Tobin's Q	
2014-2	ROA, Interest Coverage, R&D Ratio	Tobin's Q, Cash Flow ratio	
2013-1		Board Earning Management Contagion	
2013-2	ROA	Future returns	
2012-1			Compensation, Pay-performance sensitivity
2012-2		ACARs	
2012-3		Credit spread, Loan covenant, Loan size, Credit rating downgrades, Stock returns	
2012-4		Tobin's Q, Acquisitions	Director selection
2012-5	ROA	Total stock return, Market-to-Book	Compensation, Compensation + LTIP
2011-1			Bonus, Salary
2011-2	ROA		
2011-3	Firm value (post-SOX, pre-SOX)		Director's compensation, Director appointment
2011-4			CEO's compensation
2010-1	ROA		Executive compensation
2009-1			CEO salary, CEO total compensation, CEO pay-performance sensitivity, Future Director Appointment
2009-2		Backdaters	
2009-3			CEO compensation (salary + bonus, total compensation), CEO power & influence
2009-4	Fund net returns, Expense Reimbursements, Expense Ratio, Advisory fees		Sub advisor selection, Director selection
2008-1	ROA	Market-to-Book Value	Board Monitoring,CEO Stock Ownership,CEO performance-contingent compensation,CEO Background
2008-2		Tobin's Q	Executive compensation, Corporate governance index
2005-1	ROA		
Total	9	11	12

Table 4-7. List of studies with the classification of FP variables

4.4.4 Findings

Overall, 21 studies analyse various hypotheses in relation to the link between SN and FP. Table 4-8 shows the findings of studies in the format of explanatory variables, dependent variables, predicted relationship and obtained results after analysis. The direction of analysis is from SN to FP in all studies.

The impact of social network on compensation is tested in eight studies. All fivestudies that define social network at the director level predict and support the positive impact of the social network on compensation:[2010-1],[2011-4],[2012-5],[2012-1] and[2014-1].However, we do not see this pattern among four studies that define social network at firm level. While [2009-1] and [2009-3] predict and support the positive impact of social network on compensation, [2008-2] and [2011-4] predict and support the negative impact of social network on compensation. The positive impact of social networking on director selection is predicted and supported in [2009-1],[2009-4], [2011-3] and[2012-4].

In addition, in relation to ROA being the most popular accounting-based measure among the reviewed studies, the positive impact of social network on ROA is indicated, [2005-1],[2010-1],[2011-2],[2012-5],[2013-2]and [2014-2], except for when a CEO is also a family member, which shows a negative impact on ROA [2011-2].

4.4.5 Endogeneity

Researchers are interested in the causal relationships between social network and firm performance. They use observational data, which could be correlated with the unseen error term. Therefore, endogeneity is an important issue that could directly affect the research findings (Bascle 2008). Endogeneity occurs in cases where the independent variable in a regression model is associated with the error term or some kind of causality between dependent and independent variables. Table 4-4 indicates whether studies consider endogeneity in their research. As far as we are concerned, 85.7 per cent of studies do check endogeneity. Studies deal with endogeneity by using lagged data (11 studies), fixed-term effect model (3 studies) or instrumental variables (3 studies). When studies employ questionnaires or interviews or analyse data for one year, they do not check endogeneity: [2008-1],[2009-4]and [2009-1].

Paper No	Findings			
	left	right	Predicted direction	Support?
2014-1	PIB	Shareholder value (Tobin's Q)/ M&A decisions	+	Yes
	PIB	Free cash flow	-	Yes
	PIBC, IDDC	CEO total compensation	+	Yes
2014-2	SNI	R&D ratio/ Cash ratio/ Interest coverage/ ROA/ Tobin's Q	+	Yes
2013-1	BoardLinks to Earning Manipulators/ Board position	Board Earning Management Contagion	+	Yes
2013-2	Centrality metrics	Future returns	+	Yes
	Well-connected boards	Change in profitability (ROA)	+	Yes
2012-1	CEO social networks	CEO Compensation level	+	Yes
	CEO power in the managerial labour market	Pay-performance sensitivity	+	Yes
2012-2	First-degree connections/ Second-degree connections	Five-day ACAR	+	Yes
2012-3	School connections or third-party pas professional connections	Credit spread/ Loan size/ Stock returns	+	Yes
	School connections or third-party pas professional connections	Loan convenant/ Credit rating downgrades	-	Yes
2012-4	SNI	Director selection/ Acquisitions	+	Yes
	SNI	Tobin's Q	-	Yes
2012-5	CEO network (Closeness/Brokerage position)/Outside director's SN	Total Compensation	+	Yes
	Firm's social network-Closeness	Stock return/ Market-to-Book/ ROA	+	Yes
2011-1	Information networks-Density/ Tie strength/ Tie strength*Density	Bonus	+	Yes
	Approval networks- Density/ Tie strength	Bonus	-	No
	Approval networks- Tie strength*Density/ Square Density	Bonus	+	Yes
2011-2	Family-CEO	ROA	-	Yes
	Family members-participants/ Busy directors outsiders	ROA	+	Yes
2011-3	peer referral/ friend of a friend	Director appointment	+	Yes
	Board interlock	Firm value (post-SOX)	+	Yes
	Board interlock	Firm value (pre-SOX)	-	Yes
2011-4	Director level -Degree/ Closeness	CEO's total compensation	+	Yes
	Firm level-Degree	CEO's total compensation	+	No
	Firm level- Closeness	CEO's total compensation	-	Yes

Paper No	Findings			
	left	*right*	*Predicted direction*	*Support?*
2010-1	Executive director's network closeness Executive director (high closeness-management-controlled firm)	Executive compensation Executive compensation/ ROA	+ +	Yes Yes
2009-1	Firm level network (Eigenvector)	CEO salary/ CEO total compensation/ CEO pay-performance sensitivity/ Future Director Appointment	+	Yes
2009-2	Board interlock/ Joint degree	Backdaters	+	Yes
2009-3	Socially dependent boards	CEO compensation/ CEO Power & influence	+	Yes
2009-4	Joint degree/ Influence Influence joint degree& Influence	subadvisor selection/ Expenses ratios/ Advisory fees Director selection Expense reimbursements/ Fund net returns	+ + +	Yes Yes No
2008-1	CEO Stock Ownership/ Board monitoring CEO performance-contingent compensation Board monitoring	CEOs' external advice seeking behaviours CEOs' external advice seeking behaviours CEOs' external advice seeking behaviours when outside director have high levels of prior executive experience	+ + + +	Yes Yes Yes Yes
2008-2	AGEDIFF, EXEC/ ETHN, EXEC ETHN ETHN	Corporate governance index Tobin's Q Executive compensation	+ + -	Yes Yes Yes
2005-1	Board network density/ Elite school network External economic association membership network	ROA ROA	+ +	Yes No

Table 4-8. SN-FP findings

4.5 Conclusion and future work

Our study presents an overview of 21 empirical studies conducted on the relationships between SN and FP from 2004 to 2014. The study expands the view of this relationship from the perspective of data characteristics, which concentrates on the characteristics of data sample, data sources, SN profile, FP profile, findings and endogeneity. First, we provided a brief overview of each paper to cover the aim of each study, the definition of social network profile, the full description of the analysed sample and the datasets and, finally, the findings related to SN and FP. Then we discussed and compared data-related characteristics such as sample size, industrial sector, market index, country coverage, type of data source for SN and FP and, finally, the replicability of the analysis. The findings of this study confirm that these studies cover different periods, mainly between 1997 and 2010.These studies are biased toward the US publicly traded firms presented in the S&P1500 index. The majority of these studies analyse a sample of US firms. The availability of datasets is another important issue that directly influences the data sample selection. The lack of transparency in data-set availability, sample selection, selecting variables or derived variables leads to the conclusion that only 38 per cent of the reviewed studies are replicable. The majority of studies do not have any concern about the industrial sector, using a structured dataset to extract SN and FP variables. However, some use unstructured datasets (e.g. interview or document), which need to be processed before they can be useful in extracting variables.

In addition, each study has its own definition of social network. Studies employ a set of social network metrics, which in most cases are not justified, and then interpret accurately. This level of uncertainty in social network definition and using a variety of social network metrics comes from the lack of a deep understanding of social network theory and its application in a business context.

This study shows that studies employ a variety of financial data, which we categorised into accounting-based, market-based and organisational-based. The results show that the majority of studies focus on organisational-based variables such as director appointment, compensation and bonuses. ROA and Tobin's Q are the most frequent variables in accounting-based and market-based groups respectively. The results show that all the reviewed studies examine the links from SN to FP and most check for endogeneity.

Theoretical Implications

The theoretical contribution of this study is to enrich the domain knowledge by providing comprehensive insights into the literature examining the relationship between SN and FP. Another contribution of this study is to reduce inconsistency in the use of terminologies. To be more specific, this study defines SN and FP and provides the classifications for each, which helps in recognising the key area that is associated with and affects the SN–FP relationship.

One of the most important contributions of this research is to provide an extensive overview of the relationship between SN and FP at the data level, which has not yet been conducted. The researcher investigates both research streams at data level, because data forms the basis of any research. The main contribution of this paper is to identify issues with data collection, data characteristics and offer recommendations on both these issues.

Managerial Implications

The results of our study confirm that managers need to pay attention to the structure of the board of directors and appoint directors considering not only their experience and reputation, but also their links to others. This confirms the role of the board of directors based on resource-dependence theory (Hillman & Dalziel 2003). The benefits of using social networks would increase if managers looked at the social network between directors as opportunities rather than threats. The fact that social networks and their associated resources provide benefits to firms' financial profiles is examined in various studies. It is obvious that the social network facilitates access to resources such as bank loans [2012-3] or plays an important role in M&A [2012-3] in the sense of not leading to value destruction for acquirer shareholders. In addition, the social network between directors could offer information related to firm profitability (e.g. [2014-2][2013-2][2005-1]), improving the image of firms in the market([2014-1][2014-2][2008-2]) or director appointments([2009-1][2009-4][2011-3][2012-4]).

This study focuses only on the findings that directly depict the relationship between SN and FP. The interdependencies, mediation or moderation findings need to be addressed

in future research. In addition, we recommend examining the influence of the research methodology and analysis method on the SN–FP relationship. Furthermore, each study covers a time span of between 1997 and 2010. By taking into consideration the advances in technology and social media channels, there is greater potential for directors to be part of different types of social network. Therefore, it is recommended to analyse the more recent years.

Those studies focusing on one year of study alone examine one snapshot of a social network. However, a social network evolves through the addition or deletion of nodes and links between them. It would therefore be appreciated if the study examined their hypotheses for a longer period of time.

There is no doubt that the study of social networks has expanded in recent decades into many research disciplines, including firms' financial profile. Perhaps in future research, social network should be defined more precisely by identifying the node (e.g. directors) and links (e.g. sitting on the same board). Once social network has been defined, social network metrics could be defined and interpreted accordingly. Although there is a variety of social network metrics, social network centrality metrics are the most popular.

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Appendix A:**List of Abbreviations:**

Abbreviation	Stands for	
ACARs	Acquirer Cumulative Abnormal Returns	FP(Financial Profile)
AndrewMetrick	Andrew Metrick's website	DS (dataset)
AR	Annual Report	DS
ASR	Annual stock returns data	DS
BankEmp	Bank's employee database	DS
Board position	Board chairman, audit committee chair, audit committee member	FP
BoardMag	Corporate Board Member Magazine Director Database	DS
CEOs' external advice seeking behaviours	CEO advice seeking from not friend executives / or with different functional background	SN(Social Network Profile)
CGC CSD	Chaebol group Chaebol Chong-soo-dle	DS
CO	Colombia	Country name
Compact D/SEC	Compact Disclosure database	DS
CONFECAMARAS	The Colombian Confederation of Chambers of Commerce	DS
IDDC	Independent Directors on Compensation Committee	SN
Intl.	International	General
LPC	Dealscan of Loan Pricing Corporation	DS
LSE	London Stock Exchange	Index
MB	Growth opportunities	FP
MDL	Management Diagnostic Limited	Firm name
NEI RF	National Equity-Issue Registry Forms	DS
PF-1B	Private firms with annual sale >$1billion	Index
PIB	Powerful Independent Board	SN
PIBC	Powerfully Independent Board Compensation Committee	SN
PID	Powerful Independent Director	SN
RET	Annual Stock Returns	FP
SDC Platinum MA	SDC Platinum Mergers & Acquisitions Database	DS
Selected-DS	IBES/ Marquis Who's Who/ Notable Names / Business Week archives/ Family Business with proxy disclosure/ Blockholders	DS
SN	Social Network	SN
SNI	Social Network Index	SN
TF	Thomson Financial	DS
L	Lagged variable	
I	Instrumental Variable	
F	Fixed-effect model	

Chapter 5 Social Network Metrics: the BoardEx case Study

Abstract

Social networks and methods for their analysis have attracted considerable interest in various research areas. One type of social networks that has been the subject of extensive analysis, especially in the corporate governance literature, is networks between company directors and firms, between directors and between firms (board interlock). The purpose of this paper is to discuss social network metrics for such types of networks and examine their interpretation and correlations from a domain-specific viewpoint. This work will help position, review and compare previous literature, especially in finance/corporate governance area that examines such types of networks.

For the purposes of this paper, the BoardEx dataset is used to define the social networks between directors and firms and their corresponding metrics. This dataset keeps information about individuals, mainly from USA and Europe, who work in publicly quoted firms and major private firms at board and executive management levels. The information includes in-depth profiles such as academic qualifications, current and past job positions, membership to professional and other bodies, peer esteem indicators such as awards and honorary positions, etc.

In addition to a detailed description of the dataset, the different types of networks that could be created are defined based on network theory. Furthermore, five node level metrics have been chosen to be analysed, namely degree, closeness, betweenness, eigenvector and clustering coefficient. These metrics are defined theoretically based on the network theory literature and their application and interpretation is elaborated. Finally, the correlations between these metrics is discussed theoretically and exemplified through the case study.

Keywords: Social network analysis, BoardEx, Director social network, Firm social network

5.1 Introduction

Social networks and methods for their analysis have attracted considerable interest in various research areas such as sociology (Wasserman & Faust 1994; Bonacich 1987), email communications (Tyler et al. 2005), economics (Boginski et al. 2006)and finance (Fracassi & G. A. Tate 2012) among others. A social network is defined as a set of nodes and a set of links (ties) representing the relationship between the nodes (Brass et al. 2004).

The analysis of social networks examines the structure using network theory (Wellman 2007) and their characteristics are defined using various social network metrics (Borgatti 2005)(Freeman 1979)(Wasserman & Faust 1994)(Bonacich 2007). In general, social network metrics can be classified into three main types (Ahuja et al. 2012):

- metrics that relate to the nodes(individual nodes or groups of nodes)
- metrics that relate to the links
- network level metrics

In the case of multiple networks examined at the same time (single or multi-level)(Bródka et al. 2012), it is also possible to define inter-network metrics especially in the context of network evolution over time (Ahuja et al. 2012).

The purpose of this paper is to review the selected social network metrics that relate to the nodes as these have been defined in the literature. These metrics will be defined theoretically and their application and interpretation through the BoardEx case study (BoardEx 2011) will be discussed. For the purposes of this paper, various social networks will be defined and they will be used to explain the application and interpretation of the metrics.

This paper is organised as follows. Section 5.2 describes the BoardEx case study, the datasets and the various social networks that could be created on the basis of the datasets. Section 5.3 defines various node centrality metrics as these have been used in the network theory literature and provides their interpretations in relation to the case study. Section 5.4 discusses the correlations between the various node centrality metrics based on network theory and also experimentally through the examination of the Boardex dataset for 2011. Finally, section 5.5 summarises the discussion.

5.2 The BoardEx Case Study

BoardEx (BoardEx 2011) keeps information about individuals, mainly from USA and Europe, that work in publicly quoted firms and major private entities at board and executive management levels. The information includes in-depth profiles such as academic qualifications, current and past job positions, membership to professional and other bodies, peer esteem indicators such as awards and honorary positions, etc. On the basis of this information, BoardEx (BoardEx 2011)provides business networking services to organisations and individuals that would like to find out information about certain individuals and their contacts (interpersonal links) and the relationship of their contacts with other individuals (social network).

The dataset includes information about SP1500 firms and their directors on an annual basis. Table 5-1 gives an overview of the SP1500 firm dataset. This contains information about the SP1500 firms and their directors for each year.

The dataset also includes information about the directors on an annual basis in terms of their educational background (see Table 5-4), other employment in SP1500 or nonSP1500 firms (see Table 5-2) and finally, other activities that directors are involved such as members of committees, charities, etc. (see Table 5-3).

SP1500 Firms		
Column Name	**Description**	**Example**
Report Date	The date the record was created.	28-May-01
BoardID	This is a unique id generated by BoardEx	11053344
Company Name	The name of the company.	3COM CORP
ISIN	The ISIN listed is the latest ISIN attached to the Company	US8855351040
Director ID	The id for the director. This id is a BoardEx provided unique id.	10245211188
Last Name		Claflin
First Name		Bruce
Middle Name		L
Date of Birth		10-Oct-51
Gender		Male
Nationality		American
RoleID	This is a unique id generated by BoardEx	39
Role Name	Gives the role (job title) of the director. The role name corresponds one-to-	President/CEO
Role Description	The role description contains additional information including in some	NULL
SD/ED	SD or ED. Indicate whether a director is an executive or not.	ED
Date Started Current	The date when the director was assigned the specific role	03-Jan-01
Date Started in	The date when the director started in the company irrespective of the role	03-Jan-01

Table 5-1.SP1500 Firm dataset

Current Other Employment		
Column Name	**Description**	**Example**
Report Date	The date the record was created.	28-May-01
Board ID	This is a unique id generated by BoardEx	11053344
Company Name		3COM CORP
ISIN	The ISIN of the SP1500 company; empty if de-listed,	US8855351040
Director ID	This is a unique id generated by BoardEx	392532746
Last Name	Last name (director)	Gassée
First Name	First name (director)	Jean-louis
Middle Name	Middle name (director)	F
Other Current Board ID	Unique id generated by BoardEx	697911980
Other Current Company Name		BE INCORP
ISIN (1)	The ISIN of the other company if it exists	NULL
RoleID	This is a unique id generated by BoardEx	315
Role Name	Gives the role (job title) of the director. The role	Chairman/President/CEO
Role Description	The role description contains additional	Also Co-Founder
ED or SD	Values are ED, SD or SM.	ED
Start Date	The date when the specific role started	Oct-90
End Date	The date when the specific role ended	10-Dec-01
Date Started in Other Co	The date when the director started working on the	Oct-90

Table 5-2. The Directors' Other Employment dataset

Other Activities		
Column Name	**Description**	**Example**
Report Date	The date the record was created.	28-Dec-01
Director ID	This is a unique id generated by BoardEx	1000009283
Last Name	Last name (director)	Bergman
First Name	First name (director)	Stanley
Middle Name	Middle name (director)	M
CompanyId	This is a unique id generated by BoardEx	1518087243
Organisation Name		American Dental Association (ADA)
Role ID	This is a unique id generated by BoardEx	16
Other Activities Role	Includes other roles during the same time	Committee Member
Role Description	Main role	Oversight Committee
Start Date	Year, date or unknown values	UnKnown
End Date	Year, date or unknown values	UnKnown

Table 5-3. Directors' Other Activities dataset

Education		
Column Name	**Description**	**Example**
Report Date	The date the record was created.	28-Dec-01
Director ID	This is a unique id generated by BoardEx	1000499329
Last Name	Last name (director)	Joseph
First Name	First name (director)	Pamela
Middle Name	Middle name (director)	NULL
UniversityID	This is a unique id generated by BoardEx	724731664
University Name		Boston University
Date Graduated	The values for this column areyear, date, unknown or NULL	1965
AccreditationID	This is a unique id generated by BoardEx	243
Accreditation	This is the name of the accreditation i.e., degree title, certificate	Attended
Education Description	Includes further information that could help define a tie.	Attended Art Students

Table 5-4. The Directors' Education dataset

Based on the BoardEx datasets, a number of networks could be defined and analysed. In general, these are 2-mode (or affiliation or bipartite) networks (Borgatti & Everett 1997) where one set of nodes is the directors and the other set of nodes is SP1500 firms (see Table 5-1), educational institutions (see Table 5.4) or organisations (see Table 5.3).

