Corporate Carbon Opacity and Voluntary GHG Statement

Assurance

Rina Datt
University of Western Sydney

Gabriel Donleavy
University of Western Sydney

Qingliang Tang*
University of Western Sydney

Contact author:
Dr Qingliang Tang,
Email: q.tang@uws.edu.au

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ABSTRACT
Corporate voluntary greenhouse gas (GHG) statements contain managers’ private information about future sustainability potential which is difficult for external investors to verify. We hypothesise that firms with a higher degree of carbon information asymmetry will have a greater incentive to voluntarily purchase an independent GHG statement of assurance. We use the data collected from the Carbon Disclosure Project (CDP) and a total sample of 768 of the largest listed US companies to test the hypothesis. The results show that our proxies for carbon opacity are significantly associated with the propensity of voluntary GHG assurance. In addition, the tendency for GHG assurance manifests in our sample firms whose financial information is deemed transparent.

Key Words Carbon Emissions, Voluntary GHG statement assurance, Private Information

Data Availability: The data are publicly available from the sources identified in the paper

I. INTRODUCTION

A vast literature presents evidence of the effects of human activity in general and of GHG emissions in particular, on global warming (IPCC 2013; Stern 2006), and business firms are expected to play a role in stabilising climate change (Luo et al. 2012). While some companies take proactive approaches, other firms just minimally meet regulatory requirement (Tang and Luo 2013). Information about a firm’s strategies and activities and their impact on CO₂-equivalent emissions is thought by some to be vital for the decisions of stakeholders (Thornton and Hsu 2001). Some firms voluntarily report their carbon
information. However, the quality and reliability of such disclosure is an issue (Freeman and Jaggie 2005; Stanny and Ely 2008; Reid and Toffel 2009). First, energy and carbon data such as scope 1, 2 and 3 emissions\(^1\) are inherently difficult to obtain and there is a lack of any internationally recognised protocol to measure emissions. Second, a GHG statement may not only just present emissions data, but also often may cover other carbon related information, such as carbon risk, carbon governance and activities. There is no current accounting standard for GHG disclosure which adds complexity to the task of data comparison between firms. Finally, managers under pressure to reduce the negative impact of their operation on environment have incentives to manipulate (i.e. “green washing”) carbon information\(^2\). Amid these uncertainties, there is an increasing demand for independent assurance to enhance the credibility and validity of these disclosures (Huggins et al. 2011; Kolk 2008). Despite their importance, there has been a lack of regulation requiring the assurance at all or international standards regulating the quality of such disclosures.\(^3\) (Zhou 2010) This began to change with the International Auditing and Assurance Standards Board (IAASB) issuing ISAE 3410\(^4\) in 2012 (IFAC 2012). Since the existing literature on carbon emission disclosures is very sparse (Simnett et al. 2009; Obermair 2010), this paper attempts to fill this gap by examining the determinants of voluntary GHG statement assurance by an external party.

\(^1\) Scope 1 is defined as emissions that are direct GHG emission from sources that are owned or controlled by the entity. Scope 1 can include emissions from fossil fuels burned on site, emission from entity owned leased vehicles and other direct sources. Scope 2 emissions are indirect GHG emissions resulting from the generation of electricity, heating and cooling, or steam generated off site but purchased by the entity and transmission and distributed losses associated with some purchased utilities (e.g. chilled water, steam and high temperature hot water). Scope 3 GHG emissions sources currently required for federal GHG reporting include transmission and distribution losses associated with purchased electricity, employee travel and commuting, contracted solid waste disposal and contracted wastewater treatment. Additional sources that are currently optional under federal reporting requirements, but are significant, include GHG emissions from leased space, vendor supply chain, outsourced activities, and site remediation activities. (www.epa.gov/aintrnt.gh.index)

\(^2\) Lyon & Maxwell (2006) define ‘greenwash’ to be circumstances where disclosure context examination has revealed a propensity for selective disclosure of positive information without full disclosure of negative information.

\(^3\) Current assurance standards for carbon emissions disclosure includes ISAE3000, provides framework for the provision of assurance other than historical financial information. ISO 14064 was developed over several years by International Organizational for Standardization, which is not part of accounting and auditing profession. ISO 14064 gives guidance on what to do but does not specifically give the exact requirement. The ISO 14064-1 gives the specific requirement for designing and developing firms GHG inventory. The ISO 14064-2 details the requirement for quantifying, monitoring and reporting emission reductions and the removable enhancements from the GHG project. The ISO 14064-3 provides requirements and guidelines for the conducting of GHG information validation and verification.

\(^4\) According to IAASB, ISAE 3410 is a topic specific assurance standard, under the umbrella of ISAE 3000, which provides requirements and guidance specific to engagements on GHG Statements. ISAE 3410 is not effective until September 30 2013.
Following Chow (1982), we accept the assumption that voluntary GHG assurance is motivated by the desire to reduce carbon information asymmetry between managers and outside stakeholders. We identify carbon emissions, carbon intensity industry membership, and firm size as the proxies for information asymmetry and agency costs and predict they would be associated with the propensity to purchase external assurance. Our data are collected from Carbon Disclosure Project (CDP)\(^5\) database for a total 768 large listed US companies. The CDP report is a general-purpose, stand-alone disclosure which reveals company’s emission measurements, carbon activity and future sustainability potential. Due to its optional nature, CDP disclosure contains managers’ private information which cannot be readily verified by outsiders. Thus the value of the information is apt to be dramatically increased by such a confirmation mechanism as independent assurance.

We present evidence that the volume of carbon assurance increased steadily from 2010 to 2012 (i.e. 43 percent in 2010, 51 percent in 2011 and 65 percent in 2012)[\(^6\)]. Our results show that firms with opaque carbon information (i.e. high carbon information asymmetry) have a greater tendency to have their GHG statements externally assured. In addition, we also show that large firms, and firms facing higher climate change risks in carbon intensity sectors, are more likely to have their emissions verified independently. These results are consistent with our prediction that the (actual or perceived) level of information asymmetry by management of the firms drives the tendency toward to carbon assurance. Note our sample firms are large and have their financial statements audited by big auditors so their financial information is supposed to be transparent. However, transparent financial

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5 CDP was launched in 2000 and is an independent, not-for-profit organization. CDP produces reports on behalf 3050 organisations in some 60 countries. CDP reports measure and disclose GHG, water management and climate change effect etc. information of largest companies around the world (CDP, 2010).

6 This is in contrast to the study done by KPMG (2011) that USA and Canada both had extremely low adoption of their sustainability report assured relative to UK, Australia etc. That is: US was at 13 percent and Canada at 21 percent compared to UK at 51 percent, Australia at 50 percent, and South Korea at 65 percent and India at 80 percent (KPMG 2011). This low rate in the US may be partly due to the recent high profile corporate scandals, coupled with litigious culture, as the companies sought to avoid the unnecessary legal risk considered to arise through voluntary disclosure (The CSR Assurance Statement Report, 2008).
statements do not entail adequately transparent GHG statements. Our results are robust when we control for carbon performance, GHG disclosure, profitability and leverage which are potentially correlated with the propensity for both carbon disclosure and statement assurance.

