Environmental Performance:
A case study of the impact of Social Networks and Environmental Governance

Abstract— following the wake of the recent global financial crisis, we are witnessing an increasing consensus among corporate leaders that any decision model for a successful business should link to climate change. The board of directors is a key governance feature that directs and controls a company, in this sense; previous works have shown there is a direct relationship between financial decision making and the social networks characteristics of the board. In this paper we explore whether the characteristics of the social networks of the board of directors also influence the ways companies make environmental decisions. These decisions often have an impact in two important dimensions: firstly, the level and quality of information that is disclosed to the public in relation to the “green” activities and policies that the company has embarked on and secondly, the performance of the company in environmental terms.

In this paper, we focus on the latter, environmental performance, and show that companies that are highly connected also tend to perform much better than companies with weaker social links. Moreover, we present evidence that highly connected companies also tend to have formal environmental governance structures and related performance incentives, both monetary and non-monetary. This complements previous results from the authors which indicated there was a direct relationship between the level and quality of the disclosure of environmental information and the social connections of the board of directors of the companies.

The empirical analysis presented in this work is undertaken using a unique dataset created from the aggregation of a variety of secondary data sources, including environmental governance data and social network data. The dataset comprises of 287 company records from the S&P 1500 index and has been examined using clustering algorithms, social networks analysis and traditional multiple regression and correlational analysis.

Keywords— Board of Directors, Environmental Governance, Environmental Incentives, Environmental Performance, Social Network Analysis, Clustering, BoardEx, Climate Disclosure Project, S&P 1500.

I. INTRODUCTION

Companies have responsibility to the global environmental problems directly and indirectly. In recent years companies and organizations have started measuring and reporting their Environmental Performance as part of worldwide efforts to achieve sustainable development and trace the ecological footprint of their managerial decisions. The environmental performance of companies is a very complex subject and various types of complex assessment and measurement are involved [1].

During the last decade corporate governance discussions have shifted progressively toward contemporary social issues (e.g. climate change, labour rights and corruption) that matter to a wide range of consumers, shareholders, stakeholders and owners [2]. Therefore, corporate governance scholars are increasingly interested in companies’ social and environmental performance [2]. It is obvious that governance mechanism is not an isolated component of a company but there is a complex relationship between governance agenda and other initiatives and activities of a company. Hence, it is one of the main challenges to understand how environmental activities of companies are governed and examine the characteristics of effective governance structures.

Social networking ties (informal and formal) are known to play a significant role in shaping the behaviour and decision making process of their members and the organizations that they work for. Within this context, previous research examined the effects of social networking links and compensation packages. Westphal et al. [3] suggest that ties based on interlocking board memberships have effects, similar to informal social ties. These interlocking directorships, in addition to being assets in their own right, reflect in the corporate realm, the directors’ existing social ties. Fracassi and Tate [4] studied the effects of social networking on hiring senior executives and demonstrated that socially powerful CEOs hire directors that are more socially connected with them. Horton et al. [5] found out that the executives’ connectedness to executives is positively associated with their compensation and that executive compensation, arising from these connections, has a significant positive association with future firm financial performance. Schonlau et al. [6] suggest that board social networks affect the decision to acquire, the choice of target, the method of payment, and ultimately the financial performance of the firm around the merger.

Previous literature investigated extensively the implications of director social links on the firm’s financial performance and governance, focusing on the potential costs of connections but also on their potential benefits as they create social networks between companies and argue that these networks facilitate easier access to a wider range of information and at lower costs while at the same time, improving its quality, relevance and timeliness [7]. For example, [8] noted director-interlocks enable managers to achieve an optimal ‘business scan’ of the latest business practices and overall business environment. In relation to environmental performance and corporate social responsibility, previous literature is rather limited in examining the role of social networks between directors and organisations.
[9]. On the other hand, there is a lack of research on the effects of social networks in relation to environment management issues. Walls and Hoffman [10] are pioneers in that respect as they investigate the linkage between environmental deviance, the environmental experience and the social networks of the board of directors [11][12]. They argue that positive deviance towards environmental issues is demonstrated by organisations that are on the periphery of their field-level networks and ones that have experienced board members in relation to environmental matters.