The two types of networks that are usually examined in the literature and that could be created from the BoardEx dataset are as follows:

Education Network (ED_network)

Two directors are socially connected through their education network if they went to the same school (Ed) and graduated within one year of each other with the same professional, master or doctorate degree (see Figure 5-1 panel A).

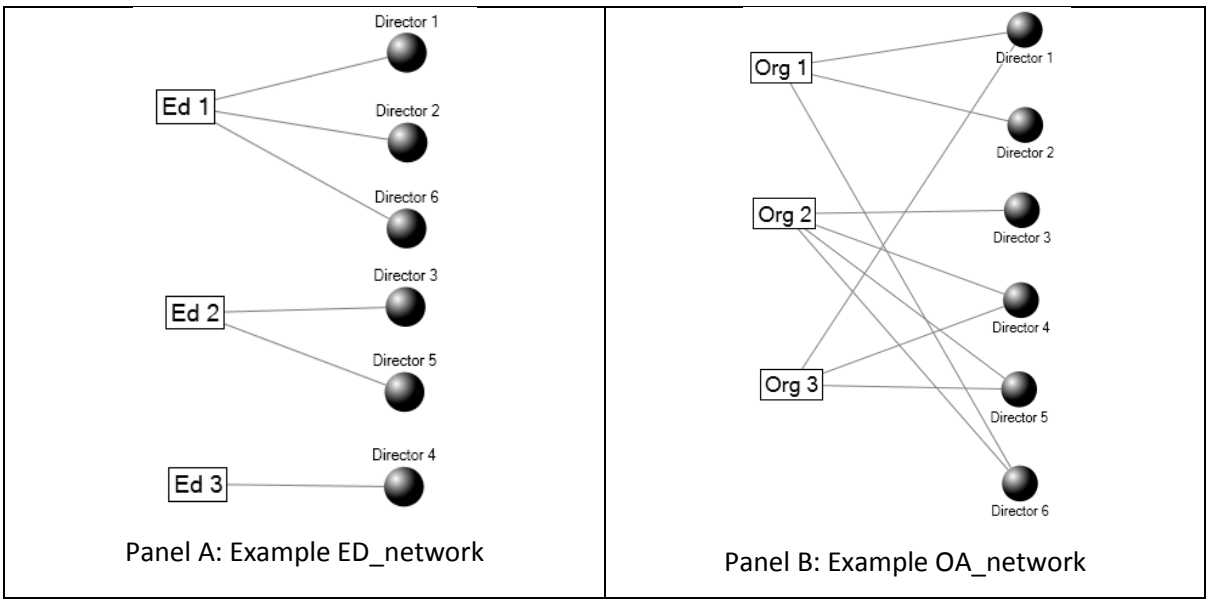
Other Activities Network (OA_network)

Two directors are socially connected through their other activity network if they share membership in organizations and had an active role in it(see Figure 5-1 panel B).

Figure 5-1 Panel A shows examples of links between six directors and three educational institutions(Ed). All directors have someone else that they have met through some educational activity except director 4. Figure 5-1 Panel B shows examples of links between six directors and three organisations (Org) such as clubs or charities where the

directors have some worthwhile activity other than simple membership. Org 2 is the one that involves most of the directors in some of its activities.

In general, a network is defined as a **n-mode network** if the nodes can be partitioned in exactly n mutually exclusive sets such that there are no links within a set i.e., the endpoints of every link come from different sets (Borgatti & Everett 1997). In addition, all nodes for all the sets have at least one link (there are no isolates) and that the network is undirected (links do not have direction) and connected (all nodes are reachable from all others) (Borgatti & Everett 1997).



Panel A: Example ED_network

Panel B: Example OA_network

Figure 5-1. Examples ED and OA 2-mode networks

On the basis of the board membership or employment, a director can work for an SP1500 firm (see Table 1) or another firm (nonSP1500) (see Table 2). On the basis of this, a 3-mode network could be defined. Furthermore, depending on which year the employment or board membership is analysed, a current employment and a past employment network could be created from the same dataset. Thus, two 3-mode networks are defined.

Current Employment Network (CE_network)

Two directors are socially connected through their current employment network if they work in the same firm, SP1500 or nonSP1500.

Past Employment Network (PE_network)

Two directors are socially connected through their past employment network if they have worked in the past in the same firm (SP1500 or nonSP1500) at the same time. Both of these networks have the same structure as shown in Figure 5-2.

Figure 5-2 shows an affiliation network in terms of employment and includes four SP1500 firms, two nonSP1500 firms and six directors. The links between firms and directors show the affiliation in terms of board membership (links between SP firms and directors) or employment and board membership (links between non SP firms and directors). Most of the directors are affiliated with only one firm whereas few are affiliated with multiple firms. It is because of the latter directors that board interlocks for the SP1500 firms are created.

To study the properties of n-mode networks using graph (network) theory, a process of transformation called *projection*, is normally used to map an n-mode network to a 1-mode network. This involves choosing one of the nodes as the primary node and creating links between nodes from this set if they were connected to at least one common node from one of the other node sets. This process could create a ***binary network*** or a ***weighted network*** if link weights are defined on the basis of the number of common nodes (Newman 2001). In general, the transformation process results in loss of information so it is appropriate to consider this before the projection is carried out. Projecting 2-mode networks into 1-mode networks is a straightforward process (Opsahl 2013). However, projecting an n-mode network to 1-mode network where n>=3 requires a consideration of what types of links are considered important for the analysis of the primary node set.

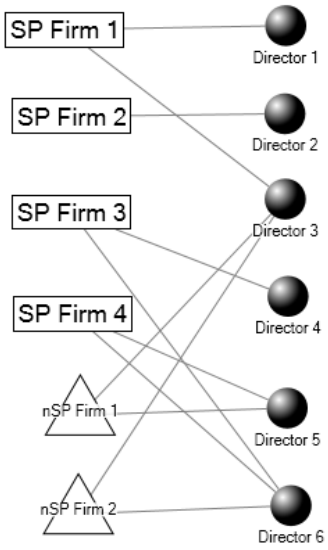


Figure 5-2. Example CE or PE 3-mode network

For the BoardEx case study, primary nodes can be considered the director node set and the SP1500 firm node set as these are normally the subject of study in the literature(Diaz et al. 2013; Shahgholian et al. 2012; Shahgholian et al. 2014). The non SP1500 node set might also be considered. For the purposes of this paper, we assume that two types of 1-mode networks are created in order to study their properties using graph theory and define appropriate metrics for their study.

Figure 5-3 shows the 1-mode network that results from the projection of the 2-mode network of Figure 5-1 Panel B taking the “director” node set as the primary node set. For example, director 4 and director 5 have two links, one through org 2 and one through org 3, as shown in Figure 5-3.

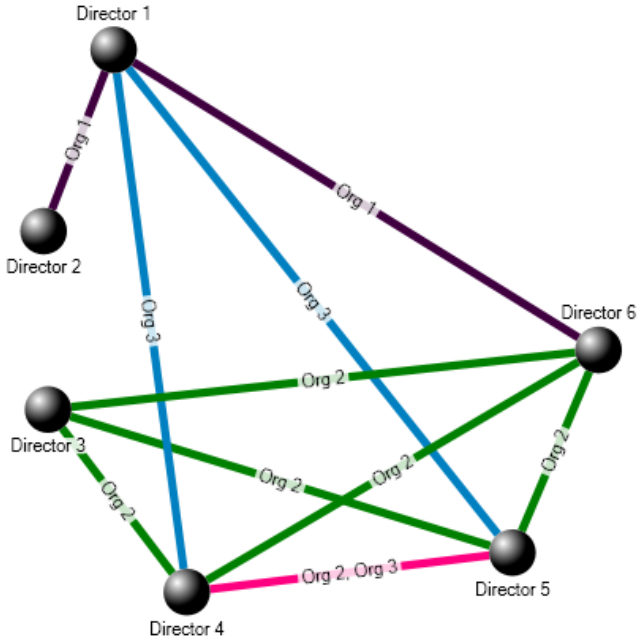


Figure 5-3. OA 1-mode director network

Figure 5-4 shows the network that results from the projection of the 2-mode network of Figure 5-2 taking the "director" node set as the primary node set. This is the social network between the directors of SP1500 firms and it has been the subject of many studies in the literature (Fogel et al. 2014; Fracassi & G. A. Tate 2012; Horton et al. 2012; Larcker et al. 2013). Links between directors are defined either through SP1500 firms or nonSP1500 firms. For example, director 4 and director 6 are linked through SP1500 firm 4 and director 3 and director 6 are linked through nonSP1500 firm 2, as shown in Figure 5-4.

Director-to-Director networks that are defined on the basis of all the n-mode networks (e.g., Figure 5-3 and Figure 5-4) could be merged. The resulting network could be defined either as binary network or a weighted network and it has as director node set the union of the merged director node sets and as links the union (or multiplex) of the links of the merged node sets(Ahuja et al. 2012).

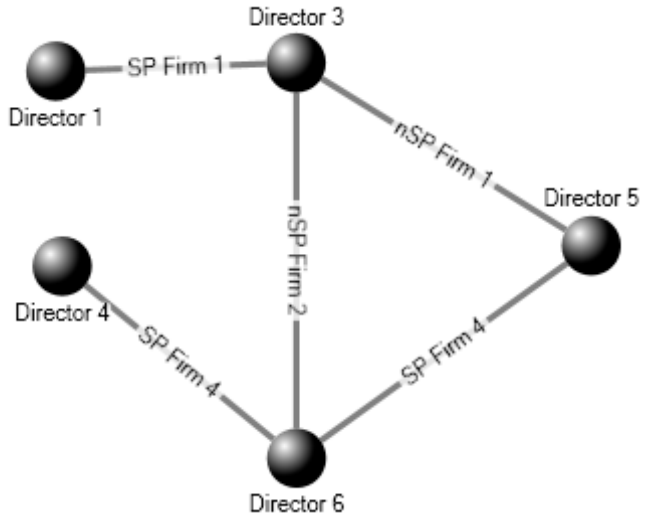


Figure 5-4. Director-to-Director 1-mode network

Of particular interest in the literature is the study of inter-firm networks that are created by directors sitting on many boards or directors related through their joint employment in non SP1500 firms or directors having educational ties. These are referred to as ***board interlock networks***(Mariolis 1975)and they are essentially, Firm-to-Firm 1-mode networks.

Figure 5-5 shows the Board Interlock network that result from the projection of the network of Figure 5-2. As one can see, there are two types of links between SP1500 firms. One type that is created through directors sitting on the board of the two SP1500 firms e.g., SP1500 firm 3 linked to SP1500 firm 4 through director 6. The other type is links created through the involvement of directors in non SP1500 firms e.g., director 3 and director 5 are employed in non S1500 firm 1 and as a result SP1500 firm 1 linked to SP1500 firm 4. Finally, as it is shown in Figure 5-5, SP1500 firms that do not share directors with other firms are isolates in the resulting board interlock network e.g., SP1500 firm 2.

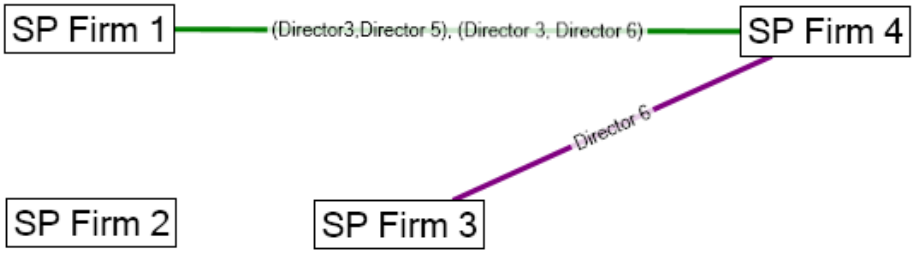


Figure 5-5. Board Interlock (Firm-to-Firm 1-mode) network

The next section defines the various node centrality metrics on the basis of the Director-to-Director and Board Interlock networks.

5.3 Node Centrality Metrics

The idea of centrality was investigated as a concept to explain how networks of individuals or organisations behave (Freeman 1979). The main centrality metrics that have been defined in the literature include degree, betweenness, closeness, eigenvector and clustering coefficient (Freeman 1979; Bonacich 1972; Wasserman & Faust 1994).In this section, the node centrality metrics will be defined from the network theory perspective and they will be interpreted in relation to the BoardEx case study and specifically, in relation to the director-to-director network (Figure 5-4) and the board interlock network (Figure 5-5).

5.3.1 Degree

A node with high degree maintains numerous links with other nodes. Nodes have higher degree to the extent they can gain access to and/or influence over others(Freeman 1979; Borgatti 2005; Wasserman & Faust 1994).

Node degreeis the number of links of a node in a non-directed graph(Wasserman & Faust 1994):

$$C_D(n_i) = \sum (number\ of\ edges\ ends\ to\ node\ n_i)$$

To normalize the degree so that networks of different sizes g may be compared, a normalised degree metric (*ndegree*) is defined by dividing the number of links with the theoretically maximum possible degree (e.g., g-1 nodes if every node is directly connected to node *i*). The normalised degree (nDegree) can be expressed as either a proportion or percentage(Wasserman & Faust 1994). Below if the formula for the proportion and the nDegree value ranges from 0 to 1.

$$C'_D(n_i) = \sum number\ of\ edges\ ends\ to\ node\ n_i / g - 1$$

In relation to the BoardEx case study, the interpretation behind degree is that nodes (directors or firms) "well connected" in terms of having many links will have access to many alternative sources of information, channels of communication, resources and so forth (Rowley 1997; Larcker et al. 2013). In the case of the board interlock network, degree is the measure that most takes into account the information to which a company is exposed because it measures the fraction of firms to which the firm is connected (Fracassi 2014). Similarly, for the director-to-director network, a director with high degree will have more direct sources of information and at the same time, more opportunities to influence and be influenced (Fogel et al. 2014; Renneboog & Zhao 2011a).

5.3.2 Betweenness

A central node occupies a "between" position on the geodesics (shortest paths) connecting many pairs of other nodes in the network. As a point in the shortest path connecting two other nodes, a "between" node might control the flow of information or the exchange of resources, perhaps charging a fee or brokerage commission for transaction services rendered. If more than one geodesic links a pair of nodes, it is assumed that each of these shortest paths has an equal probability of being used (Wasserman & Faust 1994; Freeman 1979).

Node betweenness for node *i* is the sum of the proportions, for all pairs of nodes j and k, in which node *i* is involved in a pair's geodesic(s)(Wasserman & Faust 1994). It is defined as:

$$C_B(n_i) = \sum_{j<k} \frac{g_{jk}(n_i)}{g_{jk}}$$

Normalising the betweenness metric (*nbetweenness*) is done by dividing it with the maximum possible betweenness metric of all nodes in the network and expressing it as a proportion or percentage. The maximum possible betweenness for a network with *g* nodes is $(g-1)(g-2)/2$.

Betweenness focuses on the shortest paths between network nodes while ignoring other paths. The use of this measure assumes that information and resources flow through the shortest possible paths between network nodes despite longer paths potentially serving a similar role (Larcker et al. 2013).

In relation to the BoardEx case study, for the board interlock network, the betweenness of a firm C is the number of shortest paths linking any two firms in the network that pass through firm C. This metric captures effectively the position of the firm in the network and implies that a firm with high betweenness is part of a large number of the shortest communication channels between other firms in the network and as such, it can be argued that it possesses high information-collection ability in terms of both time and cost (Renneboog & Zhao 2011a). Similarly, for the director-to-director network, directors with high betweenness are the gate-keepers of large number of information flows and as such, able to influence a large number of directors as well as be able to collect information quickly from many sources.

5.3.3 Closeness

Closeness reflects the proximity of a node to all others in the network i.e., a node that is close to others can quickly interact and communicate with them without going through many intermediaries (Freeman 1979). Thus, closeness measures a node's independent access to different nodes in the network which results in "fewer message transmissions, shorter times and lower costs" (Rowley 1997). It relates to the degree of the node and the degree of the nodes that it is directly linked to.

Node closeness is the inverse of the sum of geodesic (shortest path) distances from node*i* to the *g-1* other nodes (i.e., the reciprocal of its "farness" score assuming that closeness equals to one divided by farness)(Wasserman & Faust 1994; Freeman 1979; Freeman 1984):

$$\mathbf{C_C(n_i) = \left[\sum_{j=1}^{g} d(n_i, n_j)\right]^{-1}}$$

Closeness can be calculated only for a connected graph, because the geodesic distance is "infinite" (undefined) if members of a pair of nodes are not mutually reachable (no path exists between *i* and *j*). Normalising closeness (*ncloseness*) is done dividing the raw value

by the maximum possible distance expressed as a proportion or percentage. In a network with *g* nodes the maximum possible distance between any two nodes is: $(g-1)$.

In addition to the definition above, there are other types of closeness based on the "distance" definition. These are (Analytictech 2015):

- **Sum of reciprocal distances:** distances are the reciprocal of the lengths of the geodesic paths
- **Average of reversed distances:** the reversed distance is the diameter minus the geodesic distance (Valente & Foreman 1998)
- **All paths:** distances between nodes are the sums of the distances of all paths connecting them
- **All trails:** distances between the nodes are the sums of the distances of all trails connecting them

Closeness has been used in the literature as a measure of influence rather than information flow. In relation to the BoardEx case study, for the board interlock network, low closeness indicates the ability of a firm to access independently all other firms through a minimum number of intermediary firms and is therefore dependent on fewer intermediary firms than the peripheral ones. It is the inverse of the number of steps that a firm needs to take to reach any other firm. Low closeness makes information collection or resource exchange quicker and more readily available (Larcker et al. 2013; Renneboog & Zhao 2011a).

For the director-to-director network, if director *i* is connected with a very popular (high degree)director *j* then he/she can reach and influence many other directors through him, but he/she is not necessarily exposed to the information that passes through the popular director *j*. Closeness averages the degrees of separation – that is, the number of links in the shortest paths – between the individual in question and every one of the other N–1 individuals in the network (Fogel et al. 2014). Closeness therefore refers to how efficiently and effectively the individual can communicate with others by either communicating directly or through intermediaries(Horton et al. 2012b).

5.3.4 Eigenvector

The eigenvector metric takes into consideration not only how many links a node has (i.e., its degree), but also the degree of the nodes that it is connected to. Unlike degree, which weights every link equally, the eigenvector weights links according to their eigenvector values. Eigenvector can also be seen as a weighted sum of not only direct links but indirect links of every length. Thus it takes into account the entire pattern in the network (Bonacich 2007; Bonacich 1987).

A nodes' eigenvector is proportional to the sum of the eigenvector values of all nodes directly connected to it. It is useful in determining who is connected to the most connected nodes. The eigenvector of a node is defined as (Bonacich 1987; Bonacich 2007):

$$e_i = \lambda^{-1} \sum_j a_{ij}\, e_j$$

Where λ is a constant (known as the eigenvalue) and e_i is the eigenvector of node i. The formula indicates that the eigenvector of a node is proportional to the sum of eigenvector of the nodes it is connected to.