Our research design is different from prior studies in some important dimensions and has made new contributions to the literature. First, our paper identifies some proxy variables underlying those managerial incentives which are empirically associated with voluntary GHG assurance. This evidence has not been documented in prior literature. Second, we focus on \( \text{CO}_2 \) emission which is different from general environmental issues. Carbon differs from other toxic chemical emissions in that the harm of GHG pollution is essentially global, long-term, and probably irreversible (Lash and Wellington 2007). Carbon mitigation and disclosure require firm-specific capabilities guided by different jurisdictional pressures (Luo et al. 2013). Corporate social responsibility (CSR) is a multidimensional construct and the explanatory patterns are likely to differ across and within any one jurisdiction (Chatterji et al. 2009; Strike et al. 2006; Walls et al. 2011). We investigate this complex phenomenon in a tightly focused manner by considering only the GHG dimension. Third, we have chosen the USA as our research setting. This is not only because the USA is the second largest emitter after China in the world, but also since the USA did not sign Kyoto Protocol, the US governmental policy signal is likely to be weak.\(^7\) Corporate incentives may play a larger role there for firms to voluntarily engage in industry sponsored emission abatement programs. Accordingly, it is likely that commercial considerations rather governmental regulation drives the purchase of independent verification of emission disclosure statements. The USA setting allows us to better isolate the incentives for voluntary assurance from compliance

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\(^7\) USA is the second largest emitter of carbon at 8.11 percent, with China being at 23.33 percent followed by Europe at 14.04 percent (United Nations Statistics Division, 2011)
with mandatory GHG legislation, etc. Also since the US does not have a national mandatory emission trading scheme, its firms may well be faced with increasing market pressure to measure, monitor and disclose their carbon emission and have the disclosure assured by external party. The use of a single-country design provides a useful complement to international designs. Our single-country research design allows the incorporation of country specific controls for other (non-hypothesized) value-drivers in order to further isolate the effect of carbon exposure. Fourth, while prior studies typically use data from firms’ annual reports or sustainability statements (Kolk 2003; Ballou et al. 2006), this study relies on stand-alone CDP reports that have been considered as more comprehensive than alternative databases (Luo et al. 2012). Stand-alone carbon statements are currently subject to very limited regulation Although voluntary in nature, in the absence of internationally accepted standards, CDP adopts a set of norms that all participating (i.e. reporting) companies must follow so carbon information is presented in a consistent manner which significantly reduce the scope of manipulation of carbon data by corporate management. In sum, our study provides extra insights on carbon assurance practice and an understanding of the factors that are correlated with carbon assurance which should be useful for law makers who consider developing policy initiatives for carbon assurance and for accountants who provide services in such a burgeoning and highly promising market.

The reminder of this paper is structured at follows. Section II is a discussion of the differences between financial statement assurance and GHG statement assurance. Section III contains the literature review and hypothesis development. Section IV presents the
research model and design. Section V presents the empirical results. The paper concludes with a summary and conclusion in Section VI.

II. A Comparison between Financial Statement Assurance versus GHG Statement Assurance

Financial Statements versus GHG Statements

Every business has processes, products or services that emit GHG either directly or indirectly. While financial statements focus on financial aspects, a GHG report is a statement of an entity’s quantified Co2 emissions over a particular period. Analogous to financial statements, the constituent elements of GHG statements may also include comparative information and explanatory notes, such as a summary of significant quantification and reporting policies and a categorized listing of removals (i.e. negative emissions) or emissions deductions (ISAE 3410). Financial statements are intended for the general decision-making purposes of their users. GHG Statements too have a variety of uses (IAASB, 2012, Summary of ISAE 3410). They may be required under a regulatory disclosure regime, such as the National Greenhouse and Energy Reporting System in Australia or the European Union Greenhouse Gas Trading Scheme. The disclosure may be on a voluntary basis and included as part of a broader sustainability report or as a stand-alone document.

Earnings management incentives versus “greenwashing” incentives

Various managerial incentives exist to manage earnings for purposes other than to give a true and fair view of the financial position and operating performance of the company. Managers also have incentives to manipulate carbon information to alter the perception of users regarding the true
carbon performance. This practice is labelled “greenwashing” of carbon information. However, unlike financial reporting with its well developed accounting standards, there are no internationally accepted and authoritative methods for measuring carbon emissions and performance, so managers have a greater temptation to engage in carbon information management. A greenwashing practice tends to unduly emphasise positive aspects of carbon emissions performance and to ignore negative information. Greenwashing managers are often motivated by endogenous climate change objectives but by exogenous carbon legislations and institutions. Greenwashing incentives arise accordingly from perceived economic, regulatory, physical and reputational risks. For example, if the entity has made commitments to aggressive GHG targets (e.g. becoming carbon neutral), this may provide an incentive to understate emissions so the target will appear to be achieved within a declared timeframe. Conversely, if the entity is expecting to be subject to a regulated emissions trading scheme in the future, this will encourage the entity to overstate emissions in the meantime to increase the opportunity for it to receive a larger allowance at the outset of the scheme (ISAE 3410, (A61)), because allocation of free allowance is often based on historical emissions records. In addition, the risk of greenwashing is high, if the responsible staff’s compensation is contingent upon carbon performance. This is similar to earnings management that is associated with manager’s bonus linking to an earnings target. Finally, permit (allowance) price increase can strengthen the incentive to overstate because saved permits can sell for a higher price.

Financial information asymmetry versus carbon information asymmetry

It is generally accepted that there is information asymmetry between inside managers and outside stakeholders due to the separation of ownership and control. The information asymmetry historically covers financial information. Carbon information asymmetry is a different type of information asymmetry. GHG statement assurance is often performed by different people and guided by different standards from traditional accounting assurance.
Financial statement assurance versus GHG statement assurance

GHG quantification is subject to inherent uncertainty and voluntary disclosure of carbon information relies on private information known only to management. Third party verification is necessary for its credibility. The objectives of the assurance practitioner are to obtain reasonable assurance that the GHG statement is free from material misstatement, whether due to fraud or error, and that the GHG statement has been prepared, in all material respects, in accordance with the applicable criteria (ISAE 3410, IAASB). While the purpose of GHG statement assurance is similar to traditional financial statement assurance, a review of the literature suggests some significant differences.

For example, GHG engagements are ordinarily expected to be undertaken by a multidisciplinary team of experts who possess, in addition to assurance skills; GHG competencies, such as an understanding of laws and regulations related to emissions reporting, GHG quantification and measurement methodologies. And scientific and engineering expertise are often required or desirable. There is incomplete scientific knowledge about the measurement of GHGs. For example, the rate of GHG sequestration in biological sinks, and the “global warming potential” values used to combine emissions of different gases and report them as carbon dioxide equivalents, are incompletely understood. There is yet to develop an internationally recognised system to measure and calculate emissions. Another source of uncertainty is that a firm may not have a robust system to collect and process data. Moreover, investigation methods adopted may be different in GHG assurance from a financial statement assurance. For example, a large part of carbon emissions must be identified in individual geographical locations or facilities within an organisation. Thus, ISAE 3410 emphasises the importance of performing procedures on “site visits” to obtain an understanding of the entity’s emissions. Finally, risks
of misstatement in a GHG statement are associated with very different factors from those relevant to a financial statement. The accuracy of the measurement of the carbon footprint is dependent on the development of scientific, regulatory and physical mechanisms. It also depends on the firm’s internal control system, the degree of complexity of its operations and the nature of the business (ISAE 3410, 23; Para. A52–A53, A70). The strength and weakness of the systems and institutions may affect the application of the applicable criteria to the entity’s circumstances and change the susceptibility of the entity’s GHG statement to material misstatement. These risks can affect the GHG statement as a whole. For example, deficient control environments and non-compliance with the provisions of carbon laws and regulations may have direct effects on the content of the GHG statement (Para.A87). Management’s technical GHG incompetence and overriding of internal controls for emissions (ISAE 33R, Para. A79–A80) are common factors that can increase misstatement in the GHG statement. Misstatement can also take place in other ways. For example, there might be double counting, omission of a significant emission, such as scope 3 emissions (fugitive emissions), and abnormal emissions (Para. A88 (a), (e) (f)), or intentional or unintentional misclassification of emissions sources. Furthermore, the risk increases with the complexity of determining the organizational boundary and whether related parties are involved (Para. A27–A28). Management could make subjective, unrealistic or biased judgements, estimates, and assumptions on the energy or emission data (Para. A88 (g)). As a result, the quantification methods and reporting policies selected and applied may be inappropriate and unreasonable and inconsistent with the applicable criteria (Para. A29, A131–A133). Thus techniques of the assessment of the risk in GHG assurance can be different from financial statement assurance.
III. RELATED LITERATURE and HYPOTHESIS DEVELOPMENT

