THE IMPACT OF CARBON REPORTING SCHEMES AND CREDIBILITY ENHANCEMENT MECHANISMS ON CARBON EMISSIONS GROWTH

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THE IMPACT OF CARBON REPORTING SCHEMES AND CREDIBILITY ENHANCEMENT MECHANISMS ON CARBON EMISSIONS GROWTH

QINGLING (IRENE) GE

A thesis in fulfilment of the requirements of the degree of Doctor of Philosophy

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The ratification of the Paris Agreement has led to a rapid transition towards a mandatory reporting landscape for carbon emissions on a global scale. Demand has increased the need for performance and impact disclosures of carbon emissions at both the country and company levels. Extant research literature currently lags the regulatory momentum and development of carbon disclosures in examining the benefits of regulatory reporting schemes, as well as credibility enhancement mechanisms such as carbon assurance. My thesis examines the impact of carbon reporting schemes and credibility enhancement mechanisms, carbon policy risk, and the cost of debt financing on carbon emissions growth.

Study One examines the impact of variations of current carbon-related reporting schemes across countries. It uses a panel of 123 countries (1,600 country-year observations) covering the period 1990-2016. Study Two differentiates between home and host countries' reporting schemes for multinational companies and collects 6,664 observations from 45 countries covering the period 2011- 2017. My results reveal that the strength of carbon reporting schemes and credibility enhancement mechanisms contribute to curbing carbon emissions growth at the country and the company level. The effects of credibility enhancement mechanisms are both robust and enduring. There is also evidence of a trade-off between the strength of reporting schemes and credibility enhancement mechanisms. My results demonstrate that the credibility of reported carbon emissions is a critical first step in working towards climate change mitigation. Study Three employs data sets from the first two studies and measures the impact of carbon policy risk. It finds that carbon policy risk, and the cost of debt financing, have a negative association with carbon emissions growth. This provides evidence of the role of financial institutions in facilitating a client company's carbon emissions reduction.

My thesis results constitute empirical evidence that informs both companies regarding the benefits of undertaking carbon assurance and emissions reduction programs in the face of diverse regulatory reporting schemes, and global and national regulators regarding the role of accounting and credibility enhancement mechanisms in holding countries and companies accountable for carbon emissions growth. Strengthening reporting schemes and emphasizing credibility enhancement mechanisms could aid in slowing down carbon emissions growth.

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ABSTRACT

The ratification of the Paris Agreement has led to a rapid transition towards a mandatory reporting landscape for carbon emissions on a global scale. Demand has increased the need for performance and impact disclosures of carbon emissions at both the country and company levels. Extant research literature currently lags the regulatory momentum and development of carbon disclosures in examining the benefits of regulatory reporting schemes, as well as credibility enhancement mechanisms such as carbon assurance. My thesis examines the impact of carbon reporting schemes and credibility enhancement mechanisms, carbon policy risk, and the cost of debt financing on carbon emissions growth.

Study One examines the impact of variations of current carbon-related reporting schemes across countries. It uses a panel of 123 countries (1,600 country-year observations) covering the period 1990-2016. Study Two differentiates between home and host countries' reporting schemes for multinational companies and collects 6,664 observations from 45 countries covering the period 2011- 2017. My results reveal that the strength of carbon reporting schemes and credibility enhancement mechanisms contribute to curbing carbon emissions growth at the country and the company level. The effects of credibility enhancement mechanisms are both robust and enduring. There is also evidence of a trade-off between the strength of reporting schemes and credibility enhancement mechanisms. My results demonstrate that the credibility of reported carbon emissions is a critical first step in working towards climate change mitigation. Study Three employs data sets from the first two studies and measures the impact of carbon policy risk. It finds that carbon policy risk, and the cost of debt financing, have a negative association with carbon emissions growth. This provides evidence of the role of financial institutions in facilitating a client company's carbon emissions reduction.

My thesis results constitute empirical evidence that informs both companies regarding the benefits of undertaking carbon assurance and emissions reduction programs in the face of diverse regulatory reporting schemes, and global and national regulators regarding the role of accounting and credibility enhancement mechanisms in holding countries and companies accountable for carbon emissions growth. Strengthening reporting schemes and emphasizing credibility enhancement mechanisms could aid in slowing down carbon emissions growth.

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LIST OF ABBREVIATIONS

APEC	Asia-Pacific Economic Cooperation
COP	Conference of Parties
CRF	Common Reporting Format
EER	Extended External Reporting
EKC	Environmental Kuznets Curve
EU	European Union
EU ETS	EU Emissions Trading Scheme
GAL	Global Administrative Law
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
IPCC	International Panel on Climate Change
ISAE	International Standards on Assurance Engagement
MNC	Multinational corporations
NC	National Communication
NDC	Nationally Determined Contribution
OECD	Organisation for Economic Co-operation and Development
TCFD	Task Force on Climate- Related Financial Disclosures
TPA	The Paris Agreement
UNEP	United Nations Environmental Panel
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER 1 INTRODUCTION

1.1 Research Aims

This thesis explores how carbon reporting schemes, related credibility enhancement mechanisms[1] (including independent carbon assurance engagements), and financial institutions can facilitate climate change mitigation. My thesis aims to interpret and explain the role of accounting and credibility enhancement mechanisms in carbon reduction discrepancies across countries and companies. The ratification of the Paris Agreement[2] (TPA), which holds 189[3] member countries to account, has served to focus public attention on the climate crisis and initiate a global movement to turn awareness into actions. In turn, this global goal to reduce carbon emissions gives rise to policy implications in that countries are held accountable for their reduction targets in terms of Greenhouse Gas (GHG) emissions. But companies, and not countries, ultimately are responsible for a large proportion of GHG emissions. Indeed, company level GHG emissions are important: the 100 largest companies in the world have been responsible for 71% of the global GHG emissions (CDP, 2017).

[1] Accounting and related credibility enhancement mechanisms are important to benchmark performance and build accountability at both the country and company levels. At the country level, the credibility of reported emissions data is emphasized by the UNFCCC through expert reviews, assessments and stocktakes. At the company level, independent assurance engagements are one of the key mechanisms mostly studied and encapsulated under the theme of credibility enhancement mechanisms. Currently, credibility enhancement mechanisms are largely voluntary, with the exception of the reported emissions under the EU Emissions Trading Scheme (EU ETS), where the submission of an independent third-party verification report is required.

[2] A breakthrough consensus that sets a goal of limiting global warming to less than 2 degrees Celsius (2 °C) compared to pre-industrial levels and which came into effect on 4 November 2016.

[3] To date, 189 Parties out of 197 Parties at the Convention ratified TPA. On 4 November 2019, the U.S. withdrew from TPA which took effect on 4 November 2020.

At the country level, public interest theory and global administrative law (GAL) both highlight the relevance of accounting and credibility enhancement mechanisms in the building of reporting metrics and accountability to reduce carbon emissions. At the company level, institutional theory serves to identify internal regulatory differences across countries in reporting metrics and accountability aimed at reducing carbon emissions.

There has been a significant increase in national legislation and related strategies[4] aimed at regulating GHG emissions, but a substantial deviation in global emissions from the historical growth trend is yet to be observed (International Panel on Climate Change (IPCC), 2018). In response to the momentum of growing national legislation, companies have actively developed reporting practices and increasingly sought independent assurance to prepare credible reports in accordance with relevant and reliable reporting criteria (KPMG, 2015, 2017, 2020; Task Force on Climate-related Financial Disclosure (TCFD), 2017, 2019). Extant literature finds that a company's carbon disclosures have an impact on its market valuation (e.g., Chapple, Clarkson, and Gold, 2013; Matsumura, Prakash, and Vera-Muñoz, 2014; Griffin, Lont, and Sun, 2017; Choi and Luo, 2020; Griffin, Lont, and Pomare, 2020). However, there is still a lack of empirical evidence as to whether credible reporting practices lead to carbon emissions reduction. Consequently, the first two empirical research questions that I address in this thesis are:

1) Whether and to what extent carbon reporting schemes and related credibility enhancement mechanisms (including independent assurance engagements) impact on carbon emissions growth at the country level?

[4] In 2012, 67% of global GHG emissions were subject to national legislation or strategies as compared with 45 % in 2007. These plans and strategies are in early stages of development and implementation in many countries and the aggregate impact on future global emissions remains difficult to assess.

2) Whether and to what extent carbon reporting schemes and assurance impact on carbon emissions growth at the company level?

Further, policy targets at the country level induce carbon risks for reporting companies. As a key source of funding for companies, financial institutions have been called onto the central stage to motivate companies to identify and evaluate carbon risks and steer companies away from investing in carbon intensive projects (UNEP-FI, 2019a). Thus, the third empirical research question that I address in this thesis is:

3) Whether and to what extent the role of financial institutions has been fulfilled in addressing carbon policy risk and, in addition, whether and to what extent the relation is moderated through its interplay with the carbon accounting and assurance mechanisms?