In relation to the BoardEx case study, for the board interlock network, it is important to measure how central a firm is in terms of its own degree measure but it is also important to consider the degrees of the firms that it is linked to. If firm C_i is linked to firm C_J with high degree, it means that the firm C_i has better opportunities to get access to information or influence the rest of network through C_J(Renneboog & Zhao 2011a). In other words, eigenvector is a refinement of the degree metric which recognizes that having more direct connections is more influential when such connections can reach or influence more outside boards. In other words, a board is well-connected when its direct contacts are also well- connected (Larcker et al. 2013). It could also be interpreted as a metric that relates to the group of firms that C_i is linked to which collectively can have access to information or influence the rest of the network in a more substantial way (they have high degree).

Similarly, for the director-to-director network, a director that is linked to many directors who are themselves well-connected is assigned a high eigenvector value but a director who is connected only to near isolates is not assigned a high value, even if he/she has high degree. Eigenvector is recursively calculated and it is a weighted average of the importance of the individual's direct contacts, with weights determined by the importance of their direct connections, with weights and so on (Fogel et al. 2014).

5.3.5 Clustering Coefficient

The clustering coefficient is a measure of local triangle density and describes the extent to which the neighbours of node *i* are acquainted with one another (see Figure 5-6). If none of them know each other, it is zero while if all of them are acquainted, it is one. Always, the clustering coefficient values are between zero and one.

The clustering coefficient for a node v_i is calculated as follows(Aggarwal & Wang 2010):

$$C(v_i) = \frac{2t_i}{k_i(k_i - 1)}$$

where t_i is the number of triangles attached to the node v_i and k_i is its degree. The denominator $\frac{2}{k_i(k_i-1)}$ expresses the maximum possible number of triangles of a node given its degree. The clustering coefficient is not defined for nodes with degree k<2.

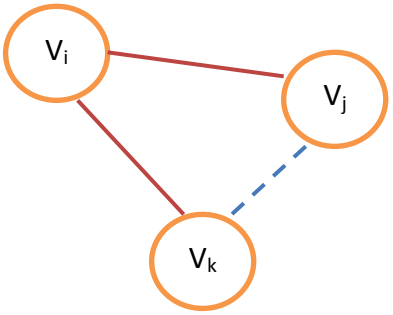


Figure 5-6. Clustering coefficient example

The clustering coefficient could be used to indicate the presence of communities (local density) in a network i.e., groups of nodes that have direct links between them. It is also appropriate to compare nodes with the same degree in relation to their clustering coefficient values as this indicates that some nodes might be more or less involved in local communities (Toivonen et al. 2009).

In relation to the BoardEx case study, for the board interlock network, using clustering coefficient could help to identify groups of firms (perhaps in a specific sector or location) that are more connected than other groups and that these links are formed, for example, as a result of joint employment or board membership of their directors. For the director-to-director network, large firms are likely to result in groups of directors with high clustering coefficient if their directors are not highly connected (low degree) outside the firm itself. This is because a firm can act as a community on its own since its directors are all connected with one another in a cluster. This implies that low clustering coefficient for a director means a more well-connected director with directors outside the firm.

5.4 Correlations between Node Metrics

This section discusses the correlations between the various node centrality metrics based on their formal definitions provided in the previous section, the correlations that have been reported in the literature and also on the possible ways that the correlations could be interpreted in relation to the BoardEx case study and more specifically, for the board interlock and director-to-director networks.

For this discussion, we assume that the metrics have a range of values and we distinguish between low and high values to facilitate the discussion about the correlations. Furthermore, the possible correlations between degree, closeness, betweenness, eigenvector and clustering coefficient might be interpreted as overall network characteristics through summary statistics of all the nodes of the network.

5.4.1 Correlations based on Theory

Table 5-5 summarises the main discussion points of the correlations that are based on the formal theoretical definitions. For presentation purposes, Table 5-5 is not symmetrical as correlations between the same metrics are not shown. Furthermore, we assume that all metrics are calculated on symmetric networks because eigenvector can only be calculated for such networks (Valente et al. 2008). For the purposes of this report, the networks we consider are undirected thus, symmetrical, as it is the case for the BoardEx board interlock and director-to-director networks. Understanding the correlations that are the result of the theoretical definitions of the various metrics helps with the interpretation of the overall network characteristics. In general, degree, betweenness, eigenvector and closeness are all measure of an actor's (firm or director) prominence in the network (Wasserman & Faust, 1994).

	High Closeness	Low Closeness	High Betweenness	Low Betweenness	High Eigenvector	Low Eigenvector
High Degree	Positive correlation expected (0.66)	Negative correlation expected but otherwise, connected nodes have high degree and/or high closeness.	Positive correlation expected (0.85)	Negative correlation expected but otherwise, majority of the shortest paths ofthe network bypass it.	Positive correlation expected (0.92)	Negative correlation expected but otherwise, all the nodes that are connected have low degree.
Low Degree	Negative correlation expected but otherwise, connected nodes have low degree and/or low closeness.	Positive correlation expected (0.66)	Negative correlation expected but otherwise, the few links of the node are part of one of the shortest paths.	Positive correlation expected (0.85)	Negative correlation expected but otherwise, all the nodes that are connected have high degree.	Positive correlation expected (0.92)
High Closeness			Positive correlation expected (0.44)	Negative correlation expected but otherwise, many other alternative shortest paths and/or better positioned nodes	Positive correlation expected (0.63)	Negative correlation expected but otherwise, all connected nodes are not linked well with the rest of the network
Low Closeness			Negative correlation expected but otherwise, the shortest paths are important for the network	Positive correlation expected (0.44)	Negative correlation expected but otherwise, all connected nodes are linked well with the rest of the network	Positive correlation expected (0.63)
High Betweenness					Positive correlation expected (0.72)	Negative correlation expected but otherwise, node is connected to few but important nodes
Low Betweenness					Negative correlation expected but otherwise, node is connected to many but not important nodes	Positive correlation expected (0.72)

Table 5-5. Correlations between network metrics

High degree implies that a node is well connected with other nodes in the network. For firms with large board sizes this means that their directors are more likely to have high degree. From the literature, ***degree is positively correlated with eigenvector*** (correlation value 0.92 in (Valente et al. 2008)). Thus, high degree is expected to have a positive correlation with high eigenvector and a negative correlation with low eigenvector (see Table 5-5). This is expected since the eigenvector value takes into consideration the degree values of the connected nodes. Having said that, if a node has high degree and low eigenvector means that the nodes that it is connected to are not well-connected (low degree).

From the literature, ***degree is positively correlated with betweenness*** (correlation value 0.85 in (Valente et al. 2008)). Thus, high degree is expected to have a positive correlation with high betweenness and a negative correlation with low betweenness (see Table 5-5). Since the node is connected to many other nodes, it is likely that it is part of many of the shortest paths between the nodes of the network. If this is not the case, then it means that the majority of the shortest paths between the nodes of the network bypass this node.

In addition, from the literature, ***degree is positively correlated with closeness***(correlation value 0.66 in (Valente et al. 2008)). Thus, high degree is expected to have a positive correlation with high closeness and a negative correlation with low closeness (see Table 5-5). Since both metrics are based on direct ties, it is expected that their correlation will be the strongest but this is not supported by the literature (Valente et al. 2008).Furthermore, because the node is connected to many other nodes (high degree), it is likely that it will also be close to many other nodes of the network (high closeness). If this is not the case, it means that the few nodes that it has links with are very important nodes within the network (high degree and/or high closeness).

Furthermore, ***closeness exhibits a positive correlation with eigenvector*** similar to its correlation with degree (correlation value 0.63 in (Valente et al. 2008)). Thus, high closeness is expected to have a positive correlation with high eigenvector and a negative correlation with low eigenvector (see Table 5-5). A node with high eigenvector is likely to have better access to the rest of the network (high closeness). If this is not the case it

means that the connected nodes have low closeness so they are not linked well with the rest of the network.

Also, from the literature, ***closeness is expected to have a positive correlation with betweenness*** (correlation value 0.44 in (Valente et al. 2008)). Thus, high closeness is expected to have a positive correlation with high betweenness and a negative correlation with low betweenness (see Table5-5). Although the correlation value between these two metrics is the lowest one from all others (Valente et al. 2008), a node with high betweenness is part of many of the shortest paths between two nodes and this helps the node to reach all others easier (high closeness). If this is not the case (i.e., low closeness), it implies that possibly there are many other alternative shortest paths and/or nodes that are better positioned in these shortest paths.

Finally, from the literature, ***betweenness is expected to have a positive correlation with eigenvector*** (correlation value 0.72 in (Valente et al. 2008)). Thus, high betweenness is expected to have a positive correlation with high eigenvector and a negative correlation with low eigenvector (see Table 5-5).If this is not the case (i.e., high betweenness and low eigenvector), it means that the node is part of many of the shortest paths and that the nodes that it connects to are important ones despite the fact that have low degree i.e., few connections.

In relation to the clustering coefficient metric, there are some studies in the literature that analyse its correlation with other node centrality metrics and in particular that degree is negatively associated with the clustering coefficient (Foudalis et al. 2011; Bloznelis 2013; Wang et al. 2011).

For the BoardEx case study, large firms are likely to result in groups of directors with high clustering coefficient if their directors are not highly connected (high in-firm-degree, low out-firm-degree and low eigenvector) outside the firm itself. For the board interlock network, we assume that there is a negative correlation between clustering coefficient and degree based on previous literature (Bloznelis 2013).This is reasonable if one assumes that high degree implies many links with other firms and so the likelihood for triangles is smaller(Wang et al. 2011). Furthermore, for the same network, the correlation between clustering coefficient and eigenvector is likely to be also negative. In fact,

because of the correlation between the degree and the other metrics, one can reasonable assume that a negative correlation exists between clustering coefficient and betweenness or closeness (see below).

	Degree	Closeness	Betweenness	Eigenvector
Board Interlock	negative	negative	negative	negative
Director-to-director	negative	negative	negative	negative

For the director-to-director network, a low clustering coefficient for a director means a more well-connected director with directors outside the firm (high eigenvector) and on the basis of this we can argue that it is likely to also have high betweenness as it is likely that this director will be part of many of the shortest paths. Finally, in relation to closeness, we can also argue that high clustering coefficient for directors with high out-firm-degree could relate positively to low closeness.

In the next two sections, we examine these correlations for the BoardEx case study for the board interlock (section 5.5) and director-to-director (section 5.6) networks.

5.5 BoardEx case study – Board Interlock Network

For the BoardEx case study, the year 2011 was selected to create the networks and discuss their characteristics. As these datasets are updated on a continuous basis, obtaining a dataset now from BoardEx for 2011 might be different to the one available for this study.

From the BoardEx dataset for 2011, the CE 3-mode network is created, similarly to one in Figure 5-2. The summary statistics for this network are as follows:

Node	Unique	Valid (Links)
Director	11486	46314
SP1500 Firm	1500	25471
nonSP1500 Firm	13194	20843

Table 5-6. Summary statistics for the CE 3-mode network for 2011

As shown in Table 5-6, there are in total 11846 directors involved with SP1500 firms in 2011 and a total of 25471 links between these and the SP firms (average 2.2 links per director). In the dataset, there are also 13194 nonSP1500 firms that are associated with the SP1500 directors. There are a total of 20843 such links. Not all SP1500 directors are associated with nonSP1500 firms. In fact, only 6378 directors have actual links with nonSP1500 firms which means average 3.2 links per director involved.

On the basis of the SP1500 firm dataset for 2011, the director-to-director network (see Figure 5-4) and the board interlock network (see Figure 5-5) are created. The networks are created following the same process as explained in section 2.

5.5.1 Node Metrics Analysis

The board interlock or Firm-to-Firm 1-mode network for 2011 is shown in Figure 5-7.

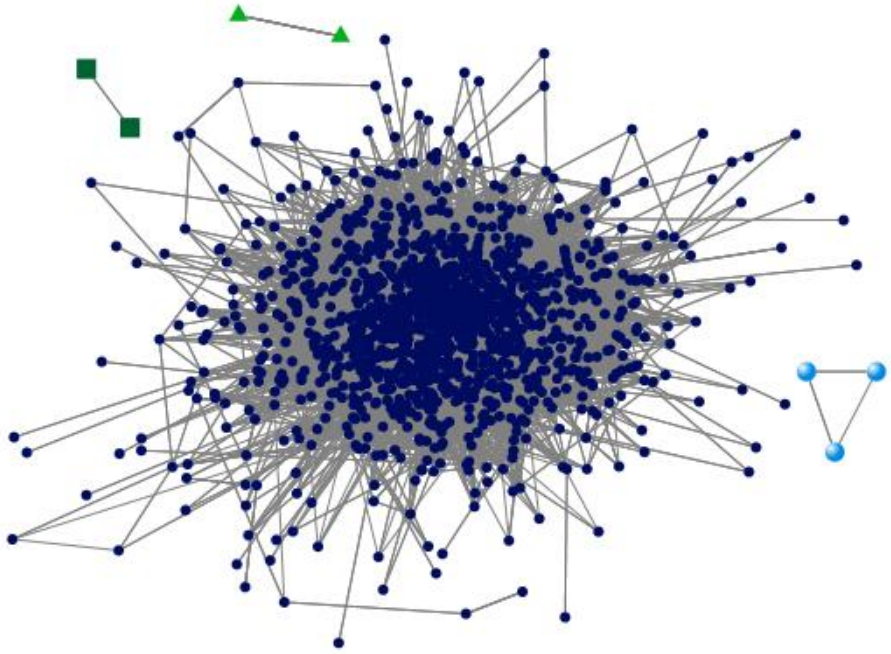


Figure 5-7. The Board Interlock Networks for 2011

There are in total 90 connected components (networks) as shown in Figure 5-7. The largest one has 1407 connected firms and the smallest one has 1 firm as shown below.

#connected components	#Firms
1	1407
1	3
2	2
86	1
Total	1500

Connected components with one firm indicate firms whose directors have no links to directors outside the firm (*isolates*). For the purposes the calculation of the node centrality metrics and the analysis, only the largest connected component (network) is considered and we refer to it as the board interlock network. For this network, Table 5-7shows the summary statistics for the node centrality metrics. The column "Valid" shows the valid unique records for SP1500 firms that are part of the network.

Field	Min	Max	Mean	Std. Dev	Skewness	Median	Mode	Valid
Degree	1	183	39.94	34.55	1.286	30	10	1407
nDegree	0.001	0.130	0.028	0.024	1.286	0.021	0.007	1407
Betweenness	0	11547.15	1116.26	1435.33	2.229	542.899	0	1407
nBetweenness	0	0.012	0.001	0.001	2.229	0.001	0	1407
Closeness	0.077	0.111	0.105	0.004	-1.293	0.105	0.106	1407
nCloseness	7.745	11.101	10.454	0.391	-1.293	10.521	10.646	1407
Eigenvector	0	0.105	0.018	0.020	1.696	0.011	0	1407
nEigenvector	0	0.148	0.025	0.028	1.696	0.016	0	1407
Clustering Coefficient	0	1	0.328	0.205	1.833	0.263	1	1407
Board size	4	32	9.6	2.332	1.087	9	9	1407

Table 5-7. Summary statistics for the metrics of the board interlock network

In Table 5-7, board size refers to the number of directors for each firm. Firms with large boards are likely to have more links to other firms (higher degree). As shown in Figure 5-8, the majority of the firms have board sizes from 10 to 20.

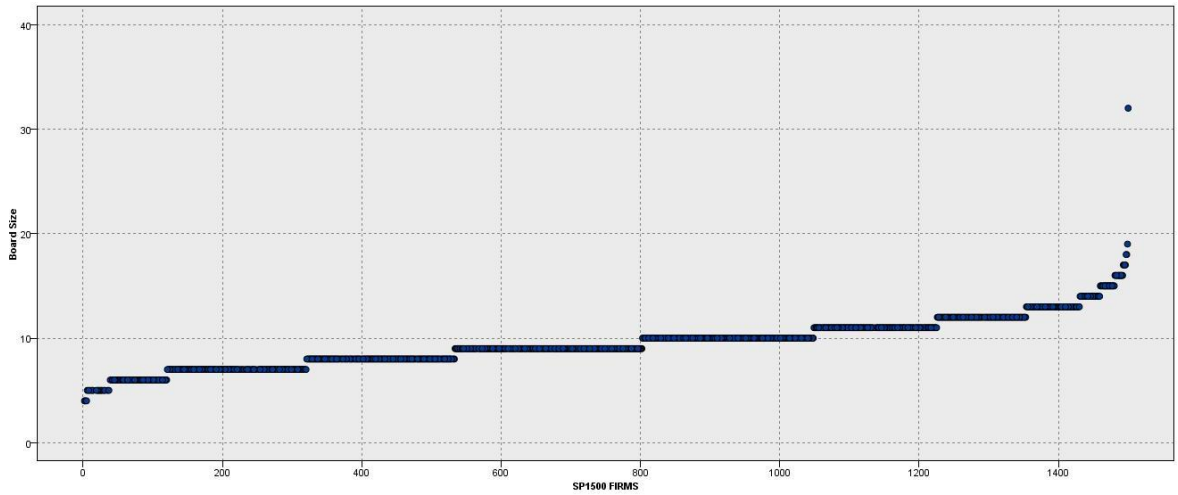


Figure 5-8. The Board Size Distribution

Figure 5-9 shows the degree distribution. The majority of the firms have degrees between 1 and about 50 and overall, the mean degree is 39.94 (see Table 5-7). The theoretically maximum degree for our network is 1406 and given that the highest degree in the network is 183, this implies that the maximum nDegree is 0.13 or that the firm is connected directly with 13% of the other firms in the network.

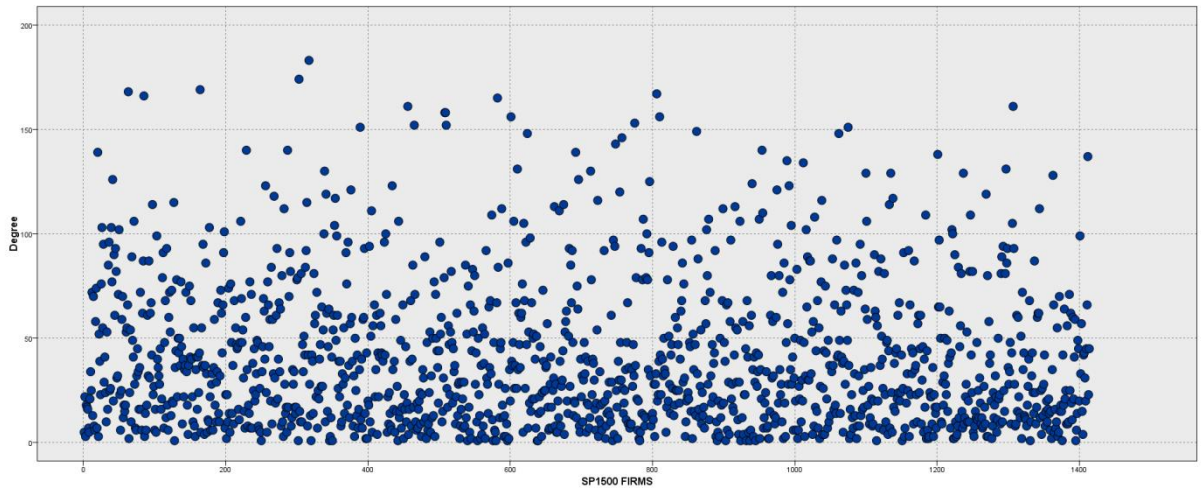


Figure 5-9. The Degree Distribution

Figure 5-10 shows the nBetweenness distribution. The theoretical maximum betweenness for our network is $(g-1)(g-2)/2$ = (1406*1405)/2 = 987715. This number relates to the maximum number of shortest paths in our network so it is not surprising that on average, firms are part of a small number of these i.e., 0.012% (see Table 7). Still, there are a small number of firms with 0.5<nBetweenness<2 and these firms have a very important position in the network since they can facilitate information flow between firms.