Related Literature

Prior studies provide empirical evidence that managers adopt audits to reduce information asymmetry and agency costs. For example, Chow (1982) documented that agency cost proxies (firm size and leverage) are positively associated with voluntary adoption of financial statement audits. Blackwell et al. (1998) held that the demand for assurance stems from the need to mitigate information asymmetry with institutional creditors who consider the assurance to be effective. Abdel-khalik (1993) also used firm size as a proxy and emphasised larger companies take the assurance as an effective within-company control mechanism to compensate for the loss of control induced by organizational design and the resultant loss of observability of subordinate activity which implies assurance plays a role to increase the transparency of the behaviour of employees. Similarly, Carey et al. (2000) examined family businesses in Australia and found assurance is associated with information asymmetry and loss of control, hence, the proportion of non-family managers and non-family directors is positively associated with the demand for external assurance. The literature suggests information asymmetry is a multi-variable concept. For example, it can happen between managers and shareholders, or between managers and creditors, or between family directors and non-family directors, etc. Particularly, the information referred to can be financial or none financial. Subordinate behaviour information is apt to be predominantly none financial (Abdel-khalik 1993).

Simnett et al. (2009) contend that traditional financial reports do not adequately represent the multiple dimensions of corporate value today. This has resulted in a search for
additional nonfinancial measures of value/performance and a growing tendency for companies to voluntarily issue general-purpose, stand-alone nonfinancial reports. However, Ball et al. (2012) argued that voluntary disclosure of information that is privately known only to the manager needs some mechanism to confirm its creditability. Crawford and Sobel (1982) demonstrate, that in equilibrium unverifiable disclosures alone are inadequate and uninformative. Stocken (2000) investigates disclosures in the context of financing an investment project and he argues that, in the absence of a mechanism to enforce verifiability, voluntary disclosures are not credible and therefore are ignored by the market.

It is difficult and/or costly for investors to verify directly the manager’s private information even it is publically disclosed. Managers seeking to provide informative disclosure of private information therefore need a device for achieving credibility One of these mechanisms is external assurance. Assurance confers several benefits, including reducing agency costs and enhancing user confidence in the accuracy and validity of the information provided. Itassurance can be used as a differentiated product that allows firms to signal a degree of reliability of the underlying information, not just as a standardized commodity determined exclusively by regulation (Ball et al 2012).

Hypothesis development

Ball et al (2012) suggest that corporate reporting is an integrated information system that consists of financial and none financial, mandatory and voluntary, and public and private knowledge and some signalling mechanism is needed to add reliability of voluntary reports. In our context, disclosure of a firm’s carbon emissions and climate change activities is largely sourced in managers’ private information and inherently complex, and such complexity
exacerbates information asymmetry. External assurance is employed to enhance the credibility of the information disclosed. However, assurance incurs costs, such as fees paid to a qualified auditor (a function of both the quantity and quality of audit resources supplied). We hypothesise that the net benefit of assurance is likely to be obtained in firms with higher levels of carbon information asymmetry. In order to empirically test the hypothesis, some variables must be identified to act as proxies for carbon information asymmetry. Based on a review of literature and assurance practice, we proposed the following factors for the purpose. The underlying intuition is, if the managers are motivated to purchase GHG assurance to reduce carbon information asymmetry, we should observe a significant association between these proxies and the incidence of GHG assurance.

*Carbon Emissions*

Our first factor underlying carbon information asymmetry is the amount of Co2 emissions because it increases the complexity of measurement. The process of emission accounting involves managers’ estimates of the degree of uncertainty, the underlying assumptions about the data and the selection of appropriate technical methods. In addition, excessive emissions enhance carbon exposure and increase the legitimacy threat from the community (Patten 2002), which will negatively affect consumers so as to make the firm’s products less marketable. This may frequently motivate managers to engage an independent party in order to give a clear and credible picture of the firm’s carbon performance. Thus, the following hypothesis is formed:

\[ H_2: \text{Cereis paribus, firms that emit high volume of scope one carbon are more likely to have their emissions verified by an external party.} \]
We use scope one emission because this is the most important part of GHG and is subject to more public scrutiny and to institutional influences (e.g. penalty for excessive emissions). Existing carbon footprint protocols generally focus on scope one and two but less on scope three emissions. Note the level of emissions (also labelled as “absolute emissions” as opposed to “intensity emissions”) is used as the reporting costs are correlated with the level of emissions, which highlight the need for an independent assurance to add integrity to the reported information (Green and Li 2012).

**Carbon intensity industry**

The second measure of carbon information asymmetry is carbon intensity sector membership. Eng and Mak (2003) and Patten (1992) found environmentally sensitive industries (e.g. oil & gas) tend to have a higher pollution propensity (Bewley and Li 2000) and thus easily be the target of environmental regulations and pressure groups (Baumert et al. 2005, Brammer and Pavelin 2006). There is great carbon information asymmetry in GHG intensity industries about the impact of “green” legislation. This is because carbon legislation is more likely to affect carbon intensity sectors than less intensive ones. For example, the American Power Act (2010) is expected to significantly affect heavy emissions sectors⁹. Climate change laws may introduce taxes and charges that will raise direct energy costs as well as less direct compliance costs (Al-Tuwaijri et al. 2004). Legislation could create some opportunities as well as potential risks. It is very difficult to assess the net effect, particularly for firms in heavy carbon pollution industries. We propose:

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⁹ Senators John Kerry (D-MA) and Joe Lieberman (I-CT) released the draft of their American Power Act in May 2010. The launch of their bill kicks off an intensive effort to pass comprehensive climate and energy legislation in the Senate, reconcile it with the bill passed by the House. The core carbon pollution limits in the bill, covering all major pollution sources. The bill would amend the Clean Air Act to establish steadily declining limits on carbon emission from the major sectors, including electricity production and heavy industry, etc. It includes measures to invest in key energy technologies, and promote innovation and job creation in these industries affected. [http://www.epa.gov/climatechange/EPAactivities/economics/legislativeanalyses.html].
Following prior studies (e.g. Luo et al. 2012), we consider the energy, utilities, and material industry to be carbon intensive sectors\textsuperscript{10}. Energy companies extract non-renewable resources (fossil fuel) with major environmental consequences, while entities in the utilities industry produce large amounts of GHG emissions and are exposed to community concerns about climate change (Simnett et al. 2009). Further, the material industry is a major user of energy and can produce significant amounts of GHG with industrial waste products. Companies belonging to these industries have a large emission footprint and are more exposed to carbon risks. Such exposure is hard for outsiders to evaluate by outsiders and this may well create a greater demand for purchased assurance.