1.2 Background

The failure of climate change mitigation and adaptation is perceived to be the most impactful risk for business and society in the coming years (World Economic Forum, 2016, 2019). To address this global risk and prevent its "severe, widespread and irreversible impacts" (IPCC, 2014), 189 countries ratified TPA and agreed to reduce GHG emissions and facilitate transitions to a lower-carbon economy (United Nations Framework Convention on Climate Change[5] (UNFCCC), 2016). All 189 countries have submitted to the UNFCCC their first Nationally Determined Contributions (NDCs) which specify long-term country-level carbon reduction targets by 2030. The European Union (EU) member countries have

5 Its ultimate goal is to stabilize GHG concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system". The UNFCCC bound its member states to "protect the climate system for present and future generations" and it came into effect on 21 March 1994.

pledged to reduce their domestic GHG emissions by at least 40 percent compared to 1990 levels. Canada is leading the non-EU developed economies by setting a goal of 30 percent emissions reduction on 1990 levels, while Australia, Japan, and the US[6] have specified their goals in the range of 25-28 percent below 2005 levels. Among the biggest emitters of the developing countries, China has determined to lower its carbon emissions intensity as a proportion of Gross Domestic Product (GDP) by 60 to 65 percent and India has pledged to reduce the emissions intensity of its GDP by 33 to 35 percent, both compared with 2005 levels.

Scientific estimations have identified an emerging emissions gap in the sense that the aggregate effects from all NDCs are not seen to be adequate to meet the global goal of limiting warming to 2 degrees Celsius (UNEP, 2015; Rogelj et al., 2016). Also, despite some countries' boasting of achievements[7] under the Kyoto Protocol[8], companies within these countries are not linking reduction targets to the global climate goal (KPMG, 2017), although, as stated in Section 1.1 of this thesis, they are the biggest emitters within the countries at which reduction policies can be targeted, with the 100 largest companies in the world responsible for 71% of the global GHG emissions (CDP, 2017). Whilst the global GHG emissions have been increasingly subject to national legislations (IPCC, 2014, 2018), substantial efforts

[6] After winning the 2020 US Presidential election, Joe Biden plans to sign the U.S., back into TPA. The U S. is the world's second largest producer of GHG emissions. Biden's policy would reduce U.S. emissions by about 75 gigatonnes in the next 30 years and thereby reach net zero emissions by 2050. This would contribute to avoiding a temperature rise of about 0.1 degree Celsius by 2100 (The Guardian, 2020; The Washington Post, 2020).

[7] Denmark, Germany, the Netherlands, Sweden, and the United Kingdom announced in Paris the cancellation of carryover credits (by overshooting the 2008-2012 targets) from the first commitment period under Kyoto. Australia decided to bank its credits for the second commitment period (The Guardian, 2015).

[8] An international agreement which binds all Parties to committed emission reduction targets. During the first commitment period, 37 industrialized countries committed to the reduction of GHG emissions by an average of five percent compared with 1990 levels.

must be made to honour the pledges governments have made under the TPA to close the emissions gap under existing policies.

Accounting and related independent assurance engagements have been emphasized under TPA to formulate reliable national reporting systems across countries. Indeed, to hold countries accountable, TPA specifies a global carbon stocktake mechanism that begins in 2023 and is carried out every five years thereafter to assess the collective progress to stabilize climate (UNFCCC, 2016). Currently, ratified parties to the UNFCCC commit to establish national systems and report national GHG inventories to safeguard their obligations (UNFCCC, 1994, 1998). Following the IPCC guidelines (1996, 2006, 2019), governments devise reporting schemes to collect emissions data from a variety of sources[9]. However, there is variation in the emissions coverage of the reporting schemes. For example, the National Greenhouse and Energy Reporting[10] (NGER) scheme in Australia captures 60 percent of the Australian GHG inventories, whilst Canada's GHG emissions reporting program covers 36 percent of its reported national emissions (GHGRP, 2018). The U.S. Greenhouse Gas Reporting Program tracks the largest facility level emitters' performance and reports approximately half of the total U.S.

[9] National GHG inventory is gathered from a variety of government and other agencies after identifying key sources of emissions and it is calculated based on emissions and removal estimates in the Energy, Industrial Processes and Product Use, Agriculture, Waste, and Land Use, Land use change and Forestry (LULUCF) sectors. As defined under the UNFCCC, any process, activity, or mechanism which removes a GHG from the atmosphere is referred to as a "sink". The LULUCF are human activities that impact terrestrial sinks. They achieve GHG mitigation through an increase in the removal and decrease of emissions emanating from accumulated carbon stocks.

[10] Established under the National Greenhouse and Energy Reporting Act 2007, this prescribed a single national framework for company's GHG emissions reporting.

GHG emissions (US EPA, 2018). And the EU ETS[11] regulates around 45 percent of total EU GHG emissions[12].

In addition to the national carbon reporting schemes that directly report emissions data, a variety of corporate legislations and exchange listing rules that exist in the various countries prescribe varied requirements regarding carbon-related information disclosure[13] in terms of regulatory type (legislation, guidelines, or initiatives), reporting scope (environmental or sustainability information), nature (mandatory or voluntary), geographical scope (national or subnational), industry covered (all or specific), reporting locations (regulatory registration systems or annual reports), and assurance mechanisms (independent verification[14] or risk-based external audit system[15]) (TCFD, 2017). These reporting schemes have driven the growth in carbon reporting and this reporting has fast become a mainstream expectation in both developed and emerging markets around the world. In response, governmental bodies, financial markets, and industry regulators have rapidly transitioned voluntary national reporting schemes to mandatory reporting regimes

[11] This system adopts a 'cap and trade' approach and effectively covers approximately 11,000 power stations and manufacturing plants in the 28 EU Member States, plus Iceland, Liechtenstein and Norway, and accounts for three-quarters of international carbon trading (EU ETS Factsheet, 2017).

[12] The EU ETS data has been extensively used by its member states for direct emissions, activity data, emission factors, and quality assurance in the processes of national GHG inventory preparation.

[13] For instance, in Australia, The National Pollutant Inventory (1998) scheme requires industrial companies to report emissions and inventories for specific regulated substances and fuel. The Renewable Energy (Electricity) Act (2000) aims to reduce GHG emissions in the Electricity sector through certificates issuance. The Carbon Credits (Carbon Farming Initiative) Act (2011) is now integrated into the Emission Reduction Fund directly and it addresses and facilitates Australia in the achievement of its international emission reduction targets. Section 299 of the Corporations Act (2001) requires the reporting entity to indicate whether its operations are subject to any significant environmental regulations and further provide performance details regarding such regulations. Consistent with the listing rules of the Australian Stock Exchange (ASX, 2003), all listed companies are instructed to disclose annually the extent to which they have followed the ASX Corporate Governance Council's recommendations regarding how sustainability considerations have been integrated into their risk management processes. The Financial Services Reform Act introduced in 2010 calls for issuers of financial products to disclose in separate Product Disclosure Documents their environmental deliberations when making investment decisions.

[14] The EU ETS requires that reported data be verified by qualified third parties.

[15] The NGER provides a risk-based system and reserves the right to inspect and conduct external audit of reported data.

(KPMG, 2017; GRI and USB, 2020). Given the dynamic and fragmented international reporting landscape and the vast demands for carbon performance and impact disclosures, there is pressure to convince the users[16] of nonfinancial statements of the accuracy and reliability of the information contained therein. Indeed, many companies have voluntarily sought independent assurance engagements to verify that they have reduced GHG emissions in line with the global climate goal[17] (KPMG, 2017, 2020).

1.3 Motivation

TPA creates a unique empirical setting that enables an investigation of countries' reporting schemes and related credibility enhancement mechanisms as mitigating factors in terms of carbon emissions growth. GAL prescribes a toolbox that adopts metrics and measurements in the monitoring of countries' benchmark performance (Kingsbury, Krisch, and Stewart 2005). In this respect, accounting and related credibility enhancement mechanisms should be important tools in verifying, monitoring, and managing counties' carbon emissions growth. However, there is no prior research that has explored accounting and related credibility enhancement mechanisms at the country level. Study One thus examines whether and to what extent the strength of carbon-related reporting schemes across countries, and the

[16] Users are a combination of both the investors and regulators groups. Carbon related reporting schemes examined in this thesis comprises not only government devised reporting schemes which directly collect emissions data from reported companies, but also reporting schemes developed by stock exchanges and included in corporations act where emissions data are publicly disclosed in companies' annual report packages.

[17] KPMG (2020) reports that two-thirds of N100 companies and three-quarters of G250 companies have set carbon targets in place, showing a notable increase since 2017 in the number of companies disclosing carbon reduction targets. In addition, assurance of sustainability information has become an established company practice. Among the world's 250 largest companies, the underlying trend for independent assurance of sustainability information is 71 percent, with the greatest growth since 2017 being in two countries, namely, Spain and Singapore.

presence of in-country expert reviews as a credibility enhancement mechanism, help to curb carbon emissions growth at the country level.

Voluntary reporting schemes have been a key driver of companies' carbon emissions disclosures and in improving the value relevance of disclosures. However, the impact of such schemes varies due to institutional differences across countries. Interestingly, there is research that indicates that companies' reported emissions data does not fully cover their operations (Liesen, Hoepner, Patten, and Figge, 2015) and is not additive at the industry or country levels (Haslam, Butlin, Andersson, Malamatenios, and Lehman, 2014). This may suggest significant discrepancies between the actual and reported carbon emissions disclosures. Independent assurance engagements can help to improve the credibility of carbon emissions disclosures and thereby prevent companies from a perception of 'greenwash'. In the carbon reporting environment for companies, reporting practices are determined by the interplay of both country level and company level factors (Grauel and Gotthardt, 2016). Furthermore, multinational companies (MNCs) operating across countries can minimise or reduce the effects of carbon reduction policies on the company, and devise standardized environmental policies that alleviate the differences in reporting schemes across countries (Christmann, 2004). Study Two therefore adopts a multilevel approach and identifies the nature of MNCs operating across countries and it differentiates the effects of the strength of reporting schemes on curbing carbon emissions growth between the home and the host countries[18].