In relation to [10], we also explore the social network characteristics of the board of directors but in addition, we examine their role together with their environmental governance practices and examine their impact on the environmental performance of the organisations. This work follows our work on the impact of social network characteristics of the board of directors but in addition, we examine their role together with their environmental governance practices and examine their impact on the environmental performance of the organisations. This work follows our work on the impact of social network characteristics on the disclosure of environmentally related information [13].

Specifically, in this paper we focus on whether the social networking of companies’ directors has an impact on several dimensions of corporate governance, including the establishment of environmental committees, the provision of incentives for climate change activities and the overall environmental performance of companies. Using clustering analysis on social network characteristics and environmental governance profiling information of 287 companies that were listed on the S&P 1500 during 2011, this paper describes the factors that drive environmental performance of companies.

The remainder of the paper is organized as follows. The next section provides a literature review on the relationship between information extracted from social network and environmental performance. Section III discusses the methodology of the study. Section IV presents the analysis and results. Finally, section V concludes the paper and describes potential areas for further research.

II. PREVIOUS WORK

Most activities of companies are associated with the growing level of multiple direct and indirect impacts on the environment. Therefore, environmental practices of companies have become an important issue in society. Since companies are multidimensional, various factors are involved in improving environmental management and achieving environmental objectives. Obviously, corporate governance is central in building long term relationships with investors, customers, shareholders, value chain members and suppliers. Therefore, most companies have focused on ensuring a high level of corporate governance. Corporate governance is not just about attaining companies’ financial objectives, but also about representing good corporate environmental performance. Roughly 60 percent of public companies have set up dedicated board committees to oversee issues related to sustainability [14]. Thus, it is important to understand how decisions are made at the board level and what the most relevant factors are to the board’s decisions. The theoretical foundation of performance is based on the idea that the structure of social interactions enhances or constrains access to resources [15]. Resources exchanged through informal networks have substantial value, including work-related resources of task advice and strategic formation. It is necessary to identify and explain the connection between the organization’s strategic objectives, the market and social context within which the business operates, the relationships on which it depends and the governance, bonuses and rewards.

In recent decades, the role of social networks in relation to the financial performance and managerial behaviour has been examined extensively [4][Hwang & Kim, 2009][6][17]. [18] finds that the implications of network connections are mixed and linked to a variety of contexts like firm value [4], CEO compensation [5][16], mergers and acquisitions [6][19] or director appointment [20].

In this context, we have turned our attention towards the existence of a responsible committee or individual that could directly determine the level of environmental performance of companies. In practical terms, this is the person who would be at the top of the chain managing information on climate chain. Environmental reporting formed the central focus of a study by Ionel-Alin [21] in which it is argued that good corporate governance practices explain voluntary environmental reporting. The size and structure of board of directors and existence of board committees have been used to determine the level of environmental reporting [21]. They believe that the aim of environmental committee is to motivate a company into implementing policies and practices for measuring and reporting the environmental impact. In addition, the environmental committees are likely to reduce the risk associated with environmental impact and to see the importance of environmental reporting for stakeholders [22]. Based on this evidence, it is possible to argue that the link between disclosure of environmental activities and policies and environmental governance has been addressed, but there is still a gap in the sense that it is not clear whether this relation extends to the actual environmental performance of companies.

Henderson defined an employer-offered reward as anything that will influence an employee to behave in a manner that will benefit the organisation [23]. Therefore, studies on various aspects of companies are considering compensation and bonus for CEO and the board of directors as one of the main area of interest. As an example, various research have examined the impact of social network of directors on corporate governance [18] or the relationship between CEO compensation and financial performance [24] of companies.. Walls et al [2] considered the role of managerial incentives for environmental performance. In their study, they have looked at salary, bonus and stock options as three main aspects of CEO compensation and they find a positive relationship between these three aspects and environmental concern. To the best of our knowledge, there is no research that takes into consideration the incentives for climate change and how these types of environmental governance practice influences the environmental performance.

Based on the above, we propose the following research hypotheses:
H1: the level of environmental performance is positively influenced by the highest level of direct responsibility for climate change issues.

According to H1, companies that appoint high level executives responsible for the environmental performance should perform better than companies that do not have such dedicated positions, or that allocate such responsibilities at lower levels of authority in the organization.

H2: the level of environmental performance is positively influenced by incentives for the management of climate change issues.

According to H2, companies that not only appoint executives to plan, implement and monitor environmental performance but that also have in place clear incentives schemes, both monetary and non-monetary, should perform better that companies that do not provide or provide only non-monetary incentives.