\textit{Firm Size}

On the one hand, large firms are likely to have multiple operations with variety of assets and liabilities. These firms have more employees, managers and sophisticated organizational structure, so they are inherently harder to understand and have wider information asymmetry between insiders and outsiders. On the other hand, large entities are more politically visible, and are under higher pressure to make greater disclosure beyond the mandatory. Moreover, large firms often engage top tier auditors to perform financial statement assurance. Thus, large firms are readily perceived to be more transparent than small firms. Despite this, we argue that these big firms provide publicly more information about financial situations not necessary environmental information. Large firms emit more than small firms, and they often have multiple sources of emissions which may be difficult

\textsuperscript{10} The industry categories are based on a Firm Global Industry Classification Standard (GICS) code.
to track. Therefore, large firms are assumed to have a higher degree of GHG information asymmetry, and financial statement assurance is not in the business of lifting the corporate “carbon veil”. Since larger organizations are subject to much greater stakeholder scrutiny and media coverage (Stanny and Ely 2008; Watt and Zimmerman 1978), corporate carbon opacity may raise concerns about the firm’s impact on environment, and jeopardise the firm’s wider reputation. Thus, we anticipate larger firms tend to purchase expensive assurance service that can improve the image of a concerned and competent firm. Based on the discussion, our third measure of carbon information asymmetry is firm size and the hypothesis is:

\( H_3: \text{The probability of external carbon assurance increases with firm size.} \)

**Other Influences**

**Carbon Mitigation Performance**

There may exist other influences that potentially relate to the decision of GHG assurance. For example, it can be argued that firms with superior performance have the incentive to release the information to demonstrate the firm does care and account for global warming impact of their operation. According to signalling theory, the purpose of disclosure is to signal to the market good performance in order to avoid potential problem of adverse selection (Verrecchia 1983). Similarly, Orlitzky and Whelan (2007) speculate that a signalling device such as arises from practising social and environmental accounting represents a differentiating (rather than a mimetic or homogenizing) characteristic whereby the reporting company may seek to gain competitive advantage. It follows high performers not only attempt to be more transparent but also to emphasise high quality, more credible disclosure that is difficult for poor performers to match (Dye 1985). Moreover, users tend to
be more sceptical of good news than bad news for disclosed positive information is viewed as less trustworthy. Hence managers are motivated to attest to stakeholders (particularly non financial stakeholders) if they outperform their peer firms, as external verification will strengthen the good signal. The argument is in favour of a positive association between carbon performance and assurance. The carbon performance is measured using the CDP performance index in our empirical model.

*Carbon Disclosure*

The need for GHG statement assurance should also be correlated with the contents of the statement. The extensiveness of a GHG statement varies widely across firms (Luo et al. 2013), which is largely due to the absence of international standards regulating what should be presented. Some carbon reports are comprehensive, and include carbon governance, risk and opportunity assessment procedures, emission reduction targets and reward package, carbon actions and carbon accounting methodology, etc. Since most non scientists would find it very difficult to comprehend such a complex disclosure, this which would significantly increase the need for external assurance. In addition, management’s expenditure of more resources to prepare such a statement gives it more incentives to signal its creditability by engaging an external assurer. Thus, it is expected that there is a positive association between assurance and the extensiveness GHG report. We use the carbon disclosure score obtained from the 2011 CDP report\(^\text{11}\) to measure carbon disclosure.

*Profitability*

Past research has demonstrated that financial disclosure increases with financial performance (Mahoney et al. 2007; Magness 2006; Ullmann 1985; Clarkson et al. 2008; Lang

\(^{11}\)CDP changed the format of the company CDP report in 2011, but its overall content is similar to that of the 2010 report.
and Lundholm 1993). It can be expected that independent carbon assurance is more likely to occur in firms with higher profitability because these firms would have more resources, so can afford the cost of disclosure and assurance (Luo et al. 2013). In addition, the public tend to have higher expectation from the profitable firms (Magness 2006) so give these firms pressure to disclose and verify financial as well as non-financial information.

**Leverage**

It is generally accepted that a high ratio of debt to assets is associated with default and litigation risk. If the perceived climate change risk is high, creditors will demand high interest to protect them from the exposure. Insufficient CO2 information will worsen opacity and further increase the perceived risk, which in turn will result in enhanced debt financing cost. Prior literature suggests leverage is a determinant of environmental reporting strategy (Cormier and Gordon 2001; Cormier and Megan 2003) and firms with high debt tend to disclose more (Jaggie and Lee 2002; Xiao et al. 2004; Hossain et al. 1995; Prado-Lorenzo et al. 2009). Particularly Chow (1982) found that leverage was positively associated with demand for voluntary financial audit. Hence, the correlation between carbon assurance tendency and leverage is expected to be direct. On the other hand, it can be argued creditors such as financial institutions should have more access to the private information of the management than other remote external shareholders. Thus, if the financial institutions are able to share some private information, they would not rely on public GHG statement which may weaken the association.

**III. RESEARCH METHODLOGY**
The original number of total US firms in our sample that have a CDP report for 2010, 2011, and 2012 is 1169, 622, and 1073 respectively.\(^{12}\) The final sample is reduced to 225, 294 and 249 for the three years after deleting firms with missing data.(Refer to appendix 1).

Furthermore, our sample firms do not include firms that participate in an emission trading scheme (ETS)\(^{13}\), because such a scheme is likely to require the participants to submit assured carbon data, so the carbon assurance may be not voluntary. In other words, GHG assurance decision could be endogenous at an ETS setting. We focus on large firms as these firms are salient in terms of emissions and thus have significant impact on climate change.

Empirical Model

To test our hypotheses, the following logistic regression model is used.

\[
ASSURED_i = \beta_0 + \beta_1 EMIT_i + \beta_2 PERFORM_i + \beta_3 DISCLOSE_i + \beta_4 LnSIZE_i + \beta_5 INTENSIVE_i + \beta_6 ROE_i + \beta_7 LEVERAGE_i + \beta_8 Year_{2011} + \beta_9 Year_{2012} + \epsilon_i \quad \text{-(1) } \beta
\]

**Variable Definitions**

*ASSURED* is an indicator variable which is equal to one if the company has engaged an external party to verify the carbon information; and zero otherwise.

**Independent Variables:**

*EMIT* is a factor behind carbon information asymmetry which is measured using the total of scope one emission in metric tons\(^{14}\). The data was hand collected from the firm’s CDP report. *SIZE* is the natural log of total sales. *INTENSIVE* is coded one if the firm is in carbon

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\(^{12}\) To explain the drop in sample in 2010, in addition to the standard S&P 500 companies which are based in the USA, CDP invited over 600 US companies to respond. Some of these were asked to respond on behalf of Wal-Mart, as they were Wal-Mart suppliers. Some of these were asked to respond as part of a one-off initiative that CDP was running with UK-Based NGO’s called Business in the Community. The 600+ companies were not sent a request in the following years. Then in 2012, in addition to the S&P 500 companies which were based in the USA CDP sent the request to over 200 US based companies that are part of the Russell 1000. (This was confirmed with the employee of CDP).

\(^{13}\) ETS is a market mechanism for emissions control at a relatively lower costs. Under a ETS, participating firms are allowed to trade surplus emission permits, allowances or certificates.

\(^{14}\) Emissions data are obtained from the firm’s CDP report. Calculation of GHG inventory is a complex process. It needs to consider not just emissions but also purchased offsets from another entity and removals (carbon sequestration) achieved by storing CO2 in geological sinks (e.g. underground) or biological sinks (such as trees).
sensitive sector (energy, material or utility) or zero otherwise. We use return on equity (ROE) to measure profitability which is determined by net income divided by shareholders equity. **LEVERAGE** is calculated as total liabilities divided by total assets (Dhaliwal et al. 2011) The financial information is obtained from DataStream database.