In line with the TPA and the development of the TCFD's carbon-related financial disclosures framework, central banks across the globe have been

[18] The home country is the country in which the headquarters of the MNC is located, and the host country is the country in which the MNC's operations are located.

determined to align their financial systems with the TPA and climate change goals (TCFD, 2019; UNEP-FI, 2019a). No regulatory intervention has to date resulted in direct requirements regarding the alignment of company's emissions reduction targets with the national targets[19], but in the process of global transition into a lower carbon economy, companies have incentives to meet and beat national emissions targets to minimise carbon costs. Extant literature assessing the association between carbon risk[20] and the cost of debt find positive statistical results (Chapple et al., 2013; Jung, Herbohn, and Clarkson, 2018; Kumar and Firoz, 2018; Maaloul, 2018). Study Three therefore explores the role of financial institutions in utilising their ability to motivate companies to address and evaluate carbon risk. It further investigates the moderating effects regarding the strength of carbon reporting schemes and the undertaking by companies of carbon assurance engagements on the relations between companies' carbon risks, the cost of debt financing, and carbon emissions growth.

As a package, the three studies in this thesis provide comprehensive and coherent evidence as to the required role of accounting and related credibility enhancement mechanisms in terms of carbon emissions and financial institutions in enhancing climate change mitigation at the country and company levels. First, the three studies share a common setting, namely climate change mitigation, and address the policy implications arising from the ratification of a global environmental accord. Second, Studies One and Two are complementary in that the

[19] The EU ETS, as do other trading schemes, places restrictions on the number of emissions permits available in the trading market. These are not considered in the thesis as a direct requirement that aligns companies' emissions reductions with national targets.

[20] Carbon risk encompasses policy and legal, technology, market and economic factors as well as reputational risks (WRI and UNEP-FI, 2015). This study primarily focuses on policy (regulatory) risk, which refers to the risks imposed on companies by the growing number of regulatory mechanisms (Carbon Trust, 2006; Subramaniam et al., 2015).

former focuses on the country level whereas the latter focuses on the company level. Studies One and Two are also connected by the notion that reported carbon emission at the company level should, to some degree, aggregate and represent reported carbon emissions at the country level. Third, Study Three further considers the role of financial institutions in an analysis of carbon risks and its interaction effects with the accounting and assurance regimes. This thesis presents a coherent picture of the roles played by multiple parties, including regulators, corporations, assurance practitioners, and financial institutions, in driving towards a lower carbon economy. As such, my thesis provides evidence that accounting and related credibility enhancement mechanisms are key mechanisms that serve the public interest.

1.4 Research Methodology

In Study One, at the country level, the UNFCCC official website provides a comprehensive country level GHG database which, to the best of my knowledge, has not been investigated in prior research. The UNFCCC GHG data interface reflects the most recent GHG data reported by countries and allows time series comparisons, aggregate and disaggregate cross-country comparisons (by emissions gas type, and by sector and by group) in addition to detailed country profiling and global mapping of carbon footprints. The availability of this database presents a great research opportunity and a unique empirical setting to examine the impact of a reporting index developed and utilized in this thesis[21] on emissions growth at a

[21] To examine the impact of the strength of carbon reporting schemes at the country and company level, a self- constructed reporting scheme index is developed to proxy for the strength of the reporting schemes. The index integrates a variety of factors that capture the differences in strength of the carbon reporting schemes across countries (TCFD, 2017; KPMG, GRI, UNEP, and Centre for Corporate Governance in Africa, 2016). These factors include: 1) the regulatory type (legislation, guidelines, or initiatives); 2) reporting scope (environmental or sustainability information); 3) reporting nature (mandatory or voluntary); 4) geographical scope (national or subnational); 5) industry sectors (all or specific) and 6) reporting locations (regulatory registration systems or annual reports) covered by the reporting schemes.

more macroeconomic level. Moreover, I compare the reported data with a scientifically estimated GHG emissions database EDGAR[22] to test for any discrepancies in emissions levels (reported versus scientific estimate), and to evaluate the role of accounting and related credibility enhancement mechanisms in alleviating such discrepancies.

In Study Two, at the company level, a multilevel research model is adopted to account for the differential influence of reporting schemes across the home and host countries of MNCs. This differentiation is important because MNCs collate GHG emissions information at the company level, but the reported emissions data is regulated by reporting schemes prescribed within countries for operations across countries, that is, across institutional boundaries. Emissions reporting studies published in the last decade have started to use multilevel research methodologies to identify and measure the crossover effects relating to the shaping and formation of MNC's carbon management systems and disclosure practices through country level institutional forces (Aguilera-Caracuel, Aragón-Correa, Hurtado-Torres, and Rugman, 2012, 2013; Aguilera-Caracuel, Fedriani, and Delgado-Márquez, 2014; Grauel and Gotthardt 2016). The data structure of the MNCs illustrated in Study Two provides an ideal research setting in which to apply the multilevel approach. Additionally, given the availability of hand-collected data regarding the details of the carbon assurance engagements, Study Two also investigates the potential effects of using different types of assurance practitioners and assurance standards on carbon emissions growth.

[22] The Emissions Database for Global Atmospheric Research (EDGAR) (2019) provides scientific estimations of global emission inventory and applies calculation methodology consistently across countries.

Further, Study Three constructs a measure of carbon policy risk using data from Studies One and Two in this thesis. To determine carbon policy risk, this measure disaggregates the GHG emissions reduction targets set at the country level for companies and calculates the differences between the disaggregated reduction targets and the reported emissions. Study Three also analyzes hand collected cost of debt financing data that reflects the current prices charged by financial institutions for companies which draw individual loan facilities at a point in time. This measure of carbon policy risk has an advantage over the interest expense ratio more commonly adopted in other studies because it provides up-to-date perceptions provided by the financial institutions in assessing the risk profiles of borrowing companies. Therefore, collection of the variable provides an opportunity for more direct testing of the incorporation of carbon risks in client's risk assessments conducted by financial institutions.

1.5 Contribution

This thesis makes the following theoretical, practical, and regulatory contributions:

1.5.1 Theoretical Contributions

First, the thesis contributes to academic literature by extending public interest theory and GAL to the climate change mitigation setting. Modern disclosure regulation research stemming from public interest theory suggests that the benefits of stringent disclosure regulations include cost savings relating to information search as well as the positive information transfer effect. GAL contends that metrics and measurements, and monitoring and related credibility enhancement mechanisms that allow performance benchmarking, promote policy efficiency, and build accountability. These theories stand for the normative approach, while this thesis presents empirical evidence as to whether and how the benefits of regulatory disclosures and assurances aggregate at the macroeconomic level (Leuz and Wysocki, 2016).

Second, this thesis contributes to country level carbon emissions research by highlighting and examining the importance of accounting and related credibility enhancement mechanisms. Extant literature centres on testing the relationships between economic growth, energy consumption, and carbon emissions growth and suggests that countries cannot rely on economic development to overturn carbon emissions growth to the rapid extent required, given the limited time span within which reduction targets are set and need to be achieved. Accounting and related credibility enhancement mechanisms could be considered as part of the mix of environmental policy and regulations that efficiently curtail future environmental degradation.

Third, this thesis contributes to the literature by presenting evidence relating to the application of institutional theory that accounts for differential regulatory effects arising from the 'institutional duality' faced by MNCs regarding operations in their home and host countries. MNCs consistently standardize internal policies and procedures to be applied throughout their operations across countries, while institutional differences shape and influence the outcomes desired by the MNCs. MNCs' unique data structures, as illustrated in this thesis, give rise to an ideal research setting in which to assess the impact of divergent regulatory effects on MNCs' aggregate performance outcomes regarding carbon emissions growth.

Fourth, this thesis fills a gap in company level carbon emissions research by supplying evidence as to the strength of carbon regulatory schemes and the effects of independent carbon assurance engagements that are undertaken on carbon emissions growth. Regulatory schemes motivate and improve value relevance of carbon disclosures. Results from this thesis shed light on the limited evidence relating to the regulatory disclosure effects with regard to influencing the growth of carbon emissions and companies' motivations to have carbon assurance engagements undertaken.

Last, this thesis contributes to the carbon risks and cost of debt financing literature using a distinctive carbon policy risk measure constructed using the approach in UNEP-FI (2019b)'s report. Countries commit to carbon reduction targets, but companies are not required to align their reduction targets with that of their respective countries. This induces a policy risk to be borne by companies if their carbon emissions growth deviates from a regulator's expectations regarding emissions reduction. Results from this thesis serve to depict whether and how companies, as well as the financial institutions, have incorporated carbon risks into their risk assessment and related pricing. This could be an important step in helping to facilitate carbon emissions reduction.

1.5.2 Practical Contribution

From the perspective of practical contributions, this thesis reveals the avenues that are relevant to companies during the transition to a lower carbon economy. Ratification of the TPA not only holds countries accountable, but it also has policy implications for companies operating within these applicable countries. Companies bear a carbon cost if their internal policies deviate from the global goal of reducing carbon emissions. Therefore, companies are motivated and have incentives to establish and improve their carbon reporting and management systems in the course of sustaining their economic growth.