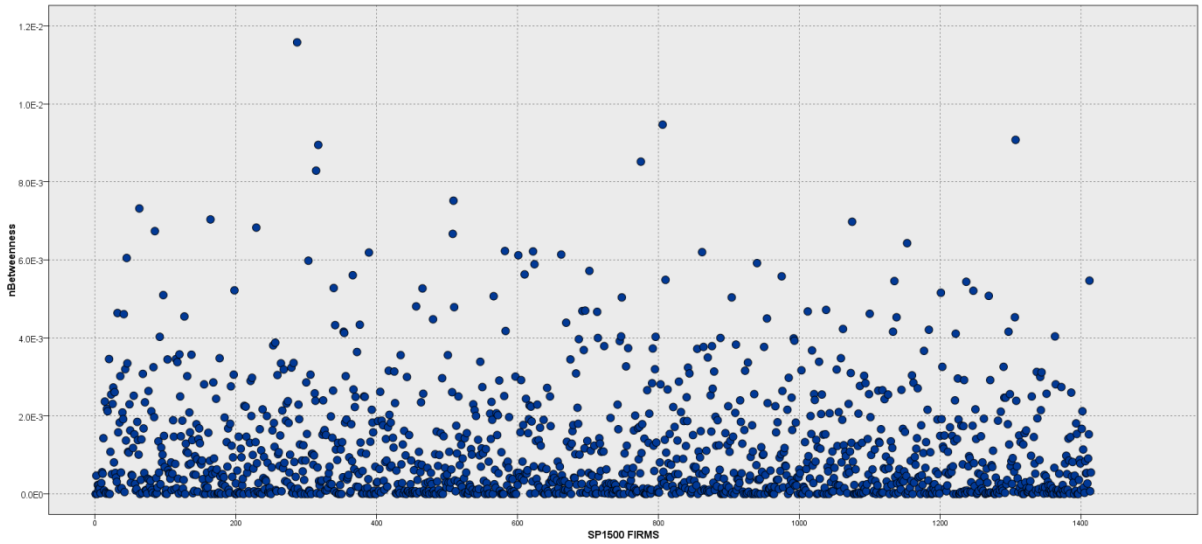


Figure 5-10. The nBetweenness Distribution

Figure 5-11 shows the nCloseness distribution. The majority of the firms have values between about 10 and 11, none above 11.5 and on average, 10.40 (see Table 5-7). This means that on average firms have to traverse 10% of the total number of firms in order to reach another firm. Firms that are better connected are the ones with low closeness e.g., 9 or below since they have to traverse fewer links to reach other firms in the network.

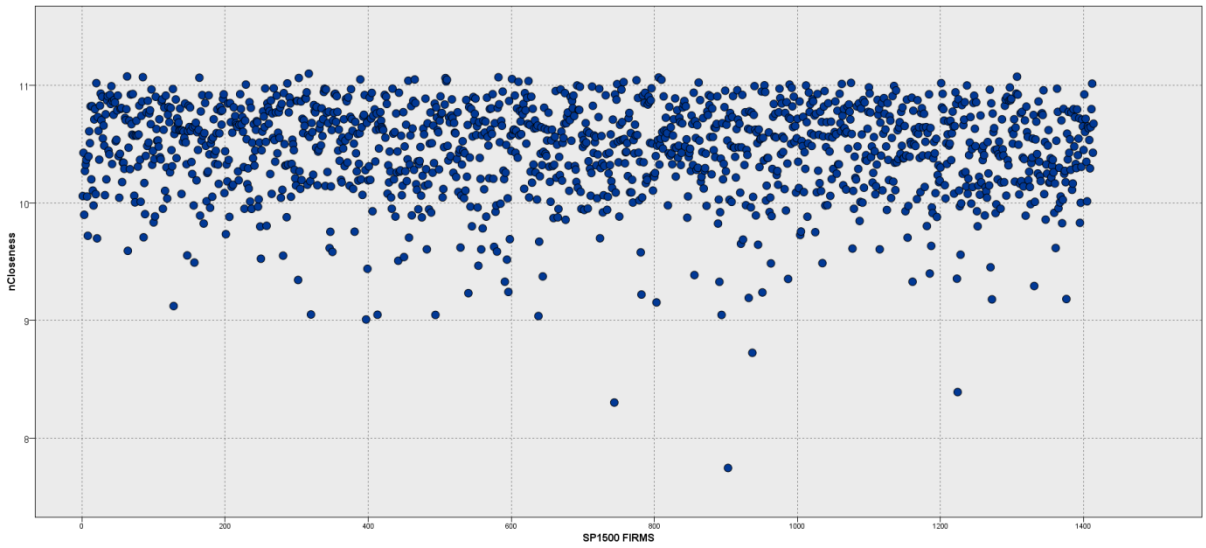


Figure 5-11. The nCloseness Distribution

Figure 5-12 shows the clustering coefficient distribution. The best connected firms have the maximum value for clustering coefficient which is 1. From Figure 5-12, one can see that there are a number of such firms but also, a substantial number of firms with zero value. The average value of 0.33 (see Table 5-7) shows that a firm has on average 33% of its directly-linked firms also directly linked to each other.

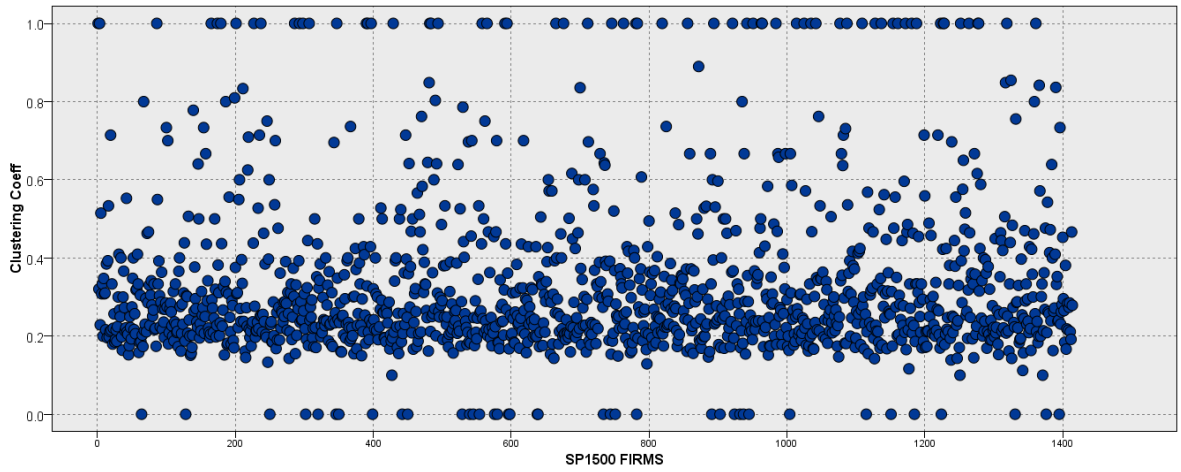


Figure 5-12. The Clustering Coefficient Distribution

More specifically, in Figure 5-12, there are thirty eight firms with clustering coefficient equal to 0. Further analysis of these, reveals that twenty seven firms of these have degree equal to 1 i.e., they cannot participate in a triangle (minimum degree = 2). The rest eleven firms have degree equal to 2 and the zero clustering coefficient can be explained because of their very low eigenvector value (0 or 0.001) which implies that their directly connected firms have degree that equals either to zero or to one.

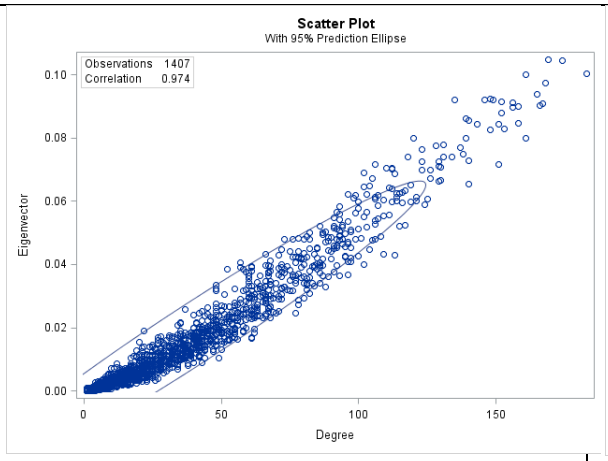
5.5.2 Correlations between the Node Metrics

Table 5-8 presents the correlation between the node centrality metrics using the Pearson correlation with $\alpha = 0.05$ for the board interlock network. The strongest positive correlation is between *degree* and *eigenvector* (correlation value 0.97). This is consistent with the existing literature (Valente et al. 2008). As shown in Figure 5-13 Panel A, the relationship is linear which can be due to the fact that both metrics are degree-based.

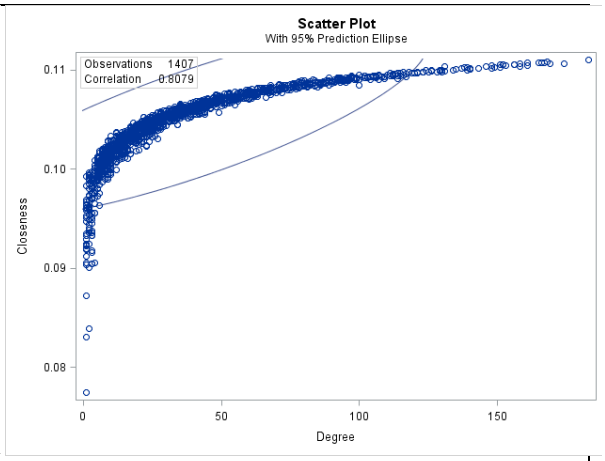
Pearson Correlation Coefficients, N = 1407 Prob> |r| under H0: Rho=0						
	Degree	**Betweenness**	**Closeness**	**Eigenvector**	**Clustering Coefficient**	**Board size**
Degree	1.000					
Betweenness	0.87***	1.000				
Closeness	0.807***	0.62***	1.000			
Eigenvector	0.97***	0.82***	0.74***	1.000		
Clustering Coefficient	-0.44***	-0.40***	-0.42***	-0.35***	1.000	
Board size	0.50***	0.45***	0.46***	0.48***	-0.26***	1.000

Table 5-8. Correlations between node centrality metrics

From Table 5-8, degree is positively correlated with closeness (correlation value 0.807). This is also consistent with the existing literature (Valente et al. 2008). As shown in Figure 5-13 Panel B, the relationship is not linear.



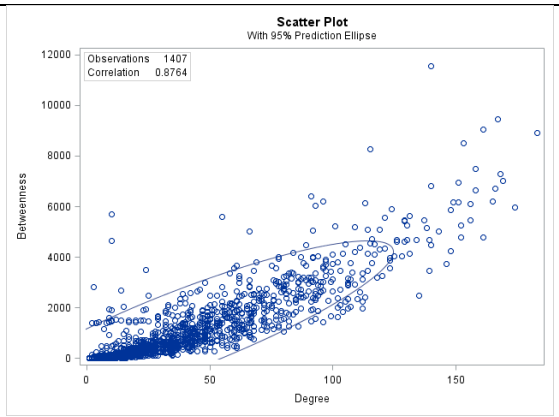
Panel A: Degree vs. Eigenvector



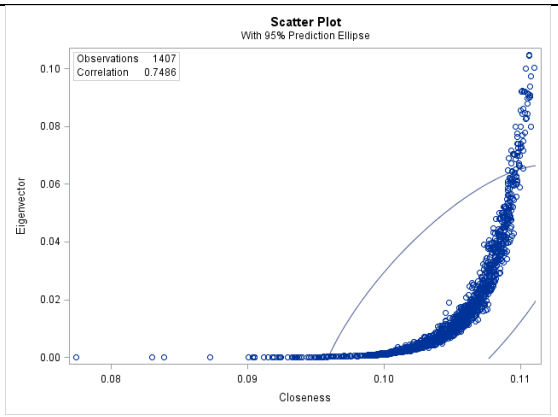
Panel B: Degree vs. Closeness

Figure 5-13. Degree vs. Eigenvector and Degree vs. Closeness

From Table 5-8, degree is positively correlated with betweenness (correlation value 0.87).This is also consistent with the existing literature (Valente et al. 2008). As shown in Figure 5-14 Panel A, the relationship seems that is linear for the low values of degree and betweenness.



Panel A: Degree vs. Betweenness



Panel B: Eigenvector vs. Closeness

Figure 5-14. Degree vs. Betweenness and Eigenvector vs. Closeness

From Table 5-8, eigenvector is positively correlated with closeness (correlation value 0.74). This is also consistent with the existing literature (Valente et al. 2008). As shown in Figure 5-14 Panel B, the relationship is not linear.

Finally, from Table 5-8, betweenness is positively correlated with closeness (correlation value 0.62). This is also consistent with the existing literature (Valente et al. 2008) where it is also has the lowest correlation. As shown in Figure 5-15 Panel B, the relationship is not linear.

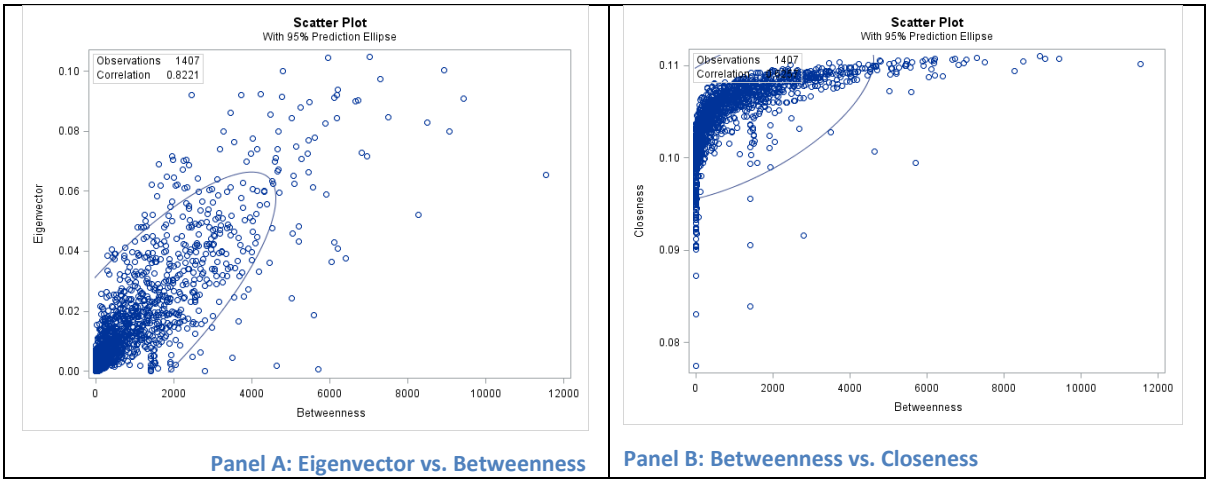
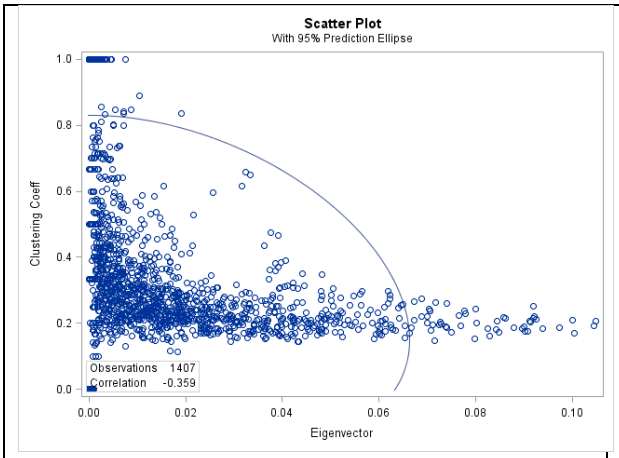


Figure 5-15. Eigenvector vs. Betweenness and Betweenness vs. Closeness

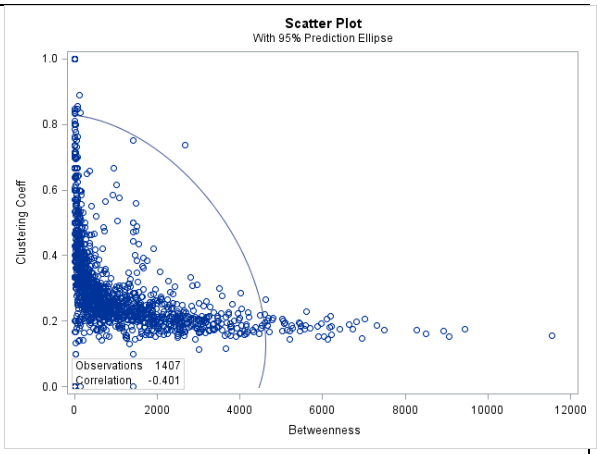
In relation to the clustering coefficient metric, Table 5-8 shows that there is negative correlation between clustering coefficient and all the other node centrality metrics. The correlations are summarised below:

	Degree	Closeness	Betweenness	Eigenvector
Clustering Coefficient	Negative (-0.44)	Negative (-0.42)	Negative (-0.40)	Negative (-0.35)

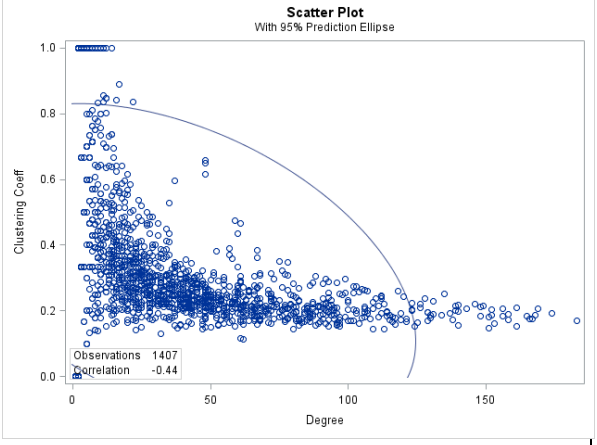
Clustering coefficient is negatively correlated with all other metrics and eigenvector has the least negative correlation (correlation value -0.35). As shown in Figure 5-16 Panel A, the relationship is not linear. The same applies for all other metrics.



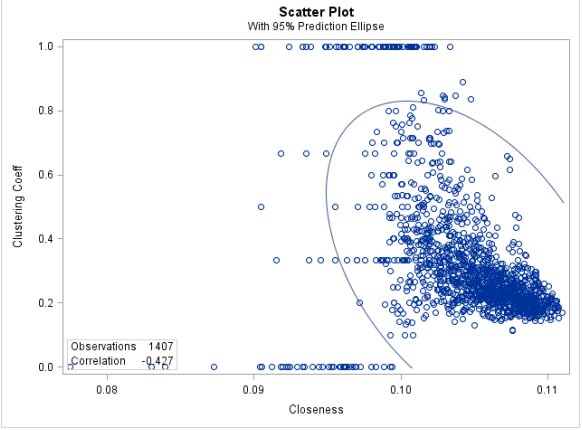
Panel A: Eigenvector vs. Clustering Coefficient



Panel B: Betweenness vs. Clustering Coefficient



Panel C: Degree vs. Clustering Coefficient



Panel D: Closeness vs. Clustering Coefficient

Figure 5-16. Clustering Coefficient vs. Degree, Betweenness, Closeness and Eigenvector

5.6 BoardEx case study – Director-to-Director Network

From the BoardEx dataset for 2011 and the CE 3-mode network, the director-to-director network (see Figure 5-4) is created following the same process as explained in section 5.2. This network is discussed in the following in terms of the node metrics and their correlations.

5.6.1 Node Metrics Analysis

The director-to-director network for 2011 is shown in Figure 5-17.