H3: the level of environmental performance is positively influenced by the level of socially connectedness of companies.

According to H3, using internal or external knowledge through the social networks in which these are shared and developed should improve environmental performance as they act as informal communication channels in which best practices and previous experiences are shared among directors through their social networks.

III. RESEARCH METHODOLOGY

A. Description of Variables

The empirical analysis presented in this section is undertaken on a unique dataset created from the aggregation of a variety of secondary data sources, including CDP [25] for environmental governance data and performance band and BoardEx [26] for information on the board of directors and their social network. The dataset has 287 company records from the S&P 1500 register, each record containing metrics related to the social network analysis and some characteristics of environmental governance and performance band score. Distribution of countries reveals that 97.56% of the examined companies are from US.

In this section, we are presenting a brief description of the variables used in this research.

1) Social Connectivity

Based on the BoardEx dataset [26], it is possible to build the social networks of directors based on their current and past job positions, education background, their membership in other activities and the overall social network index [18]. It should be noted that in this paper we concentrated on the current employment network. We believe that the assumptions which are used to create relationships between directors have direct effects on further analysis. Therefore, we define “Current Employment (CE) network of S&P companies” as follows:

Two S&P companies are linked through a director if the two companies share the same director. Moreover, if directors from two companies sit on the board of a third company, this will form CE of S&P companies as well. Multiple links between two SP companies through different SP directors are assumed to be different (multiple links). For the resulting network of companies, we have calculated a number of relevant network metrics but for the purposes of this study, we have used degree and closeness centrality. These are defined as follows:

a) Degree centrality

Degree centrality is the sum of all links that a company has with other companies divided by the number of companies in the network. It measures the fraction of companies to which the company is connected [4].

b) Closeness centrality

Closeness centrality defines a company’s ability to access independently all other members of the network. A company located centrally can reach other companies through a minimum number of intermediary positions and is therefore dependent on fewer intermediary positions than the peripheral companies [27].

Using the above metrics, we have carried out clustering analysis and have created a two-cluster model as discussed in the analysis section. This is reflected in the variable, SNclusters that takes two values, Socially Connected and Socially Independent.

2) Environmental Governance

a) Providing incentives for management of climate change issues

The information on the provided incentives for management and their type is available in the CDP 2011 dataset and it is extracted from text-based company replies to the following question: “Do you provide incentives for the management of climate change issues, including attainment of greenhouse gas (GHG) targets?”. Companies have two choices of “yes” and “no” to answer this question. In this study, we have called this attribute as “incentive” and have mapped “yes” and “no” to 1 and 0.

b) Highest level of direct responsibility for climate change

This specifies the responsibility on climate change issues within a company. Companies could select from four options: i) individual/sub-set of the board or other committee appointed by the board; ii) senior manager/office; iii) other manager/office; iv) no individual or committee with overall responsibility for climate change. In this paper, we called this attribute as “CCresponsibility” and the values reclassified from 3 to 0.

3) Environmental performance

CDP awards performance points where a company highlights that it is undertaking, or has undertaken, a 'positive' climate change action. A positive action is one that contributes
to climate change mitigation, adaptation and transparency; the performance band score is A, A-, B, C, D and E which is mapped from six to zero respectively.

B. Descriptive Statistics
The description of the variables used and their descriptive statistics is presented in table I.

From table I, we can see that the majority of the companies are socially connected (value = 2), that most of the companies are below average on the performance band and that the majority of the companies provide incentives. Fig. 1 presents the distribution of performance band from zero to six, where zero presents the lowest environmental performance and six is the best.

IV. ANALYSIS AND RESULTS
The purpose of the analysis is to examine the environmental performance of companies through socially connectivity and two environmental governance characteristics which are the CC responsibility and the provision of incentives. In order to examine the social connectivity, the K-Means [28] algorithm has been applied using social network attributes as inputs to identify interesting clusters of companies. Then, the analysis of the hypothesis formulated above is tested using a multiple linear regression model.

<table>
<thead>
<tr>
<th>TABLE I. DESCRIPTIVE STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>CC responsibility</td>
</tr>
<tr>
<td>SN cluster</td>
</tr>
<tr>
<td>Performance Band</td>
</tr>
<tr>
<td>Incentives</td>
</tr>
</tbody>
</table>

Fig. 1. Distribution of Performance Band

The distribution of GICS sector is presented in Fig. 2. Information technology and banks are the most popular sectors and only 1.39% of companies are in telecommunication services sector.