Results from this thesis also provide useful benchmarks for companies to make decisions as to whether to have independent carbon assurance engagements undertaken or not. For instance, empirical findings can aid companies when they are deliberating about the benefits of assurance engagements, as well as when they are deliberating about potential trade-offs with the likely responses exercised by other interested parties in the climate change setting, such as regulators and financial institutions.

Results from this thesis further provide implications for the operations of MNCs. MNCs face a more complicated institutional environment and greater regulatory uncertainty as countries are increasingly establishing and tightening carbon regulatory schemes in carbon risk evaluations (for example, BHP, 2019). Results from the thesis thus inform the MNCs on their reported carbon emissions by examining the differentiation in home and host country regulatory effects. MNCs can then devise strategies and plans to proactively address the prevailing uncertainties.

1.5.3 Regulatory Contribution

Regulatory contributions and implications from this thesis are threefold. First, an examination of accounting and related credibility enhancement mechanisms highlights the efforts made by such transnational regulatory bodies as the UNFCCC to facilitate the collection, verification, and monitoring of member countries' carbon emissions information. The accounting and related credibility enhancement framework constructed by the UNFCCC at the country level accelerates the planning and implementation of national GHG emissions reporting systems and thereby places emphasis on the accuracy, reliability, and completeness of reported data. Empirical evidence from this thesis is informative for regulators prior to the conduct of a global carbon stocktake that is due to take place in 2023.

Second, the effectiveness of regulatory carbon reporting schemes is of current interest to national regulators. Given the current global momentum to increase regulatory reporting schemes, empirical evidence from this thesis informs the regulators in a timely manner as to whether, and to what extent, building a national reporting framework is worth the effort, i.e., does it stand up on a cost/benefit basis? An examination of the effects of related credibility enhancement mechanisms also sheds light on national regulators' consideration of guidelines that are required to ensure that these practices are optimum. The overriding aim is to best serve the public interest. In particular, this thesis provides evidence of the enduring effects of related credibility enhancement mechanisms on curbing carbon emissions growth.

Third, an investigation into the role of financial institutions in assessing clients' carbon risk profiles and associated pricing of debt may aid financial regulators in their efforts to steer the economy away more rapidly from high energy and carbon intensive investments. Empirical evidence from this thesis can also encourage financial institutions to consider the alignment of their policies more appropriately with the global goal of limiting carbon emissions growth.

1.6 Structure of Thesis

The remainder of this thesis is organized as follows. Chapter Two discusses the background information regarding climate change mitigation and the role of the

UNFCCC, carbon reporting schemes across countries, and theories that inform the studies in this thesis. Chapter Three presents a detailed literature review. Chapter Four contains the first empirical study of this thesis, i.e., the effects of carbon reporting schemes and related credibility enhancement mechanisms on carbon emissions growth: country level evidence. Chapter Five presents the second empirical study, i.e., the effects of carbon reporting schemes and related assurance engagements on carbon emissions growth: multilevel evidence. Chapter Six presents the third empirical study, i.e., the relations between carbon policy risk, the cost of debt financing, and carbon emissions growth, and the modification of carbon reporting schemes and assurances. Chapter Seven summarizes and concludes with a discussion of the theoretical, practical and regulatory implications arising from the three studies. There is also a consideration of opportunities for future research in this area.

CHAPTER 2 BACKGROUND AND THEORETICAL FRAMEWORK

This chapter provides a description of the background information and the theoretical framework that is used to inform this thesis. Prior to addressing the research questions developed in this thesis, this chapter sets the scene for the thesis and establishes the role of accounting and related credibility enhancement mechanisms (including independent assurance) in addressing the issue of climate change mitigation. Therefore, the purpose of this chapter is to understand the role and function of the UNFCCC which, in turn, governs countries' efforts to report and manage carbon emissions reduction, address the development of regulator policies and initiatives, and revisit the theoretical literature that covers the avenues for best approaching transnational governance.

Aggregated efforts at the international level to combat climate change are potentially undersupplied due to the inherent limitations pertaining to the nature of, and the inherent difficulties arising from, tackling the underlying issues. Therefore, the role of the UNFCCC in helping tackle the issues has been prominent. Not only has it exerted considerable effort in drawing countries' attention and commitment to addressing the issue of climate change mitigation, but it has also assumed the responsibility of collecting, verifying, and monitoring reported carbon information at the country level. In response to the global commitment to reduce carbon emissions, there has been a regulatory momentum developed to promote and enhance carbon disclosures at both the country and company levels. In addition, financial institutions have the capacity to restrict and monitor the investment in carbon intensive projects, and they are expected to fulfil their functions in driving a transition to a lower carbon economy.

The theoretical framework for this thesis, which is comprised of public interest theory, global administrative law, and institutional theory, forms the normative approach that highlights carbon accounting and related credibility enhancement mechanisms as the mechanisms which accurately measure and hold responsible parties accountable. This, in turn, ensures efficient and effective management of carbon emissions reduction. Assessment of accounting and related credibility enhancement mechanisms also facilitates the provision of evidence as to the predetermined efficacy of the regulatory and financial initiatives.

The remainder of the chapter is organised as follows. Section 2.1 reviews the institutional development which endeavors to combat climate change, and it covers carbon accounting and assurance at the country level, and also carbon related reporting schemes and related credibility enhancement mechanisms across countries. It is followed by a discussion of the existing carbon initiatives regarding climate goals. Section 2.2 constructs the theoretical framework which includes public interest theory, global administrative law, and institutional theory, to explain the accounting and related credibility enhancement regimes at the country and the company level.

2.1 Background

Climate change mitigation, as a global public good, is often undersupplied (Barrett, 2007). To investigate the role of accounting and related credibility enhancement mechanisms in the context of climate change mitigation, and to understand the roles of the different parties and how they have evolved in assisting

GHG emissions reduction, it is necessary to start with certain essential background information. This Section consists of four parts. Section 2.1.1 elaborates on the issue of climate change mitigation and highlights the significance of such global environmental agreements as the TPA; Section 2.1.2 introduces the role of the UNFCCC in accounting and related credibility enhancement mechanisms at the country level; Section 2.1.3 describes and summarizes the relevant carbon reporting schemes within countries; Section 2.1.4 discusses the evolution of carbon financial initiatives with regard to the attainment of climate goals.

2.1.1 Climate Change Mitigation

Decades of scientific research have shown that the current climate warming trend, originally identified in the mid-20th century, has a greater than 95 percent probability to have been caused by human activities[23] (National Aeronautics and Space Administration, 2019). In other words, it is extremely likely that people have caused global warming. In short, the failure of climate change mitigation is one of the greatest global risks[24] facing the world, and it has been identified, in a series of the Global Risks Reports, as one of the global risks most likely to happen. The failure of climate change mitigation, coupled with extreme weather events, has received an increased prominence for many years. It has been brought up at the top – or near the top – of the list of global economic risks over the past decade, and particularly in the past three years[25] (World Economic Forum, 2019). The predictions of what will occur if there is inaction on climate change mitigation are

[23] Agreed by 97 percent of climate scientists.
[24] Global risk is defined as “an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next 10 years”.
[25] Ranked as the first by impact and third by likelihood in the Global Risks Report 2016. Failure of climate change mitigation and adaption fell in the rankings after TPA in 2017 and 2018, but they jumped back to second in both impact and likelihood in the Global Risks Report 2019 (World Economic Forum, 2019).

dire. Without action on climate change, the world will face future increases in global temperatures, more extreme weather patterns, and a loss of fragile ecosystems (IPCC, 2018; U.S. Global Change Research Program, 2018; WWF, 2020).

There has been a recognised under-provisioning of an aggregated effort at the international level to combat climate change for several years (for example, Barrett, 2007). There are several reasons[26] why this is the case. First, climate change mitigation is a global public good[27], as its very nature is public and its benefits are not only captured by its providers but they also extend to "all countries, people and generations" (Shaffer, 2012). Carbon emissions are air-borne pollutions that transcend national boundaries, while countries are individually held accountable for the reduction targets. Second, the benefits of climate change mitigation are hard to quantify, and they take time to come to fruition, but its costs are tremendous and near-term in nature. This serves to negate the appeal of reducing carbon emissions as a long-term investment (Barrett, 2007). Third, the provision of benefits is fraught with difficulties due to discrepancies in political priorities and discrepancies in such things as national capacities (Keohane and Victor, 2011; Abbott, 2012). Lastly, there are barriers to reducing carbon emissions, such as a lack of legitimate power at the transnational level to enforce agreements, and a lack of coherent plans at

[26] While these reasons do explain why there has been an under-provision of aggregated effort at the international level to combat climate change, it should be noted that there also exist international agreements on climate mitigation that are successful. For example, the Montreal Protocol which aimed to protect the ozone layer has been highly effective with a significantly high benefit cost ratio, and it constructs explicit and effective enforcement mechanisms, e.g., trade restrictions.

[27] It is defined by the Nautilus Institute as "goods with benefits that extend to all countries, people, and generations". The underlying concept is formed by a social construction where "goods exist not in their original forms, but as social constructs largely determined by policies and other collective human actions". Thus, public goods are de facto "public in consumption" (Kaul, Conceicao, Le Goulven, and Mendozal, 2003). Global public good has the characteristics of being non-excludable, non-rivalrous, and transnational in scope and gives rise to the challenges of a lack of collective action and free riding (Shaffer, 2012).

national levels to commit to actions. These barriers give rise to institutional complexity at multiple levels[28] without clear hierarchical regulations (Betsill and Bulkeley, 2003; Pattberg and Stripple, 2008; Hoffmann, 2011; Abbott, 2014; Hickmann, 2015).