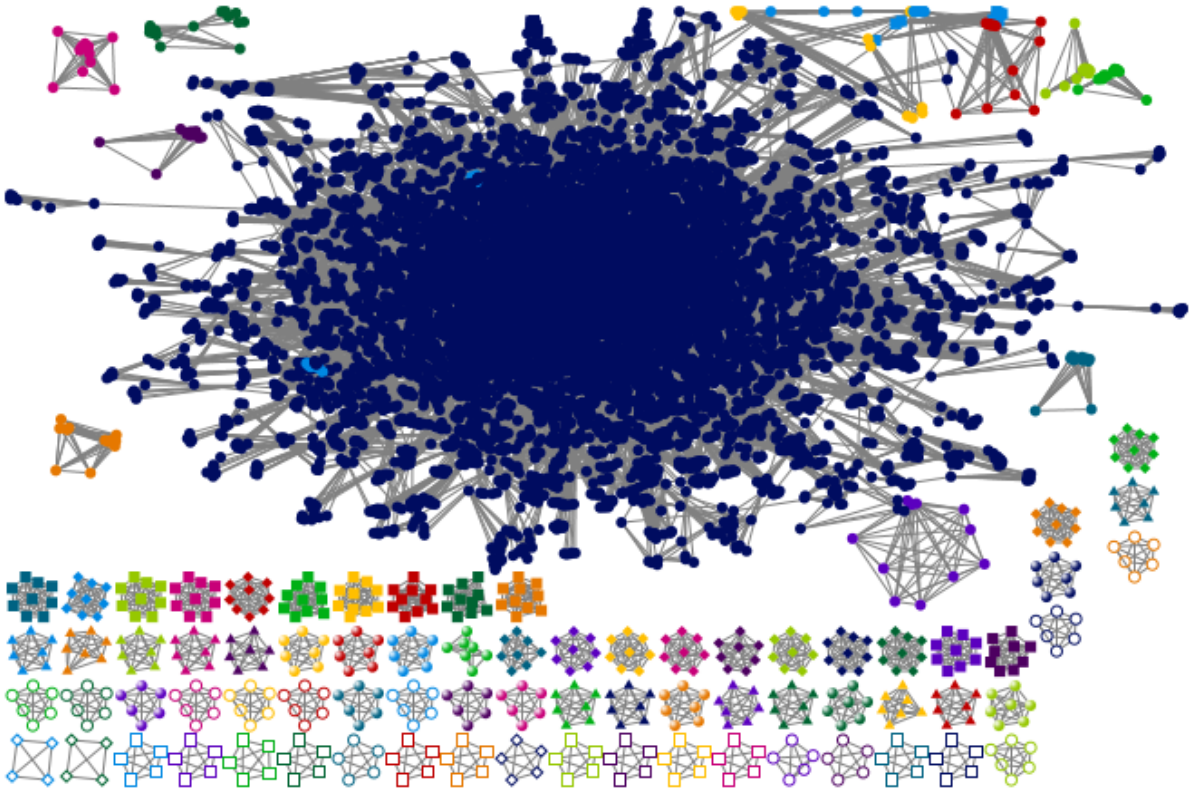


Figure 5-17. The Director-to-Director Networks for 2011

There are in total 90connected components (networks) as shown in Figure 5-17. The largest one has 10797 connected directors and the smallest one has 4 directors as shown below.

#connected components	#Directors
1	10797
1	29
1	16
1	15
1	14
1	12
9	11
5	10
12	9
6	8
20	7
14	6
16	5
2	4
Total	11500

The number of connected components (networks) is the same with number of the networks for the board interlock. This is expected since both are based on the same CE 3-mode network. The majority of these networks (86 in total) are related to one firm (represented as isolates in the board interlock networks in Figure 5-7) and represent the links between the directors of the firm.

For the purposes the calculation of the node centrality metrics and the analysis, only the largest connected component (network) is considered and we refer to it as the director-to-director network. For this network, Table 9shows the summary statistics for the node centrality metrics. The column "Valid" shows the valid unique records for SP1500 directors that are part of the network.

Field	Min	Max	Mean	Std. Dev	Skewness	Median	Mode	Valid
Degree	3	59	12.352	6.748	2.005	10	9	10797
nDegree	0.00027	0.00546	0.00114	0.0006	2.005	0.00093	0.00083	10797
Betweenness	0	598993.56	23028.40	48587.78	3.853	0	0	10797
nBetweenness	0	1.028	0.04	0.083	3.853	0	0	10797
Closeness	0.09	0.265	0.193	0.024	-0.379	0.194	0.189	10797
nCloseness	9.02	26.508	19.308	2.371	-0.379	19.43	18.92	10797
Eigenvector	0	0.180	0.001	0.01	18.256	0	0	10797
nEigenvector	0	25.483	0.08	1.359	18.256	0.001	0	10797
ClusteringCoefficient	0.153	1	0.808	0.253	-0.829	1	1	10797
Board size	4	32	9.6	2.332	1.087	9	9	1407

Table 5-9. Summary statistics for the metrics of the director-to-director network

In Table 5-9, board size refers to the number of directors for each SP1500 firm that is related to the director-to-director network. The minimum board size is 4 which indicates that the minimum direct links from a director to others is 3. This confirms the minimum degree for directors' network.

The average board size is 9.60 and the average degree is 12.35 which indicate in average directors are connected to two directors from other firms in the network. Figure 5-18 shows the board size distribution.

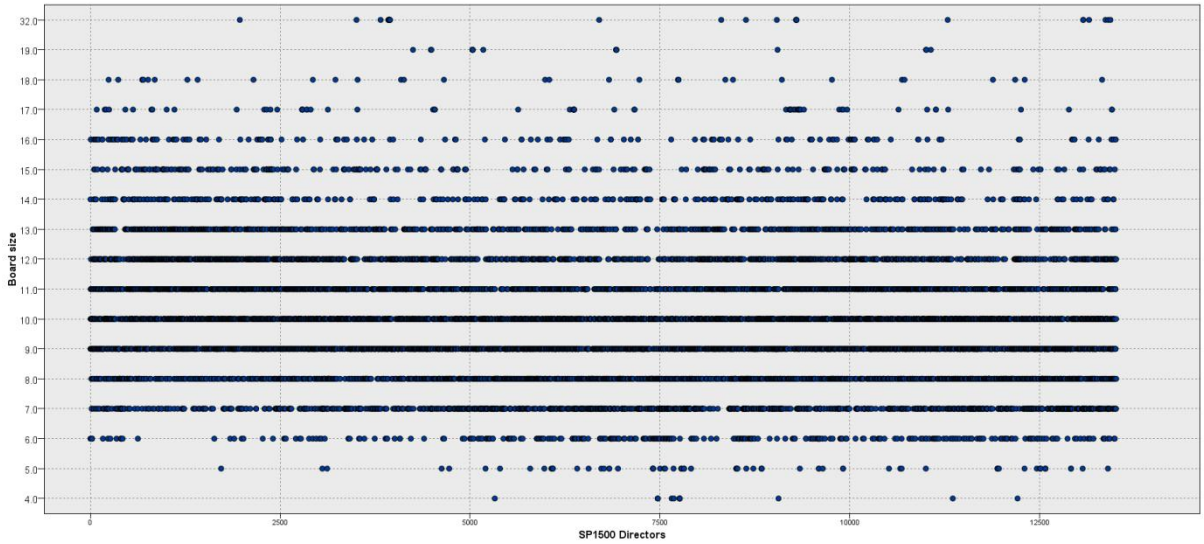


Figure 5-18. The Board Size Distribution

Figure 5-19 shows the degree distribution. The majority of the directors have degrees between 6and about 18and overall, the mean degree is 12.352 (see Table 5-9). The theoretically maximum degree for our network is 10797 and given that the highest degree in the network is 59, this implies that the maximum nDegree is 0.00546 or that a director is connected directly with 0.5% of the other directors in the network.

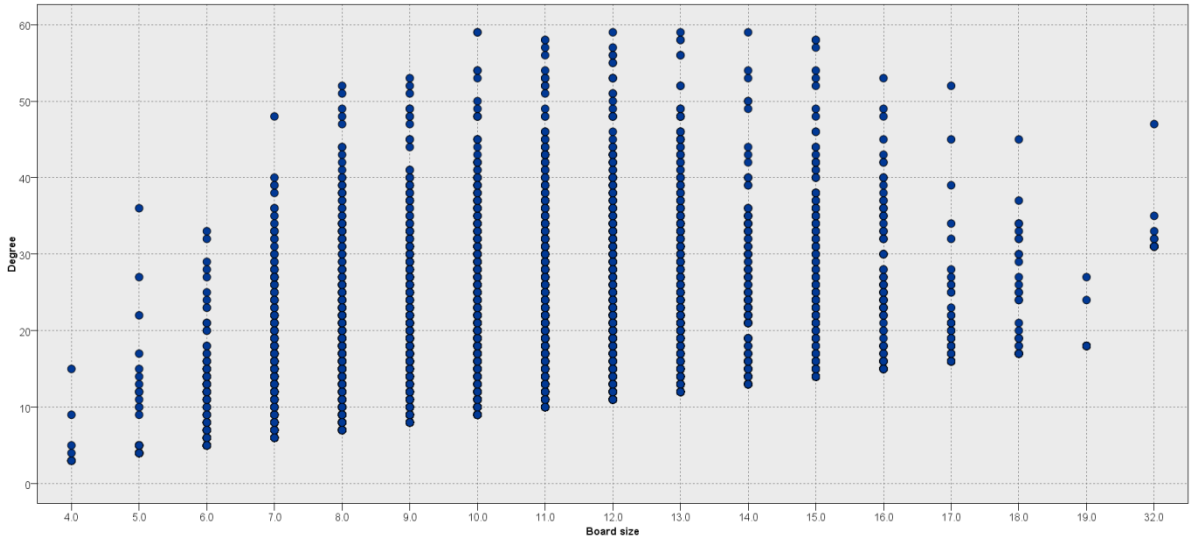


Figure 5-19. The Degree Distribution per Board Size

Figure 5-20 shows the nBetweenness distribution. The theoretical maximum betweenness for our network is $(g-1)(g-2)/2$ = (10796*10795)/2 = 58271410. This number relates to the maximum number of shortest paths in our network so it is not surprising that on average, directors are part of a very small number of these i.e., 0.0385% (see Table 5-9). Still, there are a very small number of directors with 0<nBetweenness<9.656 (total 3 directors) and these directors have a very important position in the network since they are part of the shortest paths between many other directors and thus, they can facilitate and affect the information flow between them. There are in total 10797directors i.e., 58.76% that have zero Betweenness/nBetweenness. These directors are not part of any of the shortest paths.

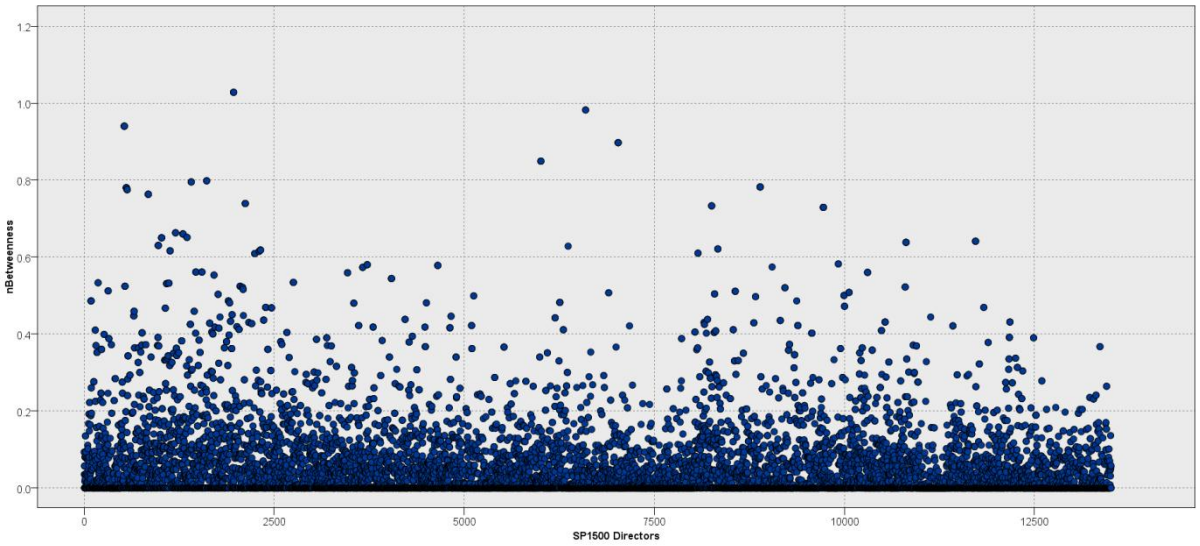


Figure 5-20. The nBetweenness Distribution

Figure 5-21 shows the nCloseness distribution. All of the directors have values between 9 and 27 and on average, 19.308 (see Table 5-9). This means that on average directors have to traverse 19.3% of the total number of directors (i.e., 2083 directors) in order to reach any other director. Directors that are better connected are the ones with low closeness since they have to traverse fewer links to reach other directors in the network.

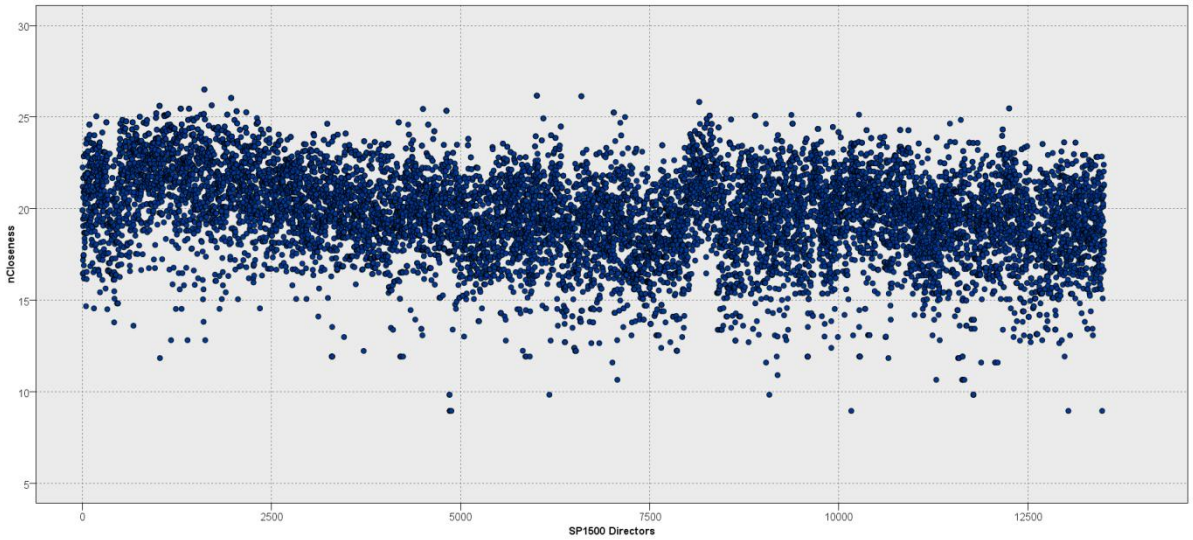


Figure 5-21. The nCloseness Distribution

Figure 5-22shows the clustering coefficient distribution. There are in total 6344 directors i.e., 58% that have the maximum value for clustering coefficient which is 1. These are the same directors that also have zero Betweenness. The average value of 0.808 (see Table 5-9) shows that a director has on average 80.8% of its directly-linked directors also directly linked to each other.

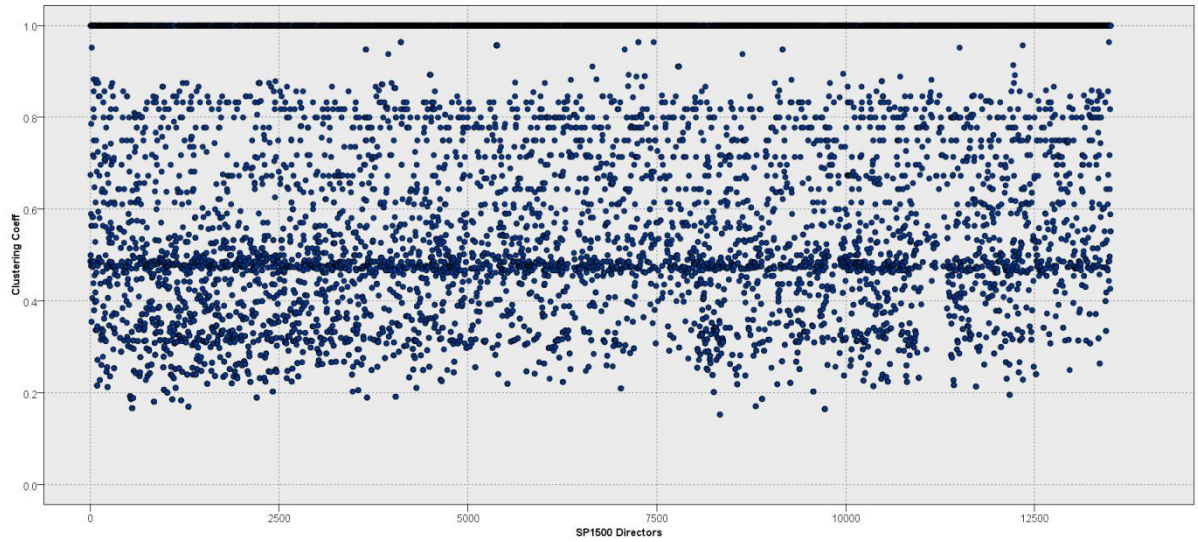


Figure 5-22. The Clustering Coefficient Distribution

The minimum value for clustering coefficient is 0.153. Finally, there are no directors with clustering coefficient zero and this is justified by the fact that the minimum degree is more than 1 i.e., 3.

5.6.2 Correlations between the Node Metrics

Table 5-10 presents the correlation between the node centrality metrics using the Pearson correlation with $\alpha = 0.05$ for the director-to-director network.

The strongest positive correlation is between *degree* and *betweenness* (correlation value 0.81) followed by the correlation between *degree* and *closeness* (correlation value 0.65) and the correlation between *closeness* and *betweenness* (correlation value 0.51). All these are consistent with previous literature even if the actual strength of the correlation is weaker.

Pearson Correlation Coefficients, N = 10797 Prob> |r| under H0: Rho=0					
	Degree	**Betweenness**	**Closeness**	**Eigenvector**	**Clustering Coefficient**
Degree	1.000				
Betweenness	0.81***	1.000			
Closeness	0.65***	0.51***	1.000		
Eigenvector	0.16***	-0.007	0.89	1.000	
Clustering Coefficient	-0.75***	-0.74***	-0.58***	0.031***	1.000

Significant in 0.05 level: ***

Table 5-10. Correlation between node centrality metrics

Director network is 10797* 10797 and it is sparse matrix. So, directors have very small eigenvalues. Eigenvector is positively and weakly correlated to degree and closeness. Degree is local centrality metrics, but eigenvector is takes into account the entire pattern of the network. Therefore, in this sparse and big network, degree and eigenvector are weakly correlated. The correlation is even weaker for closeness and eigenvector.