A. Social network analysis
To examine the socially connectivity we have created the social network of companies (CE networks) as discussed earlier. Descriptive Statistics. The pre-processing and creation of the networks have been carried out using the IBM SPSS Modeller [29]. The networks have been analysed through NodeXL (http://nodexl.codeplex.com) to calculate network centrality metrics such as degree and closeness [30]. We have examined various combinations of clustering algorithms (K-means and TwoSteps) to come up with clusters that we and interpret and explain in relation to the connectivity characteristics of companies.

We have chosen the K-Means clustering results for a two-cluster analysis that was based on degree and closeness centrality and which produced the best results as shown in Fig. 3.

Fig. 2. Distribution of GICS sector

With respect to the range of values for degree and closeness for cluster-1 we can conclude that companies in cluster-1 are not well connected to other companies and also they do not have access to the rest of network independently. Finally, cluster-1 presents the case that companies with almost same degrees have different closenesses. In addition, some of the direct connection is crucial for them to build the relationship with other companies. Based on these results, and similarly to [13], cluster-2 companies are labelled Socially Connected and cluster-1 companies are labelled Socially Independent.
For the multiple linear regression analysis, the dependent variable is Performance Band and independent variables where selected in different order to examine the proposed hypothesis. Selected independent variables are: the social network clusters (SNclusters), environmental incentives (incentives) and the level of responsibility (CCresponsibility). Two control variables were also considered in the analysis: LnTA, which is the natural logarithm of the Total Assets as a control for size of the companies, and Industry Sector dummy variables, one for each of the 10 classifications of the GISC. Columns of Table III represent the five configurations of dependent and independent variables that were studied.

As we can see in Table III, specification (1) we find evidence for the support of H1 ($\beta=0.368$, $p=0.006$). Although a positive relationship between the level of direct responsibility for climate change issues and performance band exists, this relationship becomes weaker and statistically non-significant when considering the other variables in the study.

In relation to H2, we find strong evidence on the influence of incentives on the environmental performance and this result is robust for all the specifications and control variables in the study. For example, the specification (2) the values are: $\beta=1.515$, $p=0.000$.

In relation to H3, the results of the analysis show that there is evidence that supports the positive relationship between Performance Band and social connectivity. In specifications (3) and (4) this relationship is positive and statistically significant i.e., for specification (3) ($\beta=0.336$, $p=0.053$) and for specification (4) ($\beta=0.344$, $p=0.052$). However, when controlling for the size of the companies (LnTA), the relationship becomes weaker and not statistically significant. This might be explained by the important correlation between size (LnTA) and social connectivity (SNclusters) as shown in Table II ($R=0.164^{**}$).

<table>
<thead>
<tr>
<th>Social network metrics</th>
<th>Cluster-1</th>
<th>Mean</th>
<th>Cluster-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
<td>83.1</td>
<td>182.62</td>
<td>356.64</td>
</tr>
<tr>
<td>Closeness</td>
<td>0.32</td>
<td>0.348</td>
<td>0.39</td>
</tr>
</tbody>
</table>

![Fig. 3. Social network clusters and their statistics](image)

![Fig. 4. Distribution of Degree vs. Closeness](image)

### TABLE II. PEARSON CORRELATION ANALYSIS

<table>
<thead>
<tr>
<th></th>
<th>CCresponsibility</th>
<th>PerformanceBand</th>
<th>SNclusters</th>
<th>incentives</th>
<th>LnTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCresponsibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>0.163***</td>
<td>-0.117**</td>
<td>0.048</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Pearson R</td>
<td>0.163***</td>
<td>0.317*</td>
<td>0.450***</td>
<td>0.303***</td>
<td>0.072</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>0.006</td>
<td>0.048</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>PerformanceBand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>0.006</td>
<td>0.271</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Pearson R</td>
<td>0.163***</td>
<td>0.317*</td>
<td>0.450***</td>
<td>0.303***</td>
<td>0.072</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>0.006</td>
<td>0.048</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>SNclusters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>0.048</td>
<td>0.271</td>
<td>0.281</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>Pearson R</td>
<td>0.208***</td>
<td>0.450***</td>
<td>-0.064</td>
<td>0.205***</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE III. REGRESSION ANALYSIS