Decades of effort on a global scale have been undertaken to overcome these inherent difficulties, especially efforts made by such transnational institutions as the UNFCCC. The Kyoto protocol successfully draws together only the developed countries to reduce GHG emissions in the first commitment period (2008-2012). Subsequently, TPA[29] culminates in a broad consensus being built up over decades by countries with disparate powers and divergent values and holds countries accountable for their actions in terms of human-induced climate change mitigation and adaption. To make progress with sharing goals for climate change mitigation, priorities for climate action and coordinated collaboration need to be clearly achieved and sustained.

Meanwhile, responses and actions initiated in businesses continue to flourish. For example, a number of the world's largest corporate GHG emitters, along with over 370 investors with more than US$35 trillion in assets under management, or engaged to take serious action to align with the TPA goals[30] (Climate Action 100+, 2019). This is "an exercise in transparency and peer pressure" that makes it difficult for companies to ignore the cost of, and the long-term consequences of, not reducing

[28] A number of multilateral agreements, including the AsiaPacific Partnership on Clean Development and the International Carbon Action Partnership, have been arranged among groups of nation states. Transnational governance arrangements, such as ICLEI Local Governments for Sustainability, the Gold Standard, and We Mean Business, that bypass the nation states have been launched by multiple non-state and sub-state parties involving business corporations, environmental organizations, and sub-national governments.

[29] All ratified parties to the TPA needs to submit nationally determined contributions to the UNFCCC to specify emissions reduction targets.

[30] Industry leaders such as Royal Dutch Shell, Xcel Energy, Maersk, Nestle, Volkswagen, AES Corporation, Duke Energy Corporation, and Heidelberg Cement have made public commitments on setting carbon reduction targets, while Glencore, Rio Tinto, PTT Public Company Limited, and PetroChina have announced cap or exit coal mining with the intention of aligning with the goals of the TPA.

their carbon footprint (Financial Times, 2017). Due to a need for investors to assess a company's performance compared with committed goals, and because of the need to assess the ability to manage climate-related risks compared with climate resilient opportunities, and the need for an evaluation of the robustness of corporate business plans in terms of a range of climate scenarios, a global framework has been called for and developed to standardize climate-related reporting (TCFD, 2019). The TCFD framework is widely supported by over 1,340 of the world's largest companies, a group of 72 central banks and supervisors and 8 governments[31] (Belgium, Canada, Chile, France, Japan, New Zealand, Sweden, and the UK) (TCFD, 2019, 2020). While the Kyoto Protocol is the first step in stabilizing climate at the country level, the ratification of the TPA under the auspices of the UNFCCC, and associated initiatives such as that undertaken by the TCFD, accelerates progress by sending a clear and determined political signal to prompt companies to act towards attaining a lower-carbon economy.

2.1.2 United Nations Framework Convention on Climate Change (UNFCCC)-Accounting and Credibility Enhancement Mechanisms for GHG Emissions at the Country Level

To discuss accounting and related credibility enhancement mechanisms for GHG emissions at the country level, it is necessary to understand how the UNFCCC functions when guiding, collecting, and monitoring member countries' emissions reporting.

With the ultimate goal of committing to climate stabilisation, 197 countries have become Parties to the UNFCCC to date. These Parties are categorized as either

[31] To date, there are in total of over 1700 supporters of the TCFD framework across 70 countries (TCFD, 2021).

Annex I[32] or Non-Annex I[33] countries based on their differing commitments. The Annex I Parties are mainly industrialized countries and consist of 43 countries plus the EU. The Annex I countries are subject to a reporting regime that covers their GHG activities. Since 1994, the UNFCCC has required Annex I countries to have national communications (NCs) submitted to them. The NCs provide information on emissions and the removal of GHGs; national circumstances; policies and measures; vulnerability assessment; financial resources and transfer of technology; education, training, and public awareness; and any other details of the activities which a Party has undertaken to implement the Convention (UNFCCC, 2016). Following the decisions by the Conference of Parties[34] (COP) in 2011, the Annex I Parties were further mandated to submit their first biennial reports in January 2014 and subsequent biennial reports two years after the due date for full NCs. The biennial reports outline the Parties' progress in achieving emissions reductions and the provision of financial, technology, and capacity-building support leading to aggregated commitments.

In addition, the UNFCCC requires the Annex I countries to each submit a GHG National Inventory Report and prepare quantitative data in a common reporting format (CRF) to enhance comparison on an annual basis. To complete the CRF, the Annex I countries need to provide a full set of the CRF tables for the base year, i.e., 1990, and all years up to the most recent inventory year. This time series

[32] Parties include the industrialized countries that were Members of the OECD (Organization for Economic Co-operation and Development) in 1992, plus countries with economies in transition, including the Russian Federation, the Baltic States, and several Central and Eastern European States.
[33] Mostly developing countries and includes groups of countries that are vulnerable to the adverse impact of climate change or rely heavily on fossil fuel production and are therefore more vulnerable to the impact of a transition to a lower carbon economy.
[34] The COP meets annually to review the implementation of the UNFCCC agreement and is the UNFCCC's ultimate decision-making body.

reporting for the national GHG inventory enables the UNFCCC to establish the national GHG data interface.

In terms of carbon reporting, ratified parties to the UNFCCC commit to "develop, periodically update, and publish and make available to the COP, national inventories of anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol[35]". Furthermore, as stipulated under the Kyoto Protocol, Annex I Parties "shall have in place a national system" for the reporting of national GHG inventories to safeguard their obligations during the first commitment period (2008-2012) (Article 5 of the Kyoto Protocol, UNFCCC, 1998). In accordance with the IPCC Guidelines for National Greenhouse Gas Inventories[36] (the IPCC Guidelines, 2006), Annex I Parties' reported that emissions data is collected from a variety of sources[37] through centralized reporting agencies[38].

Submitted national inventory reports and biennial reports are subject to the credibility enhancement mechanism of centralized technical reviews conducted by an international team of experts. Each NC submitted by the Annex I Parties undergoes an in-depth review that includes a desk-based study and an in-country visit. Since the submission of the first biennial report and sixth NC, the Parties have

[35] An international treaty that became effective in 1989 which was designed to phase out the production of numerous substances that were believed to be responsible for ozone depletion.

[36] Developed through an international process and first approved internationally in 1994, the IPCC guidelines were revised in 1996 and subsequently combined with the good practice guidance reports in 2006 to become the single reporting framework for national GHG inventories formulated by the UNFCCC.

[37] National GHG inventory is gathered from a variety of government and other agencies after identifying key sources of emissions. It is calculated based on emissions and removal estimates in the Energy, Industrial Processes and Product Use, Agriculture, Waste, and Land Use, Land use change and Forestry (LULUCF) sectors. As defined under the UNFCCC, a "sink" is any process, activity, or mechanism which removes a GHG from the atmosphere. The LULUCF are human activities that impact the terrestrial sinks. GHG mitigation is achieved through an increase in the removal of, and thereby decrease of emissions, of accumulated carbon stocks.

[38] All Annex I Parties except for Croatia, which follows a decentralized arrangement and outsources its data collection, have commissioned a government reporting agency through legislation to prepare and compile national emissions data.

been assessed on the completeness and transparency of the information reported. For the first five submissions of NCs, only comments and recommendations are provided to conclude the reviews.

Apart from the Annex I Parties, the Non-Annex I countries[39] are also required to submit their first NCs within three years of entering the Convention, and every four years thereafter. However, this requirement is not closely adhered to. Apart from Mexico and Uruguay which have been consistently submitting NCs since 1997, 39 countries have produced three NCs while a further 90 committed countries have to date provided only two submissions. The majority of the Non-Annex I countries lodged their second submissions 10-15 years after their first submission.

To summarize, the reporting and verification mechanisms formulated by the UNFCCC establish the carbon reporting and related credibility enhancement framework at the country level. Member countries to the UNFCCC adhere to the requirements to implement their own reporting policies.

2.1.3 Carbon-Related Reporting Schemes Across Countries

Within the context of these constructed national inventory systems, government devised reporting schemes, which require companies or facilities to regularly report emissions information, play an important role[40].

In addition, a variety of legislative and exchange listing rules require reporting entities which operate in all or specified industries to disclose carbon-

[39] No particular credibility enhancement mechanism is prescribed for the non-Annex I countries within the sample period specified in the thesis.

[40] However, there are systematic variations across the reporting schemes, including the percentage coverage of the total national GHG emissions (for details, refer to Chapter One, page 5), and reporting nature (e.g., mandatory for the NGER in Australia and voluntary for the GHG Registry in Israel).

related information in annual reports or specified disclosure documents. For instance, in Australia the National Pollutant Inventory (1998) scheme requires industrial companies to report carbon emissions and inventories for specific regulated substances and fuel. Section 299 of the Corporations Act (2001) requires the reporting entity to indicate whether its operations are subject to any significant environmental regulations and to further provide performance details regarding such regulations. Further, following the listing rules of the Australian Stock Exchange (ASX, 2003), all listed companies are required to annually disclose the extent to which they have followed the ASX Corporate Governance Council's recommendations regarding how sustainability considerations have been integrated into companies' risk management processes. In addition, the Financial Services Reform Act introduced in 2010 calls for issuers of financial products to disclose their environmental deliberations in separate product disclosure documents when making investment decisions. More recently, in the revised Corporate Governance Principles and Recommendations (4th edition, 2019), the ASX incorporates the expectation that companies 'preserve and protect' their reputations and improve climate risk disclosures with reference to the TCFD framework which is aimed at enhancing credible reporting.