Correlation between eigenvector and betweenness is -0.007 which means they are not correlated and the result is not statistically significant. According to Table 5-9, betweenness is high and eigenvector is low; therefore referring to Table 5, the negative correlation expected because node is connected to many nodes but those are not important

In relation to the clustering coefficient metric, Table 5-10 shows that there is negative correlation between clustering coefficient and all the other node centrality metrics except eigenvector. The correlations are summarised below:

	Degree	Closeness	Betweenness	Eigenvector
Clustering Coefficient	Negative (-0.75)	Negative (-0.58)	Negative (-0.74)	Positive (0.031)

In relation to the correlations from the board interlock network, the clustering coefficient is more negatively correlated with the other metrics probably because of the size of the network (number of nodes). However, the correlation remains negative as expected. The correlation between clustering coefficient and eigenvector is positive, contrary to the expectations. This means that a node A is connected to other nodes which are important in connecting node A's neighbours together and consequently having higher clustering coefficient. The correlation is weak which implies that not all nodes follow this correlation.

5.7 Summary

This paper discusses the metrics for networks between directors and firms i.e., the board interlock and director-to-director networks and examines their interpretation and correlations from a domain-specific viewpoint. These types of networks are discussed extensively in the corporate governance literature (Renneboog & Zhao 2011b)(Fracassi & G. Tate 2012)(Horton et al. 2012a)(Larcker et al. 2013).

The BoardEx dataset is used to exemplify the different types of networks and their corresponding metrics. The paper examines in detail two types of networks, the board

interlock and the director-to-director networks. For each of these, five node level metrics are examined, namely degree, closeness, betweenness, eigenvector and clustering coefficient. These metrics are defined theoretically and examined in terms of their interpretation in relation to node-level or network-level characteristics and in relation to the correlations between them. The results reported in this paper could help review and examine the existing finance/corporate governance literature in relation to the use of these metrics. It will allow comparing the different approaches in relation to the hypotheses they examine and whether these could be interpreted through the possible correlations between the metrics.

The main contribution of this paper is to identify issues with data collection; multidimensional components involved and offer recommendations on both these issues Further work could also consider additional network characteristics that might be used to explain and interpret better some of the results reported. Characteristics such as the size of the network, the network density (Rowley 1997) and the degree distribution (Wang et al. 2011) are network level characteristics that could be used. Furthermore, a metric specific to the examined type of networks that could be used to explain some of the results is the degree proportion for directors that relates to their own firm ***(in-firm degree)*** i.e., links between directors of the same firm and the degree proportion that relates to links with directors from other firms ***(out-firm degree).***As discussed in section 5.6, these could be used to explain the degree and eigenvector metrics and their correlation with clustering coefficient but could also be examined in relation to the other metrics and their correlations.

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Chapter 6 The Effect of Board Roles on Firm Environmental Governance

Abstract

This paper examines the importance of board characteristics with respect to firms' environmental governance. This study examines a set of board characteristics, which represent the board monitoring and board resource-provision roles. The board monitoring role is consistent with agency theory and comprises director independence, CEO–chair duality and director ownership. Board resource dependence is consistent with resource-dependence theory and comprises two sets of human and social capital characteristics. While human capital characteristics include board size and director tenure, social capital characteristics include social network metrics. The findings confirm that effective boards increase their monitoring of management when there are more independent directors on the board, higher CEO–chairman duality, higher share ownership for insiders and the CEO and lower share ownership for outsider–directors. In addition, board social network connections are the most important factor in providing information. Boards with larger board size and lower board tenure are classified as resource-rich boards. Moreover, resource-rich boards with effective monitoring roles tend to have a board, or a committee appointed by the board that is responsible for environmental initiatives paying incentives for the management of climate change issues and publishing information in annual reports, voluntary communications or other regulatory filings.

Keywords: Board social network, environmental governance, board characteristics, resource-dependence theory, agency theory, data mining.

6.1 Introduction

Most activities of firms are associated with multiple impacts on the environment. Although the impacts vary across sectors and subsectors, firms pay more attention to environmental issues that matter to investors, shareholders, customers and the greater

society. During recent decades, firms have increased their attempts to measure and report their environmental profiles. This is evidenced by increasing firm participation in environmental voluntary initiatives, publishing their environmental activities, adopting the ISO 14001 as the international benchmark of environmental management systems, and self-regulation as a set of internal goals and initiatives. Given that the board of directors is responsible for protecting shareholders' interests and making decisions about major firm issues, implementing and developing the environmental profile of the firm is an agenda for the board of directors. It is a mission of the board to develop their firms in developing the environmental profile by providing knowledge and other resources (Pfeffer and Salancik 1978)(de Villiers et al. 2011) and ensuring that management endeavours to address the environmental agenda (Russo and Harrison 2005)(Berrone and Gomez-Mejia 2009).

(Hillman and Dalziel 2003) propose two roles for the board, namely: (i) monitoring management (based on agency theory); and (ii) facilitating access to the resources and information (based on resource-dependence theory). Accordingly, the board plays both roles in relation to developing an environmental profile. In this study, we use a set of board characteristics to represent the monitoring role of the board, which are board independence, CEO–chairman duality and director ownerships. In respect to the board's resource-provision role, we use two sets of board characteristics, namely, human capital (static) and social capital (relational) characteristics(Hillman and Dalziel 2003). The former refers to a set of characteristics for each individual board and includes board size and board tenure. The latter is the social network between firms, which refers to the position of the firm in relation to other firms and how this position in the network helps the board to facilitate access to resources and information. We then relate the two board functionalities to firms' environmental governance. We refer to environmental governance as a set of mechanisms and processes aimed at changes in environmental-related knowledge, decision-making and behaviours (Lemos and Agrawal 2006). When firms put environmental governance into practice, this is a sign of concern for the environmental profile of the firm. The implementation of environmental governance could be translated into: (i) assigning an individual or committee responsible for

environmental initiatives, practices and progress; (ii) the presence of environmental incentives; and (iii) publishing the firm's climate change reports.

Our study offers three key contributions. First, it expands on board literature and follows (Hillman and Dalziel2003) framework to integrate both functionalities of the board of directors, namely, the monitoring function (based on agency theory) and providing resources (based on resource-dependence theory).The main reason is that these two functionalities of boards do not work in isolation and are often interrelated. de Villiers et al. (2011) takes the same approach, using a set of board characteristics to explain the monitoring and resource-provision roles of the board in relation to strong environmental performance. This study builds on the work of (de Villiers et al. 2011) and is distinguished from previous studies by examining board social network as a resource-provision characteristic.

Second, this paper contributes to the literature analysing the relationship between board social networks and firm environmental performance (Ortiz-de-Mandojana et al. 2012)(Diaz et al. 2013)(Ortiz-de-Mandojana and Aragon-Correa 2013)(Walls and Hoffman 2013)(Shahgholian et al. 2014)(Shahgholian et al. 2014).

Third, researchers using multiple regression analysis focus on estimating whether or not the influence (i.e. the effect size) of each hypothesised independent variable is associated significantly with a dependent variable(Woodside 2013). Unlike previous research, our study employs a data-mining approach to investigate the existing patterns between a set of board characteristics, including board social networks and firm environmental governance. This responds to a call from the literature to investigate "when" it is possible to improve environmental profile (Lankoski 2008). In this research, data-mining techniques help to highlight the patterns between board characteristics and environmental governance.

The paper is organised as follows. Section 6.2 reviews the related literature and hypotheses. Section 6.3 describes the data sample and variables. Section 6.4 presents the analysis and interpretation of results, and Section 6.5 concludes the paper, describing potential areas for further research.

6.2 Background, Theory and Hypotheses

In general, the board decision-making process is extremely complex and it is widely recognised that the characteristics of the board of directors have a direct impact on the decisions made by the board. Despite the number of studies conducted on boards of directors, there is still a quest for a deeper understanding of what drives board task performance (Pugliese et al. 2014). Recent developments in the field of firm and environmental profiles have led to an examination of the role of the board of directors in relation to firms' environmental performance(de Villiers et al. 2011)(Walls et al. 2012). Many studies investigating the relationship between firm profile and environmental profile examine some of the board characteristics as firm profile. Because the focus of this study is only on board characteristics, we consider those that focus only on board characteristics. For example, three studies examine the CEO salary and compensation package in relation to environmental performance (Cordeiro and Sarkis 2008)(Berrone and Gomez-Mejia 2009)(Walls et al. 2012). There are four other studies examining a subset of directors' characteristics such as diversity, board independence, board size, board compensation, CEO–duality, insider/outsider directors, directors' average age and education (Prado-Lorenzo and Garcia-Sanchez 2010)(Post et al. 2011)(Post et al. 2014)(Zou et al. 2014). All these studies provide some insights into the relationship between the characteristics of the board of directors and the firm's environmental profile. All of them suffer from analysing a narrow set of board characteristics. de Villiers et al. (2011) examine a more complete set of board characteristics, investigating the relationship between strong environmental performance and board characteristics that capture boards' monitoring and resource-provision abilities in respect to strong environmental performance and the related strategic opportunities. They define the environmental profile for each firm, which indicates whether a firm displays any of five environmental strengths reported in the KLD database. They analyse the sample of US publicly traded firms indexed in S&P with data coverage on the KLD database for the 2003 and 2004 fiscal years. They collect environmental performance data from KLD, financial data from COMPUSTAT files and board governance data from the Corporate Library's Board Analyst database. Their findings confirm that environmental strengths are positively and significantly related to director independence, and negatively and

significantly related to directors appointed after the CEO. However, environmental strengths are insignificantly related to CEO–chair duality. Moreover, the results indicate an insignificant relationship between environmental strengths and CEO–director ownership, insider–director ownership or outsider–director ownership. The findings do not provide strong support for the association between multiple directorships and board tenure in relation to environmental strengths. On the other hand, environmental strengths have a positive association with board size, an active CEO and law experts.

Research examining the impact of social network profile on environmental profile has received attention since 2012 and is therefore still at a developmental stage. The first study examining the impacts of director interlocks on firms' adoption of proactive environmental strategies was conducted in 2012 by (Ortiz-de-Mandojana et al. 2012). A sample of 90 US electric firms were classified as investor-owned firms in 2005. In this research, director interlocks are measured as the number of interlocking ties with other firms and define four types of supplier with director interlocks, namely, green equipment suppliers, firms providing a knowledge-intensive business service, financial institutions and fossil fuel suppliers. The reported analysis confirms that interlocks with green equipment suppliers have a positive impact on proactive environmental strategies. Three other types of interlock show negative relationships with proactive environmental strategies. Similarly, (Ortiz-de-Mandojana and Aragon-Correa 2013) analysed a sample of 93 US electric firms in 2005.They define director interlocks as the number of interlocking ties with other firms.Their findings confrim that firms with a higher number of interlocking director ties have a positive relationship with environmental performance, measured as a percentage of global warming potential divided by annual net generation. In addition, the firm's diversity interlock ties have a positive relationship with environmental performance.(Walls and Hoffman 2013) examine the association between the social networks of the board of directors and positive environmental deviance. The research analyses 294 US firms from 2000 to 2008 and interlocking directorship is used to define the social network between firms. On this basis, they calculate degree centrality and eigenvector centrality. The findings indicate that more central firms, measured by either degree or eigenvector centrality in the network, are less likely to deviate positively from normal environmental practices in the institutional field. In 2013(Diaz et al.

2013)examined the role of social networks on environmental performance, analysing 310 S&P1500 firms in the year 2008. Their definition of social network is that two firms are considered socially connected if they share at least one director or if one or more of their directors sit in a third firm in which another S&P1500 firm director also sits. The findings show that firms that are socially connected have better environmental performance, as well as financial performance, measured by return on equity (ROE). In addition, socially connected firms pay incentives related to climate change, publishing information related to climate change and including information on their annual reports, and there is a responsible individual or team for climate change issues. (Shahgholian et al. 2014) examined how the social network between firms (as one of the board characteristics) could impact the environmental performance of 202 S&P1500 firms in the year 2011.In this work the "Current Employment (CE) Network of S&P companies" is defined as follows: two SP firms are linked through a director if two firms share the same director. This is the traditional interlocking directorship network. Moreover, if directors from two firms sit on the board of a third firm, this will also form the CE of SP firms. The findings confirm that those firms with better social connections pay higher compensation and environmental incentives; they have a higher number of independent directors, publish annual reports and are willing to have voluntary communications. In addition, they have committees responsible for climate change.

6.2.1 Environmental Governance

In this study, we use three variables to describe environmental governance, namely, environmental responsibility team, paying environmental incentives and publishing environmental reports.

6.2.1.1 Environmental Responsibility Individual/Team

The purpose of an environmental committee is systematically to plan, implement and review sustainability policies and activities(Liao et al. 2014a). Consequently, an existing environmental committee could help to prevent the agency problem. The environmental committee is likely to evaluate the advantages and disadvantages of environmental initiatives and provide more transparent and consistent environmental information. This could help the board of directors to prioritise environmental plans. When the board is directly responsible for environmental issues or there is a committee appointed by the

board, it is more likely that the board will guarantee the development of an environmental profile by monitoring management. In addition, an environmental committee may enhance the awareness of employees about the environmental aspects of their jobs and responsibilities to reduce negative impacts. Such committees have the authority to set up monetary and non-financial rewards to encourage employees to take action in environmental activities(Liao et al. 2014b).

6.2.1.2 Environmental Incentives

The role of paying financial incentives to motivate employees to take particular actions is evidenced by previous research (Conyon 2006). Paying environmental incentives could help to promote their sustainable management. Introducing an environmental incentive scheme can help to bring shareholders' interests and employers' behaviour closer together and minimise the agency problem. Firms may have several incentives to voluntarily improving environmental performance (Khanna and Anton 2002).In addition, firms may have an incentive to show themselves as being environmentally responsible (Rodrigue et al. 2013).Depending on the board's knowledge of employees' behaviour, it can design an appropriate reward scheme, either for all the employees or for a specific group such as a sustainability team or senior managers.

6.2.1.3 Environmental Reporting

As part of firms' environmental governance, they have a set of key performance indicators (KPIs) to evaluate the success of environmental activities. Therefore, firms attempt to collect, measure, manage and evaluate against KPIs and then report their environmental information. This process provides more transparency and comparability in their environmental profile (Matisoff et al. 2013). When the board has access to more reliable and up-to-date environmental information, it has more opportunities to monitor management in relation to developing an environmental profile. Firms usually publish their environmental reports through annual reports, voluntary reports or other regulatory fillings (Carbon Disclosure Project 2014), with the aim of providing insights into the main impacts on both the firm profile and the environment.

6.2.2 Board Characteristics

6.2.2.1 Agency Theory and the Monitoring Function

Management can pursue its own interests at the expense of shareholders' interests. One way to check such managerial activities and consequently improve firm performance is to employ monitoring and incentive-alignment mechanisms (Hillman and Dalziel 2003). The antecedent of the monitoring function is board incentives in order to motivate the board to protect shareholder interests (Hillman and Dalziel 2003). When board members are independent from the firm, they are more active in their monitoring responsibility (de Villiers et al. 2011). In addition, the evidence from agency theory shows that share ownership (equity compensation) is another motivation for board members to monitor management activities and decisions.

In recent years, environmental performance has been one of the major concerns of firms. However, the direct use of agency theory in the environmental profile of firms is scarce. Environmental performance requires significant investment, which might have uncertain outcomes and generally does not have immediate returns. Management are not interested in this sort of investment, which does not have short-term financial benefits to help increase their reputation and financial incentives. Therefore, it is important for boards to monitor and focus on decisions related to environmental performance. In this study, we consider board independence, CEO–chairman duality and share ownership as board characteristics with monitoring functions in relation to firm environmental profile.

Board independence. It is confirmed that because outside directors are independent from management, they are willing to monitor management more carefully and protect shareholder interests (Duchin et al. 2010)(Ienciu et al. 2012)(Walls et al. 2012).Previous studies have investigated the role of independent directors on firm performance (Armstrong et al. 2014)(Wang 2014)(Cuadrado-Ballesteros et al. 2015). In relation to environmental performance, de Villiers et al. (2011) argue that a board with a higher concentration of independent directors is more likely to have direct knowledge and expertise of monitoring environmental performance and pursuing the available environmental opportunities. However, Walls et al. (2012) show that a larger number of independent directors generally undermines environmental performance.

CEO–chairman duality*.* When the CEO also holds the position of chairman of the board, the combination of the two roles provides significant power for the CEO. The main argument against CEO–chairman duality is based on agency theory, which predicts that CEOs, as agents of shareholders, do not always act in the best interests of shareholders. Supporting this conflict-of-interest argument, previous studies have found that the combination of the CEO and chairman positions undermines the checks and balances in the top management of the firm (Romano and Guerrini 2012), and the board has less power to remove poorly performing managers (Goyal and Park 2002). A CEO who is also chairman of the board has more power to pursue a self-interested agenda and postpone other initiatives such as environmental investment with a long payback period.

Share ownership *(insider–director ownership, outsider–director ownership, CEO–director ownership).*Employee-share ownership refers to employees owning a proportion of their firms' shares (Poulain-Rehm and Lepers 2013). The primary goal of share ownership is to align everyone's interests on firm performance. Therefore, directors with greater share ownership are likely to focus on firm performance, because their decisions impact their own wealth. In support of this, prior research shows that a board with significant share ownership monitors CEO performance and is more likely to link CEO pay to firm performance (Bahaghat and Black 1999). More relevant to our study, Westphal (1999) and de Villiers et al. (2011) confirm that director ownership improves boards' monitoring of strategic decision-making. Therefore, directors with high share ownership are likely to support environmental initiatives. de Villiers et al. (2011, p.1644) state that "in the current climate of heightened environmental awareness, it is plausible that higher ownership could motivate directors to pursue green product and process innovations with potential to enhance shareholder value in the long run". In this study, we follow (Shivdasani 1993) and (de Villiers et al. 2011) and analyse the CEO–director ownership, insider–director ownership and outsider–director ownership separately. Insider–directors usually have large ownership; outsider–directors have small share ownership; and CEO ownership is also examined separately from the remaining insider–directors to consider the possible impacts of CEO ownership in relation to environmental performance.

6.2.2.2 Resource-Dependence Theory and the Provision of Resource Function

A second board function is the provision of resources adopted by scholars in the resource-dependence theory. Resource-dependence theory is premised on the notion that all organisations critically depend on other organisations for the provision of vital resources (Drees and Heugens 2013).The primary concern of resource-dependence theory is board capital, which consists of both human capital and relational capital (or social capital)(Hillman and Dalziel 2003). The former refers to directors' experience, expertise and reputation, while the latter is the network of ties to other firms and external contingencies (Hillman and Dalziel 2003).Therefore, a larger board can bring more experience and knowledge to the board and offer better advice (Dalton et al. 1999).Board interlocks are likely to enhance coordination with important resource providers, primarily by providing an exchange channel of tacit or sensitive information and greater social cohesion between the key decision-makers representing the interlocked organisations (Mizruchi 1996)(Drees and Heugens 2013).

In terms of firms' environmental performance, there are significant differences between directors' experiences. Resource-rich directors are more likely to have knowledge of environmental issues and other firms' environmental agendas, which could help the board to plan environmental development. The contribution of at least one member into environmental practices could have a significant impact on the firm's environmental initiatives. This study considers board size, board tenure and board social networks (board interlocks) as board characteristics related to the director's ability to facilitate access to the additional information and resources required for environmental performance.

Board size. Early research using resource-dependence theory focuses on board size as an indicator of the board's ability to provide resources to the firm (Hillman et al. 2009). A larger board offers more experience and knowledge and, consequently, better advice during the decision-making process (Ienciu et al. 2012)(Walls et al. 2012). Therefore, larger boards are likely to have some directors with a certain level of environmental knowledge or directors that can provide access to the relevant resources and knowledge. Directors with such expertise can influence the board in relation to the opportunities and

challenges of an environmental agenda. In addition, (de Villiers et al. 2011) support the positive impact of a large board on better environmental performance.