**DISCLOSURE** is a control variable measured using the Carbon Disclosure score based on the CDP questionnaire survey of S&P 500 firms from 2010 to 2012. The questionnaire asks firms a series of questions regarding (i) Governance, (ii) Strategy, (iii) Carbon targets and Initiatives, (iv) Communications, (v) and (vi) Climate Change Risk and Opportunities, (vii) Emission Methodology, (viii) Emission Data, (ix) Emission Scopes 1 Breakdown, (x) Emission Scope 2, (xi) Contractual Emission Scope2, (xii) Energy, (xiii) Emission Performance, (xiv) Emission Trading and (xv) Scope 3 Emission. The responses to the above questions are scored using a content analysis method developed by CDP with guidance from PricewaterhouseCoopers (www.cdpproject.net). **PERFORM** is another control variable which is measured using the CDP’s performance index. The index is based on the evidence regarding the actions conducted by the firm to contribute to emission mitigation, climate change adaptation and etc. Similar to the disclosure score, the index is calculated using a content analysis method and increases with carbon performance. Further support for the use of the CDP scores is provided by Prado-Lorenz et al. (2009); Prado-Lorenzo and Garcia-Sanchez (2010) and Tang & Luo (2013). We incorporated year dummy variable, Year 2011, Year 2012 as a control for any systematic year effects. The results are run for each separate year and on a pooled basis. The pooled analysis is run both with and without year dummies Simnett et al. (2009).

Note firms must answer all these questions and cannot delete or alter these questions so the reporting format is consistent across all participating organisations. The score increases with carbon disclosure, which is the number of scores that has been awarded for a firm divided by the maximum number that could be awarded multiplying by 100 (i.e. scores awarded/scores attainable) x 100= Carbon disclosure score. Our method is consistent with prior literature in the sense that “the study uses a quality-adjusted method of content analysis, so that sentences are not merely counted but also weighted to reflect their likely significance” (Hassel et al., 2005, p.231).
IV. RESULTS

Descriptive Statistics

Table 1 shows the descriptive statistics for the variables used for the year 2010 (Panel A), 2011 (Panel B), 2012 (Panel C) and for all three years in Panel (D). We also perform t tests to compare the difference in the mean of these variables between firms with and without assured GHG for each year and for the total of three years. The results show that firms that have their emission assured tend to be larger, are more likely to be in a carbon intensity industry, have higher scope one carbon emission and higher carbon performance index and are more transparent (i.e. higher disclosure score). In addition, carbon assured firms are more profitable and higher leveraged than unassured firms. All these results are predicted by our hypotheses. The findings are also consistent with prior studies with regard to, size (Adams et al. 1998; Haniffa and Cooke 2005; Stanny and Ely 2008) industry membership (Prado-Lorenzo et al. 2009; Zhou, 2010 and Obermair 2010) and profitability (Simpson and Kohers 2002; Waddock and Graves 1997a).

Insert table 1- about here-

Correlation Matrix

Table 2 presents the Pearson correlation matrix for results pooled for 2010-2012 followed by table 3, 4 and 5 for 2010, 2011, and 2012 respectively. The results in Table 2 show that, as expected SIZE, INTENSIVE (sector), PERFORM, DISCLOSE, EMIT 1, ROE and LEVERGAE all are positive and significantly correlated with the dependent variable ASSURED. These results
are consistent with our argument that higher degree of carbon information asymmetry is a factor that incentivises management to adopt voluntary GHG statement assurance. SIZE is negatively correlated with INTENSIVE(sectors), and LEVERAGE and positively correlated with DISCLOSE, EMIT 1 and ROE, but not with PERFORM. The results in Table 3, 4 and 5 are generally similar.

- Insert table 2 about here -

- Insert table 3 about here -

- Insert table 4 about here -

- Insert table 5 about here -

Logistic Regression

Carbon emissions

Table 6 presents the regression results. H1 states that firms with large emissions are exposed higher risk and uncertainty. The higher emissions also cause large information asymmetry, so managers are more likely to purchase assurance. This prediction is supported by the results in Table 6 that the coefficient of EMIT 1 for the polled years and 2011 is positive and significant (t= 1.39, p=0.10, one-tailed, t=1.31, p=0.10, one-tailed, respectively). The results suggest the perceived carbon information risk drives firms to make a decision to have their emission assured externally to reduce the inherent uncertainty and information asymmetry.
The results in Table 6 show that the coefficients of \textit{INTESIVE} are all positive and significant for individual year and for the pooled years (2010-2012), 2010, 2011, 2012 respectively \((t=2.45, p=0.05, \text{ one-tailed}, t=1.62, p=0.10, \text{ one-tailed}, t=1.47, p=0.10, \text{ one-tailed}, t=1.86, p=0.05, \text{ one-tailed})\). The evidence is consistent with our expectation and previous studies (Prado-Lorenzo et al. 2009; Zhou 2010; Obermair 2010). Firms in carbon sensitive sectors are likely affected by existing and proposed carbon legislation.

Firm Size

We find some support for H3 that firm size is significantly and positively associated with the probability to purchase external carbon assurance \((t= 2.64, p= < 0.001, \text{ one—tailed for the three years 2010-2012}, \text{ and } t=2.14, p= <0.05, \text{ one-tailed for 2011})\). Though the association is more pronounced in the year of 2011, the evidence is largely consistent with our argument that large firms tend to have large information asymmetry with regard to carbon emissions and carbon activity, though they are probably more financially transparent than small firms. Thus, GHG assurance seems to be a device to raise the carbon veil. The reduced information asymmetry may decrease political cost (Watts and Zimmerman 1978: Ghazil 2007) and regulatory pressure, as well as legitimize their existence and build a green image (Hossain et al. 1995).

Other influences

With respect to carbon performance, we find a positive and significant coefficient of \textit{PERFORM} for the polled years, and for 2010 and 2011 (polled years, 2010 and 2011 \(t=2.45, p=0.01, \text{ one-tailed}, t= 4.76, p=0.01, \text{ one-tailed}, t=2.00, p=0.10, \text{ one-tailed}, \) respectively). The results imply that firms with superior carbon performance are more likely to have external
verification to strengthen their positive ‘signal’, which is in favour of signalling theory. In addition, we expect the probability of external carbon assurance increases in carbon disclosure score. The prediction is supported from the results for the polled years and 2012 where the coefficient of DISCLOSE is positive and significant ($t= 4.22, p=0.01$, one-tailed, $t=5.53, p=0.01$, one-tailed). The stakeholder theory might explain the results. If companies attempt to utilise voluntary environmental disclosures to show their accountability and meet the demand of stakeholders, these firms would have the incentive to have acquired external attestation so as to strengthen the effect of the carbon disclosure.

A direct correlation was expected between leverage and carbon assurance, but the coefficient of LEVERAGE was not found to be significant in any of the years under our investigation (Table 6). It is unlikely that carbon information is unimportant for them. A more plausible explanation would be that the banks that provide finance to the firm perhaps have access to other sources of the information. These financial institutions should be able to directly demand carbon information rather than rely on publicly disclosed information. Finally, the control variable, ROE was not significant in any of the years, suggesting profitability is unrelated to GHG assurance.