Worldwide, the total number of instruments that require or encourage companies to report information about their carbon-related performance has grown rapidly (KPMG et al., 2016). This has primarily been driven by regulatory growth in Europe, Asia Pacific and Latin America, and by the rise in 'comply or explain' reporting approaches and increasing activity by financial market regulators and stock exchanges. Europe continues to assume the leading role in terms of the overall number of instruments in place and the introduction of new schemes that focus on climate change mitigation, such as energy efficiency and emissions trading. This is in line with the fact that the EU counties are active Members of the Annex I Parties who first ratified the Kyoto Protocol. It is also evidenced by the observation that the number of schemes devised by governments and stock exchanges grew between 50 and 75 percent between 2013-2015 for the emerging markets in Latin America and the Asia Pacific, e.g., India, Indonesia, Malaysia, and South Korea, regions (KPMG, 2015).

Driven by the TPA of 2015, carbon related reporting schemes continue to dominate the growth in sustainability reporting instruments[41] (GRI and USB, 2020). Governmental bodies remain the most prolific issuers of reporting schemes, while the growth in reporting schemes issued by financial market regulators and industry bodies has been strong. Among the financial market regulators, the TCFD framework encourages companies to address carbon risks and measure carbon metrics, and central banks have become the most prominent promoters of this.

Carbon reporting initiatives devised by multiple regulatory bodies form diverse reporting regimes with companies/facilities as the reporting entities. While developed countries have been leading the formulation of climate change mitigation mechanisms, economies in the developing countries are ratcheting up. There is now a global momentum in place to increase the carbon regulatory landscape.

2.1.4 Carbon Initiatives by financial institutions and the Climate Goal

In addition to the reporting schemes formulated, there have been several initiatives launched by financial institutions to curb GHG emissions. The very first *Statement by Banks on the Environment and Sustainable Development*, that outlines

[41] Since 2016, the number of reporting instruments issued by governmental bodies has grown by 74 percent (GRI and USB, 2020).

the views of the international banking community on the environment and sustainability issues, was made in 1992 (UNEP-FI, 1992). The same kind of initiatives, such as the *Equator Principles* and the *Carbon Principles*, were subsequently developed by a group of leading financial institutions in 2003 and three leading U.S. banks in 2008 respectively, to assist and provide a consistent approach for banks to address and evaluate carbon risks (Labatt and White, 2007; Cogan, Good, and McAteer, 2008; Rainforest Action Network, 2011).

Nevertheless, the first Statement established under UNEP led to the development of a network of over 170 leading banks across the world. More recently, in September 2019, 33 of these Member banks, with over US$13 trillion in assets, created the *Principles for Responsible Banking*. These Principles are aimed at promoting the banking industry as undertaking a leading role in achieving the goals expressed in the Sustainable Development outline and the TPA. Collectively, the banking sector needs to align their portfolios to finance a low-carbon economy, to take actions to use products, services, and client relationships to achieve climate neutrality within a year of joining, and to be publicly accountable for their impact and for their progress towards meeting their commitments (UNEP-FI, 2019a). Specifically, these Members should promote the application of the carbon-related financial disclosure framework developed by TCFD to counterparty borrowers to guide them in the enhancement of carbon transparency in terms of business conduct.

Meanwhile, the Basel Committee on Banking Supervision recently published its very first stocktake report on its Members' existing regulatory and supervisory initiatives on climate-related financial risks (Basel Committee on Banking Supervision, 2020). This report concludes that while most members have conducted research into the measurement of carbon-related financial risks, operational difficulties, including data availability, methodological challenges, and the mapping of transmission channels, remain. While members are disclosing information on carbon-related financial risks to some extent, they are still far from being able to quantitively assess the carbon-related financial risks in the context of capital.

The World Business Council for Sustainable Development sees the financial sector as a leader with respect to sustainability for the following two reasons (Schmidheiny and Zorraquı´n, 1996; Esty, 2017). First, financial institutions have incentives to include sustainability in their corporation and/or project evaluations, not only because there are direct, indirect, and reputational costs, but also because reduced environmental costs have more immediate and significant impact on improving the performance of organizations in the financial industry (Coulson and Dixon, 1995; Coulson and Monks, 1999; Scholtens 2006, 2009; Wu and Shen, 2013; Shen, Wu, Chen and Fang, 2016). On the other hand, it takes at least 1-2 years before it is possible to enhance the return on assets for companies in other industries (Jo, Kim, and Park, 2015).

Second, financial institutions not only provide finance, but they are also involved in business strategy decisions and project design and implementation (Jappelli and Pagano, 2002; Denis, 2004; Scholtens, 2006). For instance, signatories to the *Equator Principles* are required to appraise a borrower's environmental risks and their compliance with national laws and international environmental provisions. Borrowers are also required to provide an appropriate environmental management and implementation plan, and to monitor and communicate evidence of compliance with the *Equator Principles* throughout the duration of projects.

Nevertheless, despite global initiatives and the theoretical support for the importance of financial institutions' roles in facilitating the transition to a lower-carbon economy, financial institutions have not been conducting a decisive and rapid shift away from coal and fossil fuel financing (Banktrack, 2019, 2020). For example, there has been a 42% increase in coal-fired plants financing by 'big four' UK banks during the period 2017-2019 as compared with the three-year period prior to the ratification of TPA. The contracts needed to support coal power expansion beyond the banks' current policy limits were reached via general corporate lending and underwriting. Assessing 35 banks across North America, Europe, Japan, and China, Banktrack (2020) indicates that major global banks' fossil financing has increased each year since TPA came into effect, and JP Morgan Chase has been the No.1 banker of fossil fuels in four consecutive years. Moreover, significant gaps exist with regard to banks' self-promoting roles relating to disclosures using the TCFD framework.

Taken overall, it has been advocated that financial institutions take an active and high-profile role in driving the transition to a lower carbon economy. However, the current momentum is trending towards a reduction in investment in carbon intensive projects and the hoped-for role of financial institutions seems to be falling in line with the advocated goal of carbon emissions reduction.

2.2 Theoretical Framework

To comprehend the variations in reporting schemes and credibility enhancement mechanisms at the country level and their impact on climate change mitigation, I delved into the literature in diverse fields in order to construct a theoretical framework that illustrates and examines the issues that are the focus of this thesis. Carbon-related reporting schemes fall under the theoretical umbrella of regulation. Regulation is defined as “sustained and focused control exercised by a public agency over activities that are valued by a community” (Selznick, 1985; Ogus, 2004). Regulation is often perceived as a specific set of commands with a deliberate state, and all forms of social and economic influences related to it (Breyer, 1982; Baldwin, Cave, and Lodge, 2012). However, in a broader sense, the influence of regulation revolves around behaviour restrictions and the prevention of certain undesirable activities (Baldwin et al., 2012). Over the past decade, regulatory debate has rapidly shifted from the motives and rationales for regulation to policy and administrative issues relating to standard-setting and enforcement. This global phenomenon was prompted by the activities of international organizations and facilitated by the financial crisis of 2007-09, when deregulation succumbed to the demands for more rigorous regulation of the financial markets.

Public interest theory provides the foundation for explaining the development of regulation. Its emphasis is on the trustworthiness and it implies a benevolent view of political processes. The public interest approach assumes a world of few transaction costs and institutional biases and the possibility of unproblematic enforcement and compliance. Also, these assumptions are unsurprisingly prone to several problems which include: (a) the need to identify an agreed conception of the public interest; (b) doubts surrounding the existence, and level of, disinterestedness on the part of the people and organizations involved; (c) the extent of the expertise and efficiency attributed to the regulators; (d) understatement as to the degree to which economic and political power influences regulation; and (e) the extent of the failure to deliver public interest outcomes (Stigler, 1971; Francis, 1993; Baldwin et al., 2012). Nevertheless, public interest theory maintains a normative approach in that it considers "what reasonable human goals a program might sensibly have, regardless of its historical origins. It assumes that regulators seek in good faith to attain such goals, regardless of the existence of other possible motives in fact" (Breyer, 1982).

In considering the components of a good regulation, there are five criteria in terms of a legislative mandate that need to be assessed, including, accountability, due process, expertise, and efficiency (Baldwin et al., 2012). In a related vein, GAL research reinforces and extends the tenet stemming from the criterion of a good regulation to better enable a beneficial impact of a regulation. Further, while there are external factors, such as a global financial crisis and the ratification of international agreements, that shape the evolution of a regulatory framework, endogenous factors such as institutional forces are critical in driving regulatory development.