Board tenure. Longer director tenure means a long-term commitment to the firm. Directors with longer tenure are the source of knowledge about a firm's past performance and resources. Therefore, they can help the board with developing knowledge based on the firm's resources and performance in the past. However, along with this significant aspect of board tenure, there are also some negative aspects. Some studies suggest that long tenure is associated with less flexibility regarding change (Musteen et al. 2006). In addition, (Golden and Zajac 2001, p.1090) confirm that extended tenure of board members is associated with greater rigidity, and can result in entrenchment behind existing practices and procedures, with directors distancing themselves from new ideas. In such situations, a board with longer tenure may not be sufficiently flexible to establish an environmental agenda. Directors with shorter tenure have served on the boards of other firms more recently and therefore have more information related to the environmental initiatives of those firms.

Social networks. Social networks may facilitate value creation through the combination and exchange of resources (Tsai and Ghoshal 1998). Social networks enable the diffusion of knowledge, guide the allocation of resources and build consensus around best practice (Scott 2014). Social network analysis is the quantitative method used to build the social network profile of the board, which describes the position and behavioural characteristics of the board in relation to other firms in the network. The position of firms in the network is measured using social network centrality metrics, which are degree, betweenness, closeness and eigenvector (Shahgholian et al. 2015). The more centrally the firm is located, the more access it has to information and resources in the network (Granovetter 1985)(Walls and Hoffman 2013).The most recent empirical studies have linked director social networking profile to almost every important aspect of management and financial behaviour of firms, including shareholder value (Fogel et al. 2014), corporate finance policy decisions (Fracassi 2009), firm value (Fracassi and Tate 2012)(Larcker et al. 2013), CEO compensation (Hwang and Kim 2009)(Horton et al. 2012), director appointment (Qi 2011) and mergers and acquisitions (Fracassi and Tate 2012).

In the context of environmental initiatives, when the board is centrally positioned in the network, it can gain access to more information about environmental initiatives directly and find out more about other firms' environmental activities and developments. To the best of our knowledge, the research examining the impact of the social network profile on environmental profile has received attention since 2012 and is therefore still at a developmental stage (Ortiz-de-Mandojana et al. 2012)(Diaz et al. 2013)(Ortiz-de-Mandojana and Aragon-Correa 2013)(Walls and Hoffman 2013)(Shahgholianet al. 2014)(Shahgholianet al. 2014). Despite their differences in defining social networks and using a variety of social network metrics, as well as various environmental profile measurements, they all confirm the positive impacts of board social networking on the firm's environmental profile.

6.3 Research Method

6.3.1 Sample Selection

Our initial sample was based on 4,233 firm-year observations listed as S&P1500 firms, based on BoardEx (BoardEx 2011) data from 2009 to 2011. We used mainly BoardEx data to build social networks at firm level. In the next step, we merged social network data with environmental governance data derived from the Carbon Disclosure Project (CDP) (Carbon Disclosure Project 2013). Therefore, our sample reduced to 832 firm-year observations. The main reason for this is that it is mainly S&P1500 firms that report their environmental data to the CDP. Finally, we eliminated60 firms without board governance data on the RiskMetrics. The final database consisted of an unbalanced panel data set of 267 firms from 2010 to 2012. We lagged board characteristics data by one year to allow for changes in environmental governance to take place based on the board characteristics in the previous year. Each record contains metrics related to the board's social network, a number of board characteristics and environmental governance subject areas. The sample was restricted to the S&P1500 firms. The distribution of countries reveals that 99.05 per cent of the examined firms were from the US. The data covers 10 different industries classified by Global Industry Classification Standard (GICS) code; the largest representatives are financial (15.37% of firms), information technology

(14.01%),consumer discretionary (12.24%) and industry (12.24%), health care (10.75%), utilities (10.34%), consumer staples (10.07%), materials (8.03%) and energy (5.44%) industries.

6.3.2 Research Design

We employed data-mining techniques to model the impact of board characteristics on environmental governance. The methodology used in this analysis is a progressive clustering analysis approach. First, the K-Means (Alonso & Shuster, 2002) algorithm was applied using only social network attributes as inputs to identify two initial clusters of firms, called socially connected and socially independent. Next, we applied the k-means algorithm to the identified clusters in the previous step and a set of variables representing the board's resource-dependence characteristics. In addition, firms were profiled by the set of board-monitoring characteristics. At this point, there were two sets of clusters for board monitoring and board resource-provision roles. In the final stage, the firm's environmental governance profile was formed by applying the k-means algorithm to a set of environmental governance attributes and the board-monitoring and board resource-provision profiles of firms. Some additional analysis is shown on the relationships between the type of incentives and the individual or group entitled for that type of incentive.

6.3.3 Variable Measurement

A brief description of the variables used in this study is presented in this section.

Environmental Governance data. Environmental problems are often extremely complex and this is widely recognised as a multidimensional problem. While previous research focused mainly on environmental performance, including CO_2 emissions (Fujii et al. 2013)(Pintea et al. 2014)(Misani and Pogutz 2015), GHG emissions (Hatakeda et al. 2012), environmental disclosure (Cong and Freedman 2011) and environmental management (Busch and Hoffmann 2011)(Uhlaner et al. 2012)(Tao and Zhang 2014), the focus of this study is on firms' environmental governance.

The environmental governance data was obtained from the Carbon Disclosure Project (CDP). The CDP's data is used extensively in academic research (Kim and Lyon 2011)(Diaz et al. 2013)(Lee et al. 2013)(Shahgholianet al. 2014). The Carbon Disclosure Project (CDP) is a UK-based, not-for-profit-organisation, formed in 2000 as a United Nations initiative. Its mission is to gather and disseminate climate change information in an effort to create a unified response to global warming(Carbon Disclosure Project 2013). One category of questions is related to firm environmental governance and includes *cc_responsibility*, *pay_incentives*, *intentives_type*, *incentives_entitiled*, *publishing_cc_reports*.

cc_responsibility was constructed based on the firms' responses to this CDP question: "Where is the highest level of direct responsibility for climate change within your company?"Firms had four choices to identify the position of the individual or name of the committee with this responsibility, namely, (i) board: the board or other committee appointed by the board; (ii) senior manager/officer; (iii) other manager/officer; and (iv) no individual or committee.

pay_incentives was constructed based on the CDP question: "Do you provide incentives for the management of climate change issues, including the attainment of targets?" Firms responded to this question by selecting "Yes" or "No".

intentives_type. If firms responded that employees could benefit from incentive programmes related to climate change, they were asked to provide information about the types of incentive they were paying. The former question contains a set of predefined categories, namely, monetary, recognition (non-monetary) or other non-monetary incentives. The CDP defines monetary incentives as a bonus or some form of financial remuneration; recognition (non-monetary): employee award (e.g. employee of the year) or career-progression scheme, but not tied directly to any form of financial remuneration; other non-monetary reward, including increased holiday allowances, special assignments, parking allocations, and so on. These definitions are also supported by (I1988)and (Gomez-Mejia, Luis R, Balkin David B1995).

incentives_entitiled. In addition, firms had to identify who is entitled to benefit from the selected incentives. The CDP provided 17 predefined categories of employee for this question. In this research we grouped them into four main categories, as follows:

i. Board: board chairman; board/executive board; director on board; corporate executive team; CEO; COO; executive officer; management group.
ii. Sustainability team: energy managers; environmental sustainability managers; risk managers; other.
iii. Other managers: business unit managers; facilities managers; process operation managers; public affairs managers.
iv. All employees: all employees.

publishing_cc_reports. Firms were asked about communication of their position on climate change and carbon emissions outside their CDP response. They had to answer the following question: "Have you published information about your company's response to climate change and GHG emissions performance for this reporting year in places other than in your CDP response? If so, please attach the publication(s)". In this study, we brought the firms' responses to the same level of detail and created three main categories, namely: (i) annual reports refer to the mandatory annual financial reporting, published to meet regulatory obligations;(ii) voluntary communication if firms have published optional sustainability/CSR reports; (iii) other regulatory filings are those required through regional or national legislation, examples being the SEC filing in the US, reports made under the AB32 and EPA federal reporting rule, ETS regulation submissions, or Victorian Energy Efficiency Target (VEET) filings in Australia.

It was chosen to use binary representation of the variables in all the experiments, facilitating easier manipulation and aggregation. The value of this variable ranges from 0 to 7, where 7 shows that the firm publishes its climate change information in all of the three categories, and 0 shows that the firm is not publishing in any of them.

Board characteristics data. We employed two sets of board variables in this study. The first set of board variables measured board monitoring and incentives, as discussed under agency theory, including director independence, CEO–chair duality, CEO–director ownership, insider–director ownership and outsider–director ownership. The measurement of these variables was consistent with prior research (de Villiers et al. 2011). All the variables were calculated based on the RiskMetrics dataset.

Director independence is measured as a percentage of the number of independent directors on the board.*CEO–chair duality* is coded as 1if the CEO also serves as the board

chairman, and otherwise as 0.*CEO–director ownership* captures the percentage of the total number of shares held by a board member who is also the firm's CEO. *Insider–director ownership* is measured as the cumulative percentage of the total number of shares held by the remaining executive (i.e. non-CEOs) board members. Similarly, *outsider–director ownership* is the cumulative percentage of the total outstanding shares held by outsider (i.e. non-executive) board members.

The second set of board variables measures the provision of resources by directors, as discussed under resource-dependence theory, and includes board size, board tenure and board social network. Board tenure is calculated based on the available data from the RiskMetrics database and other metrics are calculated using the BoardEx dataset.

Board size is the number of directors on the board. *Board tenure* is measured as the average number of years the firm's directors have served on the board(de Villiers et al. 2011). Boardroom social network is defined and calculated as follows.

We obtained information on firms' board of directors from the BoardEx dataset, which keeps information about individuals, mainly from the USA and Europe, who work in publicly quoted firms and major private entities at board of director and executive management levels. The information includes in-depth profiles such as academic qualifications, current and past job positions, membership of professional and other bodies, and is collected and revised semi-automatically by analysts in charge of collecting, processing and updating information about such individuals. Once the information is validated, BoardEx provides business networking services to firms and individuals wishing to obtain information about certain individuals and their contacts (positive interpersonal ties) and the relationship of their contacts with other individuals (social network). Using BoardEx data from 2009 to 2011, we built an undirected and unweighted social network at board level, defined as follows:

"Current Employment (CE) Network of S&P firms". Two S&P firms are linked through a director if two firms share the same director. This is the traditional interlocking directorship network. Moreover, if directors from two firms sit on the board of a third company, this will form the CE of S&P firms as well. Multiple links between two S&P firms through different S&P directors are assumed to be the same. Table 6-1 reports the

summary statistics on the CE network for S&P1500 firms. On average, we have 1,411 firms and 1,380 directors per year. After building the social network at firm level through the social ties of board members, we are able to capture the firm's position in relation to others on the entire network by calculating degree centrality, betweenness centrality, closeness centrality and eigenvector (Shahgholian et al. 2015).

Year	2009	2010	2011
#Firms	1,408	1,411	1,414
#Links	27,253	27,628	28,143
#Directors	1,378	1,383	1,380
Size of largest component	1,400	1,405	1,407

Table 6-1. Summary statistics of CE network characteristics

6.4 Results

Table 6-2 displays the results of the first step in the clustering analysis framework for each year. The recorded Silhouette Coefficient evaluates the clustering model in each year. Based on this score we can see that clusters in each year have fair quality. We can distinguish two clusters in each year. The first cluster (C1) described the firms that are not particularly well connected. Compared to the second cluster (C2), they have fewer direct links to other firms (degree), their neighbours are also not very well connected to the rest of the network directly (eigenvector), they have less direct access to the rest of the network (closeness) and they participate less in transmitting information between other firms in the network (betweenness). Therefore, the first cluster (C1) is defined as a "socially independent" (SI) cluster and the second as a "socially connected" (SC) cluster. The clusters in each year follow the same pattern.

The size of socially connected clusters is smaller than socially independent clusters in each year, but the size gradually increases over the year from 39.1 per cent in 2009 to 42.1 per cent in 2011. The increased size can be interpreted as the social network evolution of firms over time, where more firms are connected based on their connection in this year, and therefore there will be a greater number of socially connected firms. In addition, the social network metrics are sorted by overall importance. Therefore, someone can conclude that degree and eigenvector are the most important metrics in

each year to form the clusters. Closeness and betweenness have the same order in 2009 and 2011, while in 2010 betweenness is more important than closeness to form the clusters.

	2009			2010			2011		
Silhouette	0.6			0.7			0.7		
Cluster no.	Metrics	C1	C2	Metrics	C1	C2	Metrics	C1	C2
Cluster size (%)		60.9	39.1		60.2	39.8		57.9	42.1
	D	54.00	123.00	D	50.46	119.98	D	48.75	116.57
	E	3.45	9.74	E	3.23	9.37	E	3.08	9.04
	C	42.10	46.85	B	0.13	0.44	C	41.86	46.88
	B	0.15	0.44	C	41.95	46.96	B	0.12	0.41

Table 6-2. Social network clusters and their statistics per year;
Note: D= degree, E=normalised eigenvector, C=normalised closeness; B=normalised betweenness

As discussed in the literature review section, we considered two groups of board characteristics: board resource-provision characteristics and board-monitoring and incentive characteristics. In this step, the clustering model was applied to each set of attributes separately in order to find the clusters. First, the K-Means algorithm was applied to board resource-provision variables, which are board tenure, board size and social network clusters obtained from the previous step. Table 6-3 presents the clusters in each year. The recorded Silhouette in each year is 0.7, which indicates that the clustering quality is fair in each year. The order of variables in all years is the same. Apparently the social network variable is the most important variable to distinguish two clusters. It is now possible to appreciate how firms that are members of the socially connected (SC) cluster also possess better indicators in terms of board resource provision. Considering the results in 2009, it can be concluded that socially connected (SC) firms have a greater average of board size. However, lower board tenure indicates that the average number of years the firms' directors have served on the board is smaller. This means that firms have hired directors more recently. Therefore, it is more likely that directors have more knowledge and expertise in relation to environmental performance through their previous directorships in other firms. The same results appear between firms in the years 2010 and 2011. Therefore, the first cluster (C1) is defined as a "board with poor resource

provision" (RP_{poor}) cluster and the second as a "board with richer resource provision" (RP_{rich}) cluster. The clusters in each year follow the same pattern.

	2009		2010		2011	
Silhouette	0.7		0.7		0.7	
Clusterno.	C1	C2	C1	C2	C1	C2
Cluster size (%)	60	40	60.2	39.8	57.9	42.1
Social network connectedness	SI	SC	SI	SC	SI	SC
Board size	10.71	12.54	10.71	12.54	10.65	12.27
Board tenure	10.38	9.80	10.38	9.80	10.43	10.11

Table 6-3. Boardresource-provision clusters and their statistics per year;
Note: SI=socially independent, SC=socially connected

At this stage, we turned our attention to clustering the board-monitoring and stock-incentive variables. The K-Means model was applied to the data in each year. Table 6-4 presents the results in each year; two clusters in each year are identified. The recorded Silhouette for each year indicates that the quality of clustering is fair. Considering the results in 2009, it can be concluded that in cluster C1 the number of independent directors is higher than in cluster C2. Stock ownership is as expected; insider–directors own more stock, which encourages them to protect shareholder interests more. In addition, outsider–directors own little stock, which means they are not particularly dependent on firm stock and they can influence the board's decisions and monitor firm management independently. On the other hand, the number of CEOs owning a high percentage of stock, as well as CEO–chairman duality, is higher. This is an original finding that contradicts existing contribution and studies in this area. The interpretation of this is that CEO interests could be in line with shareholder interests because of their share ownerships. In this case, we should not be too concerned about the contrasts between CEO and shareholders' interests. In this situation, higher CEO–chairman duality could help the CEO and board to be more focused on the decision-making process.

	2009			2010			2011		
Silhouette	0.6			0.7			0.7		
Clusterno.	Metrics (%)	C1	C2	Metrics(%)	C1	C2	Metrics(%)	C1	C2
Cluster size (%)		54.7	45.3		78.5	21.5		48.4	51.6
	CEO_{Own}	76.40	6.25	$Insider_{Own}$	80.85	22.46	CEO_{Own}	77.65	7.14
	$Outsider_{Own}$	19.09	43.85	$Outsider_{Own}$	19.15	77.54	$Outsider_{Own}$	18.36	44.58
	$Insider_{Own}$	80.91	56.15	CEO_{Own}	56.06	9.31	$Insider_{Own}$	81.64	55.43
	IndDir	85.28	80.09	IndDir	83.83	81.67	IndDir	86.57	81.92
	CEO duality	0.11	0.08	CEO duality	0.08	0.07	CEO duality	0.08	0.02

Table 6-4. Board-monitoring clusters and their statistics per year;
Note: CEO_{own}= CEO ownership; $Outsider_{own}$= outsider–director ownership; $Insider_{own}$= insider–director ownership; IndDir= independent director; CEO duality= CEO–chairman duality

This stage profiles the firms' environmental governance with respect to the board-monitoring and board resource-provision profiles. Table 6-5 shows the results. The environmental governance variables are paying incentives (PI), publishing climate change information (CCP) and the climate change responsible team (CCR).The general pattern each year is that when the board is in a better position in terms of monitoring and resource provision, there is a high possibility (at least 77.9%) that the board will be directly responsible for climate change issues in the firm. They publish the climate change information in the firms' annual reports and voluntary reports. In addition, they pay incentives for environmental activities to entitled people.

	2010			2011			2012		
Silhouette	0.3			0.2			0.3		
Clusterno.	Metrics	C1	C2	Metrics	C1	C2	Metrics	C1	C2
Cluster size (%)		54.2	45.8		53.5	46.5		55.5	44.5
	PI	Yes (77.0%)	No (77.7%)	CCR	SM (59.9%)	Board (89.1%)	BM	Low (78.7%)	High (82.3%)
	CCP	7 (75.4%)	3 (40.8%)	PI	No (58.4%)	Yes (97.5%)	BRP	Poor (84.4%)	Rich (75.2%)
	CCR	Board (91%)	Board (46.6%)	CCP	2 (28.5%)	6 (37.0%)	PI	Yes (60.3%)	Yes (90.3%)
	BM	High (74.6%)	Low (68.9%)	BRP	Poor (70.1%)	Rich (51.3%)	CCR	SM (48.2%)	Board (77.9%)
	BRP	Rich (59%)	Poor (82%)	BM	High (76.6%)	High (80.7%)	CCP	2 (29.1%)	6 (37.2%)

Table 6-5. Board and environmental governance clustering and their results per year
Note: PI=pay incentives, CCP= climate change publishing, CCR=climate change responsibility, board monitoring= BM; BRP= board resource provision

To this point, we have discovered that when the board has higher monitoring of management and is also resource-rich, it is directly responsible for climate change issues in the firm and is definitely paying incentives and publishing climate change information. When firms were responding to the CDP questionnaire, if the firm confirmed the payment of incentives then they had to answer two more questions to specify who was entitled to benefit from these incentives and the type of incentives involved. Figure 6-1 presents the type of incentives for each group, or individuals, entitled to incentives. In Figure 6-1, panel A, the type of incentives for the board are plotted. It is clear that monetary incentives are higher than other types of incentive. Boards received the highest percentage of monetary incentives in 2011. Paying recognition incentives to the boards increased slightly from 2011 to 2012. However, the percentage of non-monetary incentives remained relatively stable. Figure 6-1, Panel B indicates the type of incentives for the sustainability team. This group also received a very high percentage of monetary incentives. While their non-monetary incentives declined from 2010 to 2012, there was a significant increase in the percentage of recognition and monetary incentives from 2010 to 2012. As shown in Figure 6-1, Panel C, firms are paying a higher percentage of monetary incentives to other managers in the firm compared to non-monetary and recognition incentives. In contrast to the boards and sustainability team, the recognition incentives for this group declines over time. Figure 6-1, Panel D shows the percentage of the type of incentives assigned to all employees in the firm. Unlike the other three groups, employees are entitled to recognition incentives that are much higher than other types of incentive. The reason could be that when the board has direct responsibility for climate change issues in the firm, it is more likely to promote the environmental agenda through giving incentives to all employees.