Robust checks

We conducted several robust checks (results are not tabulated) to ascertain whether our results are sensitive to our research design. First, we use only emission one to proxy for exposure to carbon risk. But it can be argued that scope two (e.g. use of purchased electricity) and three are also correlated with climate change risk. This is because the climate change legislations targeting emission one will add the operating cost of energy companies and these companies will pass on carbon charges to its customers so as to increase energy price. As a result, the users of electricity will have to pay higher energy and
fuel cost. Thus, we use total emissions from all three scope emissions and the results are generally similar to the main tests.

Second, in the main tests, we only consider intensity versus none intensity firms. This may not adequately control the sector effects. Therefore we included eight sector dummy variables to control for the systematic sector differences and found our results are consistent.

Third, we also use sales instead of total assets as a proxy for firm size and use return on assets (rather than equity) to proxy for profitability and the findings using these alternative measures do not alter our inferences.

Fourth, we run our test on a sample which includes only the firms that purchase the external assurance for all the three years. If the firm has assurance for all the three years it means the firm has a strong incentive to do so. The results show our main inferences remain unchanged.

Finally, there is a possibility that the decision of GHG assurance might be endogenous. As mentioned before this could happen at least for some firms that participate in an ETS and the scheme may require an assurance for the GHG emissions. This is not a major concern in our setting, as US, unlike in EU, does not have a national ETS in place. Nevertheless, we found there are still some US firms that participated (probably voluntarily) in an ETS. Thus, we consider this possibility and exclude these firms from our sample firms. This treatment should mitigate the endogeneity issue. We also consider the possibility that our findings might be subject to potential self-selection bias. However, since our sample not only includes the firms that chose to be audited, but also include firms that chose not to be audited, the self-selection bias effect, if any, should be muted. In sum, our tests appear to provide generally consistent, valid and robust results. The conclusions are not altered by
firm fixed effects, indicating that the relation is not entirely due to time-invariant firm characteristics.

V. CONCLUSIONS AND FUTURE CHALLENGES

Summary of main findings and its implications

We propose that when carbon information asymmetry between managers and external stakeholders is large, investors are less likely to be cognizant of managers’ privately observed news and knowledge, providing managers with greater incentives to disclose carbon information with assurance. We expect carbon information asymmetry be higher among firms with heavy emissions, in a carbon sensitive industry with higher litigation risk and in large firms. Such firms are also likely to operate in economic environments characterized by greater uncertainty. Greater uncertainty, in turn, can motivate corporate executives to manage the risk and use assurance to signal their voluntary GHG statements are credible. Thus, we predict that the greater the information asymmetry, the greater the incidence of GHG assurance which evidences an organizational commitment to carbon risk management as disclosed in a GHG report.

We compared assurance incidence, and find it is greater in high carbon emission firms than in low emissions firms, in the firms operating in an emission intensity industry or in large firms. The results are consistent with our argument that carbon information asymmetry is one of the major drivers for the GHG assurance propensity. In addition, cross-sectional tests suggest that the tendency is more pronounced when managers take voluntarily proactive carbon control measures. Finally, the positive relation between assurance and carbon
exposure and information asymmetry exists in firms when their financial statements are supposed to be transparent.

Note our findings show that firms purchased GHG statement assurance in addition to financial statement assurance, suggesting carbon information asymmetry is a distinct dimension of information asymmetry. Thus, traditional financial statements assurance is unlikely to resolve the carbon information opacity issue, as financial statement assurance mainly concerns the authenticity of financial information.

Our findings about firm’s motivation and practice of carbon assurance are useful for regulators who are concerned about the quality of carbon information and for accountants who face the challenge to implement the first version of International Standards for GHG assurance effective from September 2013.

Limitations of the study

There are limitations to this study and a few caveats worth noting. First, we only consider large firms. Second, this study is focused on one country, namely the USA. Future research could extend this to include other countries such as those of the EU. Third, we only consider firms that participated CDP and the variables used are mainly from the CDP database. But firms may choose other channels (e.g. a sustainability statement) to communicate their carbon information. Fourth, we do not examine the CDP statements and attached assurance reports, so there is no guarantee the contents of the CDP reports are complete and accurate even with assurance.

Recent development of carbon reporting and assurance initiatives
Investment return behaviours in environmentally responsive investing are likely to emerge in a GHG-restricted world, over many business cycles. New diversification benefits might arise in investment portfolios. An investor might identify and take the characteristics of “carbon-sensitive” assets into account (Haigh and Shapiro 2011). So the quantum, format and venue of carbon reports would then become relevant for the decision inputs of investors (Hughes II 2000). However, multiple non-regulated and regulated reporting initiatives and frameworks abounded around the world at the time of writing of the paper. For example, the US SEC’s Commission Guidance Regarding Disclosure Relating to Climate Change outlines public companies’ obligations under securities laws and SEC regulations to disclose material information concerning climate related risks and opportunities (CERES 2010). The Guidance’s release coincides with important new regulatory developments, including the EPA’s adoption of regulations for GHG emissions from motor vehicles and large sources such as power plants and factories under the Clean Air Act.

More recently, the UK government has set up a very ambitious target, that is, the country will reduce its GHG emissions by 80% by 2050. In order to achieve the goal, the UK Government has proposed an Energy Savings Opportunity Scheme. Large enterprises will be required to identify cost-effective ways to invest in energy efficiency, helping reduce energy bills and increase competitiveness. All large enterprises in the UK are required to undertake energy efficiency audits by December 2015 and every four years thereafter. In addition, from 1 October 2013, all UK quoted companies are required to report on their GHG emissions as part of their annual Directors’ Report. That requirement affects all UK incorporated companies listed on the main market of the London Stock Exchange, a European Economic Area market or whose shares are dealing on the New York Stock
Exchange or NASDAQ. However, there is no requirement in the regulations for emission data to be independently verified or assured. Whilst assurance is not a regulatory requirement, it is recommended as good practice.\textsuperscript{16}

It is expected that the mandatory disclosure requirement for GHG information for UK companies listed in the US will result in higher levels of carbon transparency relative to other firms. This may put pressure on US companies and foreign firms listed in the US. There would be more US firms voluntarily disclosing GHG information, and having it assured.

\textit{Problems with GHG assurance}

The carbon assurance market is still in its infancy and unregulated. But it is developing quickly and is evolving into a sophisticated, specialised and competitive market (Green et al. 2010).

Despite this, the credibility of the assurance itself is an issue for sustainability reports in general and for the GHG statement in particular. This is because there is no single benchmark against which sustainability or carbon performance can be evaluated (CorporateRegister.com 2008). In addition, the guidelines that are currently available originate from very different professional and ethical imperatives (Ne`ron, 2010, IAASB, 2004, Accountability, 2008, ISAE 3410). Finally, assurance practitioners are themselves a disparate group of organisations (Deegan et al. 2006) who adopt different assurance methodologies, some of which are proprietary. The diversity of standards, methodologies, and practitioners increases the complexity of the assurance (Scalet and Kelly 2010; Waddock 2008) which does not add credibility to a sustainability report including GHG statement.