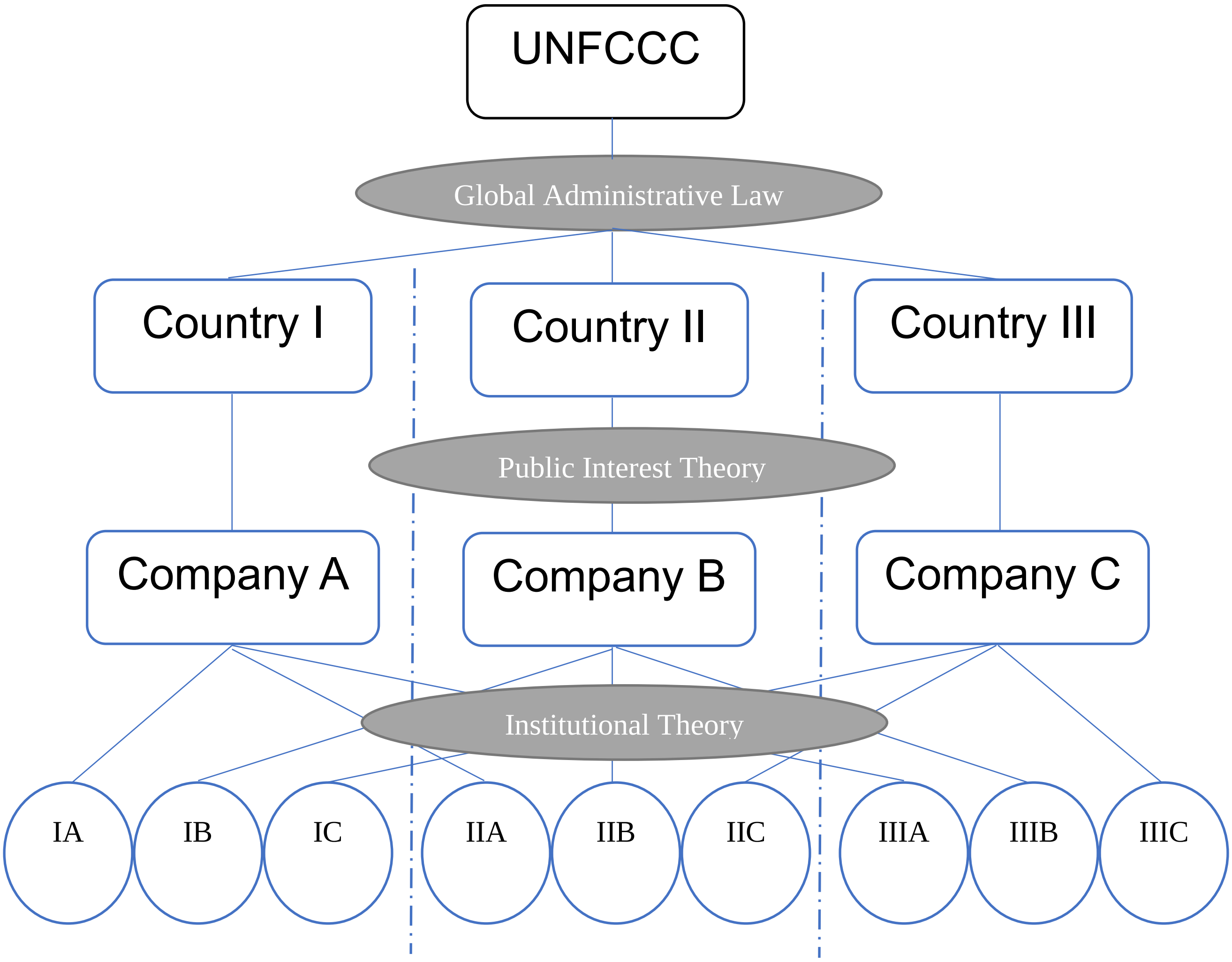
Figure 2.1 illustrates how the theoretical framework fits in the context of this thesis in understanding the role of accounting and assurance at the country and company levels. At the global level, the UNFCCC is responsible for collecting, monitoring, and verifying the reported carbon information from member countries. This is consistent with the tenet of the GAL that reporting and credibility enhancement mechanisms are tools that validate the legitimacy of a transnational institution. At the country level, countries build national carbon reporting systems and devise reporting schemes that align with the foundation of disclosure regulation[42]: public interest theory. These reporting schemes entail collecting and aggregating carbon information from companies residing within national

[42] Disclosure regulation is deemed one of the normative outputs from applying public interest theory (Baldwin et al., 2012).

boundaries and there are systematic variations across countries, as outlined in the institutional theory.

In Section 2.2.1, I exploit the theoretical foundation supporting regulation, that is, public interest theory. In Section 2.2.2, I further explore the GAL[43] to depict and understand the governance of such transnational institutions as the UNFCCC. I extend the theoretical framework in Section 2.2.3 and apply institutional theory to explain the institutional differences across countries in the context of climate change mitigation.

FIGURE 2-1 Theoretical Framework



[43] GAL refers to structures, procedures and normative standards for regulatory decision-making including transparency, participation, and review, and the rule-governed mechanisms for implementing these standards (Kingsbury et al., 2005).

2.2.1 Public Interest Theory

In capital markets, firms face economic and regulatory issues and interact with heterogeneous investors, thus shaping the corporate information environment. Studies focused on firm-specific benefits and costs of disclosure often advocate market-based incentives for voluntary disclosure (Grossman and Hart, 1980; Grossman 1981; Milgrom, 1981). Firms benefit from voluntary disclosure in triggering a first-order effect aimed at improving managers' investment decisions and their efficiency in making corporate resource allocation decisions (Shleifer and Wolfenzon, 2002; Lambert, Leuz, and Verrecchia, 2007). This is in addition to alleviating an agency problem entailed in mitigating adverse selection problems and increasing market liquidity (Verrecchia, 2001). Firms also bear the direct costs of establishing, preparing, and monitoring corporate reporting systems and any indirect costs of revealing proprietary information to competitors in the market (Verrecchia, 1983; Hayes and Lundholm, 1996) and threatening private financing relationships with clients and other financial institutions (Leuz and Oberholzer-Gee, 2006). In the event of market failures, competition and private ordering alone could largely address the problems. In the case of negative externalities, firm disclosures may reduce price efficiency in low transparency markets (Fishman and Hagerty, 1990) and distort the efficiency associated with risk sharing (Diamond and Verrecchia, 1991). And any firm's misrepresentations may have spillover effects to other participants in the market. Hence, negative externalities can cause the social value of firm disclosures to be less than the private value of disclosures (Leuz and Wysocki, 2008). In sum, proponents of voluntary disclosure believe that in the absence of regulation, the optimal level of disclosure is firm specific and could be achieved under competing market forces.

On the other hand, public interest theory is a fundamental theory in favor of disclosure regulation. The theory of public interest serves as the cornerstone of regulation growth in the twentieth century based on two major assumptions; (a) markets often fail and (b) governments are benevolent and competent in correcting the problems through regulation (Breyer, 1982; Shleifer, 2005; Pigou, 2013). Disclosure regulations covering GHG emissions reporting may be justified as a means of overcoming information asymmetry. First, firm disclosure generates positive effects in the form of information transfer and spillover (Dye, 1990; Admati and Pfleiderer, 2000; Jorgensen and Kirschenheiter, 2007) and it eliminates duplicated information search efforts, thereby reducing information costs in the capital markets (Coffee, 1984; Easterbrook and Fischel, 1984; Diamond, 1985) and making social values greater than the private values of disclosures. Second, regulation provides a low-cost standardized solution for all firms which are willing to disclose voluntarily and subsequently it produces economy-wide cost savings (Mahoney, 1995; Rock, 2002). Third, commitment to obtaining an optimal level of transparency might be too costly a burden to be borne by a firm or by private contracting parties. Regulations are associated with public enforcement and also with penalties that motivate credible reporting (Leuz, 2010).

In line with public interest theory, the goal of regulatory disclosure is to contribute to information efficiency and thereby enhance the accuracy and reliability of the available information. Regulatory disclosure does not only mitigate the specific agency problems that arise from information asymmetry regarding GHG emissions (Mahoney, 1995), but it also creates system-wide benefits in the form of reducing the effort and cost required to collect emissions information (Coffee, 1984; Easterbrook and Fischel, 1984; Mahoney, 1995). Furthermore, in the case of undersupply of information about positive externalities such as climate change mitigation, regulatory disclosures may be a relevant approach to provide the information necessary to manage its supply in order to maintain it at a more desirable level (Breyer, 1982; Djankov, La Porta, Lopez-de-Silanes, and Shleifer, 2002).

2.2.2 Global Administrative Law

Transnational regulations and administrative processes have been established using international treaties and intergovernmental arrangements to address the issue of globalized interconnectedness in such fields as international trade, security, banking regulation, and environmental protection, where the effectiveness of individual national regulatory and administrative systems are in question (Kingsbury et al., 2005).

Climate change mitigation is classified by Barrett (2007) as the aggregate effort[44] relating to global public goods[45] which are "non-excludable" and "non-rivalrous" and transnational in scope, and which are often under-supplied due to the challenge of collective action[46] and free riding[47] (Shaffer, 2012). To explain the under-supply of climate change mitigation under the conceptual umbrella of global governance, Shaffer (2012) introduced three frameworks building on analytical

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[44] Barrett (2007) classifies global public good into three categories: single best-efforts goods, weakest links goods, and aggregate efforts goods.
[45] Defined by the Nautilus Institute as "goods with benefits that extend to all countries, people, and generations". The underlying concept is formed by a social construction where "goods exist not in their original forms, but as social constructs largely determined by policies and other collective human actions". Thus, public goods are de facto "public in consumption" (Kaul et al., 2003).
[46] Positive externalities exist as the investor does not fully capture the benefits.
[47] Based on mutual interests and common understanding.

international law, namely, the global constitutional approach[48], the legal pluralist approach[49] and GAL.