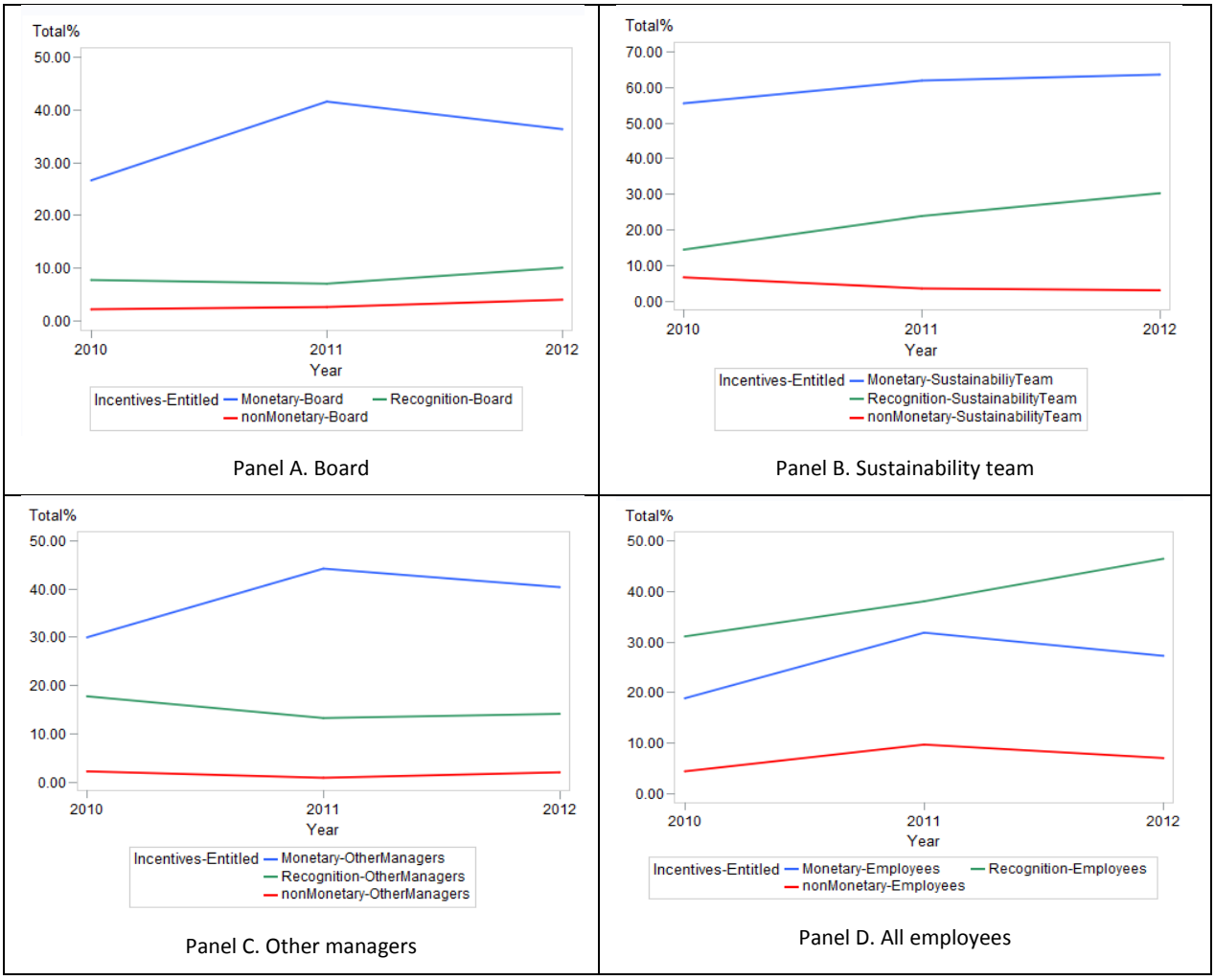

Figure 6-1. Percentage of three types of incentive per the entitled group for incentives

6.5 Discussion and Conclusion

This work has explored the extent to which a board of directors with both monitoring and resource-provision roles affects a firm's environmental governance. We identified the potential advantage of the appointment of experienced directors to the board and their social networking with directors from other firms to create value in relation to the firm's environmental governance. In addition, a board with an effective monitoring role can help management to pursue environmental governance. We investigated the relationship between environmental governance and several board characteristics, which are categorised as the monitoring role of directors linked to agency theory and the resource-provision role of directors linked to resource-dependence theory. Consistent with resource-dependence theory, we show that board social network connections are the most important factor in providing information. Boards with larger board size and lower

board tenure are classified as resource-rich boards. Consistent with agency theory, the board of directors monitors the implementation of decisions made by the board. Effective boards increase their monitoring of management when there are a higher number of independent directors on the board, higher CEO–chairman duality, higher share ownership for insiders and CEOs and lower share ownership for outsider–directors. In addition, a resource-rich board with an effective monitoring role tends to have a board, or a committee appointed by the board, to be responsible for environmental initiatives, paying incentives for the management of climate change issues and publishing information in annual reports, voluntary communications or other regulatory filings.

Research on the environmental profile of firms limits their environmental variable to just one variable, such as CO_2 emissions (Misani and Pogutz 2015) or KLD strengths (de Villiers et al. 2011), because they need to have one dependent variable in the statistical model, such as regression analysis. This study employs data-mining techniques, which provide us with the opportunities to find patterns between a set of board characteristics and a set of environmental governance using a clustering technique. In addition, we use the integration of agency theory and resource-dependence theory to define the role of the board of directors in terms of monitoring and resource-dependence theory. Our analysis presents the finding that two complimentary roles are necessary in relation to environmental governance. In addition, the social network between boards of directors is defined as one of the important factors that could facilitate access to resources and information based on the position of firms in the network. Various social network centrality metrics are employed to describe the position of the board of directors. Therefore, our study is the first to justify the social network based on resource-dependence theory and to consider its impact on environmental governance.

The practical implication of our study is for firms interested in developing their environmental profile. Taking into consideration the importance of the board of directors in relation to the board resource-provision and monitoring role, firms should be more careful when appointing directors. The board needs directors who are knowledgeable in the environmental domain and can provide the relevant resources through their expertise and social networks with other sources. When the board has a reasonable level of understanding of environmental profile and an effective monitoring capability, it is able

to pursue managers for business opportunities related to environmental products and services. In other words, firms should set up board structures and characteristics for an environmental profile. They should consider not only static board characteristics such as board independence, but also rational characteristics such as social network.

We acknowledge that our study has several limitations. First, this study analyses a period of three years; a longitudinal study approach covering an extended period of time would reveal more patterns. The main reason for this is that an environmental agenda usually requires long-term plans and investment. Second, the study focuses on board characteristics. However, we cannot ignore the role of firm characteristics such as firm age, firm size, industry sensitivity and the firm's financial situation in terms of environmental investment. Third, our sample comprises mainly the S&P1500 firms in the US, which are large firms (large-cap US equities). Although it is obvious that large firms are more visible and, as a result, more active in the environmental agenda and engaging in various voluntary environmental programmes, for small- and medium-sized firms the link between board social networking and other board characteristics with environmental profile could be different.

Beyond our study's limitations, there are a number of promising areas of future research. First, based on the resource-dependence theory, this study shows that knowledge and information gathered by members of the board leads the board of directors to pursue better environmental practices. Future research could explore the importance of board environmental experience such as membership of an environmental committee or their previous role involving environmental-related programmes. Second, following other studies that integrate agency theory and resource-dependence theory (Hillman and Dalziel 2003)(de Villiers et al. 2011)(Zona et al. 2015), our study also provides support for this integration. By taking into consideration that the board decision-making process is complex, the use of any of these theories alone may not be sufficient. Therefore, the integration of agency and resource-dependence theories could provide more insight into other board-related outcomes. Third, this research employs the common social network centrality metrics. For future research, we recommend exploring the evolution of the board social network (Shahgholian et al. 2012) and how social network evolution could affect firms' environmental profiles.

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Chapter 7 Discussion and Conclusion

This chapter summarises the thesis. It begins by restating some of the key topics, the structure and contributions of the work, and continues with a discussion of the limitations of the latter. The chapter provides a number of future research areas based on the work presented in the thesis.

7.1 Overview of the work

The principal aim of the research, as illustrated in Chapter 1, was to examine the impact of the social network profile on the environmental profile of firms. To achieve this aim, the thesis began by defining the three dimensions of this research, which are social network profile, financial profile and environmental profile. Chapter 1 also introduced the contemporary state of the two main streams of research, which are (i) social network and financial profile, and (ii) environmental profile and financial profile. It emphasised the need to provide the research background, reducing the inconsistency and increasing transparency in both research streams. The chapter also discussed the need to define and use social network profile using social network theory. A brief overview of the existing research on the relationship between social network profile and environmental profile was presented in this chapter.

In order to increase our understanding and to help develop a common language and shared body of knowledge, this thesis built a framework following the “design science research” (DSR) methodology (Hevner et al. 2004). Chapter 2 discussed the method used to research and design an innovative solution that addresses the gaps identified in the understanding of research background and examining the impacts of social network on environmental profile. The chapter began by providing a general definition of the chosen research approach, followed by a justification of why this methodology was appropriate for the task at hand. It continued with a thorough description of how the methodology was implemented in each of the four papers. It illustrated that chapters and chapter sections can be mapped directly to the design science methodology. Then this research presents four papers as shown in Figure 7-1.

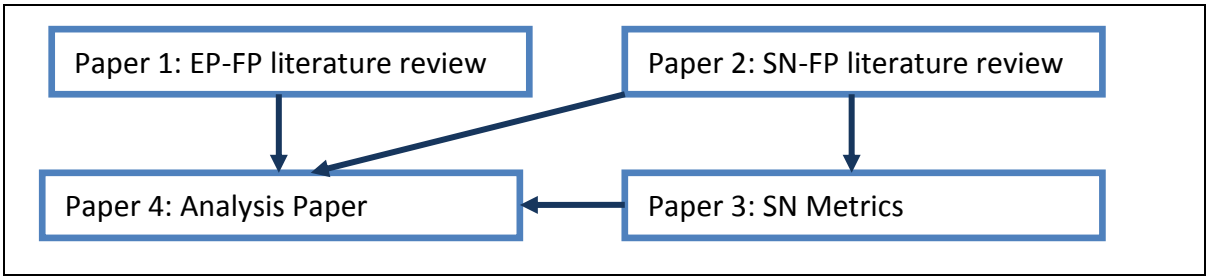

Figure 7-1 Summary of Papers

Chapter 3 presented an extensive literature review on the relationship between environmental profile (EP) and financial profile (FP), focusing on the problem of the replicability and comparability of previous studies. An overview of the existing meta-analysis was presented and the contributions of the paper in relation to other meta-analysis papers were highlighted. For each paper, a summary of their aims, the EP definition and variables, data sample characteristics and findings were presented. The main contribution of this paper was its focus on data. A number of data-related characteristics such as data sources, data-set characteristics, data sample size, sector and country coverage were examined. EP and FP variables were also examined and the most important findings discussed.

Chapter 4 presented an extensive literature review on the relationship between social network profile (SN) and financial profile (FP), focusing on the level of replicability and comparability of existing studies examining this relationship. Similar to the previous paper, for each paper a summary of aims, the SN definition and variables, data sample characteristics and findings were presented. This paper also focused on data, examining a number of data-related characteristics such as data sources, data-set characteristics, data sample size, sector and country coverage. EP and FP variables were also examined and the most important findings discussed.

Chapter 5 presented the social network definition and metrics using the BoardEx dataset, with the aim of providing an overview of the social network definition between directors and collectively between boards of directors, using social network theory. Next, social network centrality metrics were discussed based on the social network theory, as well as the business context. The paper then attempted to highlight the correlations between centrality metrics and to interpret them in relation to the business context. The BoardEx

dataset was used to define and create the social network at the levels of both directors and firms. Social network centrality metrics were calculated using UCINET 6.0 and then interpreted.

Chapter 6 presented an instantiation of the previous papers, using a subset of organisational-based variables, which are the board characteristics. The environmental governance variables were also selected as a subset of firms' environmental profiles. Social network was defined as the social network at firm level, and then the social network centrality metrics were calculated and interpreted based on the work presented in Chapter 5.Chapter 6 analysed the relationship between a set of board characteristics and the environmental governance of S&P1500 firms. A set of board characteristics was chosen on the basis of the role of the board of directors in monitoring management and resource provision. Agency theory was employed to justify the monitoring role of the board of directors, including board independence, CEO–chairman duality and share ownership. Resource-dependence theory was used to justify the role of the board of directors in terms of providing resources and information, including board size, board tenure and board social networking. A data-mining technique was used to define two sets of clusters to distinguish high-and low-monitoring boards, as well as both rich and poor resource-provision boards. The clustering analysis showed that boards with high monitoring and rich resource provision are mainly responsible for environmental issues, providing incentives to employees and publishing environmental information on annual reports and voluntary disclosure.

7.2 Contributions

This research provides additional knowledge at both theoretical and practical levels. Three main objectives of this thesis were presented in Chapter 1. In this section, the theoretical and practical contributions for each objective were presented.

7.2.1 Theoretical implications

In relation to objective (a), a theoretical contribution of this study was to enrich the domain knowledge by providing comprehensive insights into the literature examining the relationship between EP and FP, as well as SN and FP.

Another contribution of this study was to reduce inconsistency in the use of terminologies. To be specific, this study defines SN, EP and FP and provides classifications for them, which helps in recognising the key area that is associated with and affects the EP–FP relationship or the SN–FP relationship.

One of the most important contributions of this research is to provide an extensive overview of the relationship between EP and FP at data level. This has not been addressed fully in the existing meta-analysis research. Similarly, the second paper provided a comprehensive overview of the relationship between SN and FP at data level, which has not yet been conducted. The researcher investigates both research streams at data level, because data forms the basis of any research. The main contribution of both papers is to identify issues with data collection, data characteristics and offer recommendations on both these issues.

In relation to objective (b), the third paper, the main contribution is an encompassing definition of social networks and an interpretation of social network metrics. The paper provided insights into the application of social networks on business through understanding the following key factors:

- Definition and types of social network between the boards of directors;
- Providing a level of consistency in defining and measuring the social network centrality metrics by carefully considering the social network theory;
- Examining the interpretation and correlations of social network centrality metrics from a domain-specific viewpoint.

In relation to objective (c), the fourth paper analysed a subset of board characteristics in relation to environmental governance. To the researcher's knowledge, this study is one of the preliminary studies to use data-mining techniques. In this research, the integration of agency theory and resource-dependence theory in relation to existing environmental governance was examined. The research findings present that the social network between directors is an important factor for the resource-provision role of the board of directors.

7.2.2 Managerial implications

This section identifies the beneficiaries of this research, when they will use the research findings, as well as how they will benefit from them.

The first paper presented an extensive literature review on the relationship between EP and FP from 2004 to 2014, thus providing an opportunity for managers to access an almost complete set of studies in full detail. The managers can determine under which circumstances improving EP leads to improving FP, and vice versa. In addition, this study provides descriptive details of each study to cover various data-related characteristics, the EP and FP variables, and the findings. Therefore, managers can discover similar studies to their firms' characteristics. For example, firm managers in the pollutant industries need to consider studies that focus on this type of industry.

The second paper presented a literature review on the impact of social network between directors and firms (SN) on FP. This provided an opportunity for managers to consider the impacts of director social networking on FP with respect to a variety of social network definitions and measurements. Managers should consider social network to be one of the most important factors influencing the firms' FP.

The third paper focused on the social network at director and firm levels. Managers might be aware of the types and importance of social networks but they lack a detailed understanding of social network metrics. This paper provides more insights into the social network and how social network centrality metrics such as betweenness, closeness and eigenvector could affect access to various sources of information. The message of this study for managers is that they can take advantage of social networks by accessing information and resources rather than viewing social networks as threads of competition.

The fourth paper highlighted the impact of both monitoring and resource-dependence roles of the board in relation to firms' environmental governance. This could help firms in the sense that both roles of the board of directors are interlinked and essential. There is a bidirectional relationship between board monitoring and resource-provision roles. When boards of directors have sufficient knowledge about their environmental profile, they can monitor management performance; moreover, when there is a high level of monitoring, the board needs to access more information and resources. The presented results in this

paper reveal the impact of social networks as one of the most important factors in the provision of resources and information. In addition, managers can access other firms' experiences and initiatives related to environmental governance through their directors' connections to others. Environmental governance is presented as establishing the responsible board or individual, paying incentives and publishing environmental information. The researcher's opinion is that environmental governance provides the platform for improving firms' environmental profile in the long term by offering transparency, planning and controlling of environmental activities.

7.3 Limitations of the work

Despite the extensive work reported in this thesis, there are still challenges that need to be addressed through further investigation.

In both literature reviews presented in Chapters 3 and 4, the studies were selected mainly by searching using a set of keywords and expressions, and then trying to find other papers among the reference list of each study. In the case of the literature review on the relationship between EP and FP, the list of selected papers was cross-checked with the recent meta-analysis papers. Therefore, it is possible not to include some relevant studies.

In both the aforementioned literature reviews, the control variables and research methodology were not considered. In addition, when examining the relationship between EP and FP, it was found that some studies employ industrial sector as a main variable, while others include this variable as a control variable. The literature review did not pay attention to this level of differentiation using variables.

In terms of the work presented in Chapter 5, social network analysis, it is acknowledged that the social network between directors could be formed in various ways and with other individuals. However, in this chapter, the focus was only on the social network between directors and collectively between the board of directors. In addition, this paper provided the theoretical explanations and interpretations for social network centrality metrics. The main reason for this is that the majority of reviewed studies examining the relationship between SN and FP, as presented in Chapter 4,use a subset of centrality

metrics. There are a number of other social network metrics that could be useful in the business context, such as social network evolution metrics or social network multi-layer metrics.

The fourth paper employed a set of board characteristics that can describe the monitoring and resource-provision roles of the board. The researcher acknowledges that there are more board characteristics that can explain these roles. Although this research used three secondary datasets, it was extremely time consuming to perform data understanding and data processing, then selecting or calculating the relevant variables for all dimensions of the analyses, namely, social network definition and calculating social network metrics, board characteristics and environmental governance variables.

The acknowledged limitations of this research lead to recommendations for future research, which are described in the following section.

7.4 Future Work

Future research should investigate the impact of research methodology and control variables when examining the relationship between EP and FP. In addition, various theories such as agency theory, institutional theory and resource-based theory, among others, should be explored. The variables selected and the findings and interpretations are discussed from the perspective of the selected theory. Future research should consider the relationship between EP and FP from various points of view, which could provide more insights into the contradictory findings. The above discussion is also applicable to extending the literature review on the relationship between SN and FP. In addition, both literature reviews covered studies from 2004 to 2014. As discussed in the section on limitations, not all relevant studies were included as a result of the methodology of the study. In addition, it would be helpful to include incrementally the more recent studies and keep track of data-relevant characteristics and findings.

As one of the main future works, another literature review could be collected based on the two presented literature reviews in this thesis, with the aim of providing a pathway of

research opportunities and research questions to examine the interlinks between three domains, namely, social network profile, financial profile and environmental profile.

In addition, future research could examine other social network metrics such as social network evolution metrics or social network multi-layer metrics, which could be useful in explaining the connection between directors and directors on the boards of other firms.

In relation to analysing the impacts of social network on environmental governance, there are opportunities to examine the relationship between board monitoring and resource-provision roles in relation to environmental performance, environmental strategy, environmental risks and opportunities provided in the CDP dataset.

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