There is a specific concern regarding the quality of assurance and independence of assurers for GHG engagement. In financial statement assurance the market is dominated by accountancy firms because the law provides monopolistic rights to these firms to conduct the audit of financial statements. Such a state-guaranteed monopoly does not exist in the area of assurance on sustainability reports, and assurance in this unregulated market may also be purchased from other providers such as environmental management firms. Simnett et al. (2009) argue that members of the auditing profession are the higher quality assurance providers. The auditing profession has well-developed “global” standards, a body of ethics and independence requirements, as well as quality control mechanisms at both the firm and engagement levels (DeAngelo 1981; Watts and Zimmerman 1986). The argument is further supported by the fact that audit firms (especially the major firms) also bring a high level of reputational capital to their engagements. Big 4 firms are less likely to behave opportunistically or myopically. Moreover, due to their size, the Big 4 audit firms are less prone to fall victim to fee dependence, as the costs of compromising independence (litigation and reputation costs) outweigh the benefits (Craswell et al. 2002). A counter-argument is that specialist providers (such as environmental consultancies) may possess a higher level of subject-matter expertise. However, audit firms can always employ staffs who possess such expertise. Further, members of the auditing profession are believed to charge higher fee which is an indication of high quality (Simnett et al. 2009). Most importantly, consultant assurors tend to focus on aiding corporate strategic direction which might potentially impair their independence. Although they check the GHG statements, it appears they do so to help management to manage the carbon emissions and the communication with outside stakeholders. As a result, they are less likely to challenge the management in a serious way (O’Dwyer and Owen 2005).
**Future study**

Note our study covers the period before the international standards for GHG assurance became effective, because we assume the issuance of the standards would affect managerial incentives. A future study can examine the impact of the implementation of the standards on GHG assurance practice. The evolution of carbon constraints presents additional interesting avenue for future research. For example, further study can examine the impact of other firm's characteristics and institutional factors, e.g. carbon management systems, carbon reduction actions and corporate governance. In addition, an examination of the association between firm value and carbon activity, including assurance, will be an important topic.

There are two important questions for future studies in this area. The first one is related to quality of GHG assurance. As discussed, although there is serious concern about the quality of the assurance, little is known empirically about the factors that might affect it. In our context, the overwhelming majority of our firms have environmental consultant companies to do the assurance. This is probably due to the unique USA rule under the Sarbanes-Oxley Act which restricts non audit services provided by the financial auditors and the GHG assurance is regarded as a non audit service. This is in contrast to other countries where accountants share the market with other providers of assurance (Simnett et al. 2009). Arguably, the auditing profession provides a relatively high quality of service and maintain a higher standard of independence. However, further empirical evidence would be necessary from future research to continue to support this claim.
A second question for future researchers concerns the incentives for greenwashing practices. The voluntary nature of disclosure in GHG statements does not guarantee that the disclosing firm has any genuine desire to take initiatives. Instead, literature suggests some management have incentives to manipulate the information in order to influence the perceptions of users, so as to avoid a forthcoming legitimacy crisis or regulatory risk. Carbon reduction schemes require substantial investment in low Co2 technology, using clean energy and developing environmental friendly products. Unless carbon control investments increase profit simultaneously, managers are under enormous pressure to privilege the goal of profitability over the goal of ecological sustainability, but as this changes, so will the incentivesto adopt greenwashing behaviour. Analogues of the effect of financial audit on earnings management meanan independent assurance can curb or reduce the degree of, but cannot eliminate the greenwashing activity of the management. Although there is some speculation and anecdotal evidence suggesting some indicators for greenwashing practice, there is no emerging consensus apparent in the generally available literature. There is no empirically validated model that can help detect the tendency for greenwashing either. The quality of a GHG statement may be affected by greenwashing which would significantly increase the incidence of misstatement in the GHG statements. This is likely to increase as a concern for GHG assurers.. Finally, with the forthcoming assurance and accounting standards for GHG statements, our accounting students need to be equipped with adequate knowledge to implement these standards. Thus, it is necessary for university accounting faculty to develop teaching materials for new accounting students who will practice in a carbon restricted economy.
## Table 1
### Descriptive Statistics for Model Variables

| Variable   | Assured Firms |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |
|------------|---------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|            | Year 2010     | Year 2011        | Year 2012        | Years 2010-2012  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |
|            | (n= 97)       | (n= 144)         | (n= 160)         | (n= 401)         |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |
| EMIT 1     | 13.10         | 12.82            | 12.35            | 12.96            | 12.79            | 12.64            | 2.90             |
| PERFORM    | 74.68         | 66.42            | 67.47            | 68.84            | 72.00            | 16.32            |
| DISCLOSE   | 87.97         | 84.93            | 88.59            | 87.13            | 92.23            | 13.84            |
| Size       | 7.18          | 7.18             | 7.14             | 7.12             | 7.16             | 7.12             | 0.53             |
| INTENSIVE  | 0.33          | 0.28             | 0.25             | 0.43             | 0.28             | 0.45             | 0.45             |
| ROE        | 11.30         | 11.36            | 11.25            | 11.23            | 11.30            | 11.25            | 1.38             |
| LEVERAGE   | 0.14          | 0.14             | 0.15             | 0.17             | 0.14             | 0.16             | 0.20             |

<table>
<thead>
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<th>Variable</th>
<th>Not Assured Firms</th>
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<td>Year 2011</td>
<td>Year 2012</td>
<td>Years 2010-2012</td>
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<td>(n= 89)</td>
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<td>11.43</td>
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### Variable Definitions
Assure1: Categorical dependent variable, which is coded 1(one) for firms that have been assured or 0 (Zero) otherwise. Size: Natural Log of total sales. Intensive: categorical dependent variable which is coded 1 for risky industries otherwise zero, PERFORM: Performance Score is the total level of carbon performance scored using a CDP Index. DISCLOSE: Disclosure Score is the total level of carbon disclosure scored using CDP Index. EMIT: Scope 1 Emission, ROE: Net Profit divided by shareholder’s equity. LEVERAGE: Leverage Total Debts/Total Assets
Table 2 Correlation Matrix
Fiscal Years 2010, 2011 and 2012

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<th>PERFORM</th>
<th>DISCLOSE</th>
<th>SIZE</th>
<th>ROE</th>
<th>LEVERAGE</th>
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**Correlation is significant at the .01 level (2-tailed)
*Correlation is significant at the .05 level (2-tailed)
*N= 768
*Period = 3 (Fiscal years ended 2010, 2011 and 2012)
### Table 3 Correlation Matrix
#### Fiscal Years 2010

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**Correlation is significant at the .01 level (2-tailed)
*Correlation is significant at the .05 level (2-tailed)
*N=225
*Period =1 (Fiscal year ended 2010)

### Table 4 Correlation Matrix
#### Fiscal Years 2011

<table>
<thead>
<tr>
<th></th>
<th>Assured</th>
<th>EMIT 1</th>
<th>INTENSIVE</th>
<th>PERFORM</th>
<th>DISCLOSE</th>
<th>SIZE</th>
<th>ROE</th>
<th>LEVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assured</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMIT 1</td>
<td>.250**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTENSIVE</td>
<td>.187**</td>
<td>.594**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERFORM</td>
<td>.271**</td>
<td>.123*</td>
<td>0.051</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISCLOSE</td>
<td>.231**</td>
<td>0.029</td>
<td>0.044</td>
<td>.747**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIZE</td>
<td>.248**</td>
<td>.218**</td>
<td>-0.010</td>
<td>.144*</td>
<td>.144**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROE</td>
<td>.244**</td>
<td>.270**</td>
<td>.106*</td>
<td>.180**</td>
<td>.141*</td>
<td>.556**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>LEVERAGE</td>
<td>0.114</td>
<td>.422**</td>
<td>.238**</td>
<td>0.081</td>
<td>0.023</td>
<td>0.422</td>
<td>-0.075</td>
<td>1</td>
</tr>
</tbody>
</table>

**Correlation is significant at the .01 level (2-tailed)
*Correlation is significant at the .05 level (2-tailed)
*N= 294
*Period =2 (Fiscal year ended 2011)