<table>
<thead>
<tr>
<th>Dependent Variable Performance Band</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.419***</td>
<td>0.896***</td>
<td>0.327</td>
<td>0.577</td>
<td>-1.832***</td>
<td>-1.717***</td>
</tr>
<tr>
<td>std. Error</td>
<td>[0.337]</td>
<td>[0.311]</td>
<td>[0.426]</td>
<td>[0.473]</td>
<td>[0.896]</td>
<td>[0.724]</td>
</tr>
<tr>
<td>p-value</td>
<td>0.00%</td>
<td>0.40%</td>
<td>44.40%</td>
<td>22.40%</td>
<td>4.20%</td>
<td>1.90%</td>
</tr>
<tr>
<td>CCresponsibility</td>
<td>0.368***</td>
<td>0.163</td>
<td>0.188</td>
<td>0.192</td>
<td>0.162</td>
<td>0.188</td>
</tr>
<tr>
<td>std. Error</td>
<td>[0.132]</td>
<td>[0.122]</td>
<td>[0.122]</td>
<td>[0.126]</td>
<td>[0.13]</td>
<td>[0.126]</td>
</tr>
<tr>
<td>p-value</td>
<td>0.60%</td>
<td>18.40%</td>
<td>12.60%</td>
<td>12.80%</td>
<td>21.30%</td>
<td>13.70%</td>
</tr>
<tr>
<td>Incentives</td>
<td>1.515***</td>
<td>1.529***</td>
<td>1.472***</td>
<td>1.249***</td>
<td>1.344***</td>
<td></td>
</tr>
<tr>
<td>std. Error</td>
<td>[0.188]</td>
<td>[0.187]</td>
<td>[0.192]</td>
<td>[0.206]</td>
<td>[0.2]</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>SNclusters</td>
<td>0.336*</td>
<td>0.344*</td>
<td>0.201</td>
<td>0.175</td>
<td>0.175</td>
<td></td>
</tr>
<tr>
<td>std. Error</td>
<td>[0.173]</td>
<td>[0.176]</td>
<td>[0.185]</td>
<td>[0.182]</td>
<td>0.175</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>5.30%</td>
<td>5.20%</td>
<td>27.90%</td>
<td>33.90%</td>
<td>33.90%</td>
<td></td>
</tr>
<tr>
<td>LnTA</td>
<td>0.325*</td>
<td>0.284*</td>
<td>0.284*</td>
<td>0.284*</td>
<td>0.284*</td>
<td></td>
</tr>
<tr>
<td>std. Error</td>
<td>[0.084]</td>
<td>[0.079]</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>2.30%</td>
<td>20.20%</td>
<td>21.00%</td>
<td>20.60%</td>
<td>24.80%</td>
<td>24.80%</td>
</tr>
</tbody>
</table>

### V. CONCLUSIONS

Prior research highlights the impact of social network among companies and their financial performance but there is a lack of research examining the impact of companies’ social networks on their environmental performance. The paper addresses this gap by examining how social network characteristics of companies and their environmental governance characteristics explain their environmental performance.

A subset of S&P1500 companies from year 2011 has been used for the purposes of this study. The reason for this is data availability in relation to their environmental characteristics and more specifically, the availability of environmental performance and environmental governance data from CDP. The social network characteristics have been examined in relation to their current director network created on the basis of the BoardEx dataset and a corresponding company social network was created. This was analysed in relation to the social connectivity of companies and on the basis of various social network metrics and a two-cluster model was created (Socially Connected, Socially Independent). This provided the basis for the examination of our three hypotheses. The results show that there is strong evidence that the presence of incentives (monetary and non-monetary) influence the environmental performance of companies and also show evidence that the social connectivity of the companies has an impact on the environmental performance.

In terms of limitations, the study examined only one year of data and moreover, the total number of companies was 287 out of 1500. It will be a more complete study if there is availability of environmental data for all 1500 companies and furthermore, if the study considers all the years where data exist. Also, the social connectivity of companies was based on the CE network which only considers links for the year under examination.

Future work should look into examining additional years and examine whether the same hypotheses are supported across years. This will help strengthen the robustness of the results. Furthermore, the social connectivity can be re-examined and
possibly, re-defined through the examination of additional link information from Boardex such as past employment and education history of directors. Finally, additional characteristics for environmental governance or governance in general could be examined such as board size, ratio of independent directors, board composition/diversity and board experience on environmental issues.

REFERENCES