**Table 5 Correlation Matrix**
**Fiscal Years 2012**

<table>
<thead>
<tr>
<th></th>
<th>Assured</th>
<th>EMIT 1</th>
<th>INTERSIVE</th>
<th>PERFORM</th>
<th>DISCLOSE</th>
<th>SIZE</th>
<th>ROE</th>
<th>LEVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assured</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMIT 1</td>
<td>.168**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERSIVE</td>
<td>.108*</td>
<td>.563**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERFORM</td>
<td>.436**</td>
<td>.134*</td>
<td>0.038</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISCLOSE</td>
<td>.564**</td>
<td>.116*</td>
<td>-0.013</td>
<td>.701**</td>
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<td></td>
</tr>
<tr>
<td>SIZE</td>
<td>.241**</td>
<td>.307**</td>
<td>0.013</td>
<td>.231**</td>
<td>.242**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROE</td>
<td>.218**</td>
<td>.201**</td>
<td>0.039</td>
<td>.224**</td>
<td>.202**</td>
<td>.540**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>LEVERAGE</td>
<td>0.075</td>
<td>.407**</td>
<td>.252**</td>
<td>0.084</td>
<td>0.069</td>
<td>-0.100</td>
<td>-0.160*</td>
<td>1</td>
</tr>
</tbody>
</table>

*Correlation is significant at the .05 level (2-tailed)
*N= 249
*Period =3 (Fiscal year ended 2012)
### Table 6 – Logistic regression results

<table>
<thead>
<tr>
<th>Year</th>
<th>Year 2010</th>
<th>Year 2011</th>
<th>Year 2012</th>
<th>Years 2010-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-12.126</td>
<td>-9.558</td>
<td>-11.782</td>
<td>-10.137</td>
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<tr>
<td></td>
<td>(-4.11)**</td>
<td>(-5.08)***</td>
<td>(-4.75)**</td>
<td>(-8.01)***</td>
</tr>
<tr>
<td>EMIT 1</td>
<td>0.034</td>
<td>0.08</td>
<td>-0.015</td>
<td>0.057</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(1.31)*</td>
<td>(-0.19)</td>
<td>(1.39)*</td>
</tr>
<tr>
<td>INTENSIVE</td>
<td>1.044</td>
<td>0.588</td>
<td>1.051</td>
<td>0.669</td>
</tr>
<tr>
<td></td>
<td>(1.62)*</td>
<td>(1.47)*</td>
<td>(1.86)**</td>
<td>(2.45)**</td>
</tr>
<tr>
<td>PERFORM</td>
<td>0.081</td>
<td>0.024</td>
<td>0.004</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>(4.76)***</td>
<td>(2.00)*</td>
<td>(0.33)</td>
<td>(4.71)***</td>
</tr>
<tr>
<td>DISCLOSE</td>
<td>0.025</td>
<td>0.011</td>
<td>0.094</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(1.09)</td>
<td>(0.92)</td>
<td>(5.53)***</td>
<td>(4.22)***</td>
</tr>
<tr>
<td>SIZE</td>
<td>0.702</td>
<td>0.618</td>
<td>0.456</td>
<td>0.550</td>
</tr>
<tr>
<td></td>
<td>(1.16)</td>
<td>(2.14)*</td>
<td>(1.19)</td>
<td>(2.64)**</td>
</tr>
<tr>
<td>ROE</td>
<td>-0.068</td>
<td>0.151</td>
<td>0.117</td>
<td>0.089</td>
</tr>
<tr>
<td></td>
<td>(-0.31)</td>
<td>(1.27)</td>
<td>(0.94)</td>
<td>(1.16)</td>
</tr>
<tr>
<td>LEVERAGE</td>
<td>0.266</td>
<td>0.305</td>
<td>0.409</td>
<td>0.212</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(0.47)</td>
<td>(0.49)</td>
<td>(0.50)</td>
</tr>
<tr>
<td>YEAR 2012</td>
<td></td>
<td></td>
<td></td>
<td>0.990</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(4.34)***</td>
</tr>
<tr>
<td>YEAR 2011</td>
<td></td>
<td></td>
<td></td>
<td>0.101</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.48)</td>
</tr>
</tbody>
</table>

Correct Classification 82.2% 69.7% 77.9% 75.9%
Chi-Squared Statistics 123.55 pro<0.000 53.15 pro<0.000 100.55 pro<0.000 258.53, pro<0.000
Nagelkerke R² .56 .22 .45 .38

* expected sign in parentheses  
**.**, **Significantly different from zero at the α = 0.10, 0.05, and 0.01 levels respectively for one-tailed tests

### Variable Definitions:

**Assure1**: Categorical dependent variable, which is coded 1 (one) for firms that have been assured or 0 (Zero) otherwise

**Size**: Natural Log of total sales

**Intensive**: Dummy variables coded 1 for Intensive industries (energy, materials, utilities) zero otherwise

**PERFORM**: Performance Score is the total level of carbon performance scored using a CDP Index

**DISCLOSE**: Disclosure Score is the is the total level of carbon disclosure scored using CDP Index

**EMIT**: Scope 1 Emission

**ROE**: Net Profit divided by share holder's equity.

**LEVERAGE**: Leverage Total Debts/Total Assets
### Appendix 1

**Sample Distribution**

<table>
<thead>
<tr>
<th>Category</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Companies in CDP database in USA</td>
<td>1169</td>
<td>622</td>
<td>1070</td>
<td>2861</td>
</tr>
<tr>
<td>No Response (did not reply to CDP regarding request)</td>
<td>(652)</td>
<td>(153)</td>
<td>(556)</td>
<td>(1361)</td>
</tr>
<tr>
<td>Declined to participate (Decline to participate in the project)</td>
<td>(25 )</td>
<td>(42 )</td>
<td>(61 )</td>
<td>(128 )</td>
</tr>
<tr>
<td>Information provided - View Investor Response (did not answer all question)</td>
<td>(19 )</td>
<td>0</td>
<td>(0 )</td>
<td>(19 )</td>
</tr>
<tr>
<td>Information provided (Provided information relevant to the questionnaire, did not answer the questionnaire)</td>
<td>(3 )</td>
<td>(13 )</td>
<td>(9 )</td>
<td>(25 )</td>
</tr>
<tr>
<td>Details not publicly available</td>
<td>(65 )</td>
<td>(50 )</td>
<td>(60 )</td>
<td>(175 )</td>
</tr>
<tr>
<td>See Another (the response is covered by another company usually parent company)</td>
<td>(6 )</td>
<td>(4 )</td>
<td>(8 )</td>
<td>(18 )</td>
</tr>
<tr>
<td>Answered questionnaire - View Investor Response (Answered some or all of the questions in the questionnaire)</td>
<td>(1 )</td>
<td>0</td>
<td>(0 )</td>
<td>(1 )</td>
</tr>
<tr>
<td>Non Financial Data</td>
<td>(173)</td>
<td>(66 )</td>
<td>(127)</td>
<td>(366 )</td>
</tr>
<tr>
<td>Total Sample</td>
<td>225</td>
<td>294</td>
<td>249</td>
<td>768</td>
</tr>
<tr>
<td>Assured</td>
<td>97</td>
<td>144</td>
<td>160</td>
<td>401</td>
</tr>
<tr>
<td>Not Assured</td>
<td>128</td>
<td>150</td>
<td>89</td>
<td>367</td>
</tr>
</tbody>
</table>
Reference List


CDP 2010. Carbon disclosure project report