While concern has been raised over a lack of accountability checks with centralized institutions under the global constitutional approach and discrepancies in nation states' capacities to effectively engage with policies under the global legal pluralist approach, the GAL approach, which draws from national administrative law to provide alternative accountability mechanisms, provides checks and balances in terms of centralized decision-making (Kingsbury et al., 2005; Stewart, 2005). GAL's functions and arrangements are shaped by the decision-making and rulemaking principles of administrative law (Krisch and Kingsbury, 2006) and it is therefore defined as "comprising the mechanisms, principles, practices, and supporting social understandings that promote or otherwise affect the accountability of global administrative bodies, in particular by ensuring they meet adequate standards of transparency, participation, reasoned decision, and legality, and by providing effective review of the rules and decisions they make." (Kingsbury et al., 2005).

Application of GAL transcends jurisdictional power boundaries, thereby creating interlocking governance mechanisms and generating contests regarding determinations of who GAL can effectively govern. While GAL may aim at directly governing the international community of nation states or surpassing nation states to directly govern individuals in the global community, it is firmly believed that the power of decision-making lies with the nation states and may prevail to limit negative

[48] Involves centralized institutions which align interests across countries and mitigate free-riding problems.
[49] Embraces "divergences in community values, priorities, and perspectives" and focuses on decentralized procedures.

externalities and protect sovereignty when dealing with environmental issues (Krisch, 2006).

GAL provides a toolbox for such transnational institutions as the UNFCCC to safeguard policy implementation and monitor progress towards goal achievement. Transnational policymaking and administrative processes can be used to overcome the undersupply of a global public good such as climate change mitigation (Kingsbury et al., 2005). GAL's functions and arrangements are shaped by the decision-making and rulemaking principles of the administrative law (Krisch and Kingsbury, 2006) and are thus defined as "comprising the mechanisms, principles, practices, and supporting social understandings that promote or otherwise affect the accountability of global administrative bodies, in particular by ensuring they meet adequate standards of transparency, participation, reasoned decision, and legality, and by providing effective review of the rules and decisions they make" (Kingsbury et al., 2005). As such, a GAL approach offers alternative accountability mechanisms and checks and balances in terms of centralized decision-making which, in turn is seen as required for climate change mitigation (Kingsbury et al., 2005; Stewart, 2005).

Esty (2006) contends that standardized metrics and measurements are some of "the best available tools for keeping transactions costs low, minimizing the administrative burden on the regulated community and promoting rulemaking efficiency." The publication of standardized metrics covering governmental performance in terms of climate change mitigation not only enables performance benchmarking, but it also permits governance output tracking (Esty and Porter, 2005). Comparative and consistent data collection and evaluation structures provide empirical evidence with which to gauge global administrative bodies' policymaking’s effectiveness and thus improve the function of decision-making with respect to climate change mitigation.

Further, GAL literature advocates the use of monitoring and credibility enhancement mechanisms to build up reporting parties’ accountability towards the UNFCCC. Regularly scheduled reviews of the emissions reporting outcomes by independent third parties help to ensure the effectiveness of policy implementation (Esty, 2006). In the long-term, monitoring and credibility enhancement mechanisms can aid the credibility of UNFCCC’s decision-making, and safeguard UNFCCC’s prominent role in addressing and tackling climate change.

2.2.3 Institutional Theory

Institutions are “rules, norms, and beliefs that describe reality for the organization” and are constituents of the “organisational field” in which social influence are “shaped, mediated and channelled”, external to an organization (DiMaggio and Powell, 1991; Scott, 1995; Hoffman, 1999). Among the three “pillars [50] ” framework introduced by Scott (1995, 2013) that underpin neoinstitutional theory, the regulatory aspect specifies the formulation and enforcement of policies and regulations. The organisational field could be identified through industry sector or centred by special issues or events (Hoffman, 1999). Companies situated in the same fields tend to have similar corporate arrangements or practices because of regulatory compliance, mimicking, and professional standardization (DiMaggio and Power, 1991).

[50] The other two pillars: the normative aspect depicts standardized social obligations that are established through education or professionalism and their conformance, and the cultural-cognitive aspect implies that they are taken-for-granted beliefs that are cultivated or shaped by cultural backgrounds (Scott, 1995, 2013).

Institutional theory has been extensively applied in the management literature and helps build a rich theoretical framework for analysing issues surrounding MNCs (Dacin, Goodstein, and Scott, 2002; Djelic and Quack, 2003). These research employs neoinstitutional theory and holds that institutional arrangements are mostly country specific and determine national institutional systems based on three pillars as institutional pressure (e.g., Kostova, 1997, 1999; Busenitz, Gomez, and Spencer, 2000). National institutional environments grant legitimacy through organizations' compliance with institutional requirements, as legitimacy is essential for organizational survival (Kostova and Zaheer, 1999). However, application of neoinstitutional theory to MNCs is subject to challenges arising from identifying the organizational field, and shaping organizational structure and practices under multiple institutional pressures which are beyond single country-specific institutional systems, and competing legitimacy quests for MNCs' subunits (Kostova, Roth, and Dacin, 2008). MNCs operate across countries and industries from their own organizational field and intraorganizational field which becomes the institutional environment for their subunits. To a certain extent, MNCs enjoy "institutional freedom[51]" and discretion to choose practices and models they deem most appropriate, as their organizational field has been blurred and institutional landscapes have been broadened. MNCs need to maintain legitimacy in their own right and for their subunits. Subunits of MNCs must establish and maintain legitimacy externally in the host country and internally within the MNCs. The tension between the external and internal legitimacy lies in the institutional

[51] While MNCs must comply with country-specific regulatory institutional rules, the enforcement of normative and cultural-cognitive institutional forces is limited.

distance[52] between the home country in which the parent company operates and the subunits' host country. (Kostova and Zaheer, 1999).

Specifically, subunits of MNCs face "institutional duality" (Kostova and Roth, 2002). MNCs' policies and practices are formulated in their home country's institutional environment. Upon adoption, subunits are therefore influenced by institutional pressures coming from the home country, indirectly through the parent company. Consequently, how subunits perceive and interpret any policy or practice is conditional upon their relations with the parent company (Rosenzweig and Singh, 1991; Tsai and Ghoshal, 1998). This indirect institutional force channeled from the parent company, together with the direct institutional force of the host country, simultaneously compete in shaping the practices respectively of each MNC's subunit across countries.

"Ecosystems support economies, not vice versa" (Daly and Cobb, 1994). When adopting an ecological viewpoint, the earth encompasses both the social and ecological systems. To attain sustainability, resource extractions from the ecological system which, in turn, are used to support the economy, are a subset of the social system. The ecological system does not exceed its carrying capacity and waste/pollution (that is generated from the economic system) which is transferred from the economic to the ecological system does not exceed its assimilative capacity (Daly and Cobb, 1994). The ecological system is global in scale and represents the totality of 'fields'. Whether it is a top-down system, or a participatory bottom-up approach adopted for the environmental legislative framework, a proliferation of tightly regulated standards implies the use of the same means of negotiating

[52] The institutional distance is determined by the similarity or difference in the institutional environments between the home country and the host country.

environmental outcomes (Scott, Scott, and Meyer, 1994; Jennings and Zandbergen, 1995). As such, organizational fields defined in the social system “grow and become linked at the local, regional and global levels”, and they are increasingly mapped towards the interlocking suprafield of the ecological system. A stronger enforcement power of the social system results in better compliance with environmental legislation by organizations (Zucker, 1987; DiMaggio and Powell, 1991; Scott et al., 1994).

When faced a strategic challenge to address GHG emissions reduction, (Porter and Reinhardt, 2007; Hoffman and Woody, 2008), corporations have increasingly shifted away from early resistance against regulatory measures towards more constructive engagement with environmental policies and there has been an increased emphasis on business opportunities (Jones and Levy, 2007). By comparing target achievements under the Kyoto Protocol between Germany and Canada, Eberlein and Matten (2009) point out that the presence, as well as the absence, of regulatory requirements shape the degree to which companies can engage in proactive strategies, such as through participation in emissions trading schemes. To a certain extent, a stringent regulatory framework enables business to exercise strategic adaptations. Meanwhile, business involvement, in turn, is an essential factor in regulatory framework performance..

Assessing environmental standardization in MNCs, while it is speculated that MNCs may take advantage to strategically locate operations generating more pollutants in countries with less stringent environmental regulations (Cole and Elliott 2005), others argue that MNCs find it more competitive to develop a standardized organizational policy using the stronger parent company’s regulations to gain reputation through transparency (Christmann, 2004; Christmann and Taylor,

2006) and achieve legitimacy for themselves and subunits worldwide (Kostova et al., 2008). However, the extent to which practices are standardized depends on the institutional distances (Xu and Shenkar, 2002; Aguilera-Caracuel et al., 2012, 2013).

2.3 Summary and Conclusion

This chapter first introduces the background to the issue of climate change mitigation. It outlines the evolution of a global effort to combat climate change and highlights the role of the UNFCCC in consolidating and facilitating this effort. It also informs the role of the UNFCCC in accounting and credibility enhancement mechanisms relating to national GHG data. The chapter further describes the current carbon reporting and credibility enhancement regimes around the globe by summarizing the reporting instruments contained therein, and the growth trends across continental regions. It emphasizes the role of financial institutions and presents the development of finance initiatives that are targeted at monitoring and restricting carbon related investment.

This chapter presents the theoretical framework that informs the theoretical development of this thesis and its research questions. There is no prior accounting literature that has examined accounting and credibility enhancement mechanisms at the country level. Consequently, the framework developed can be traced back to the fundamental theories supporting regulations, and it enables the study of the role of transnational institutions in operation. Furthermore, institutional theory extends the framework to understanding the differences among reporting and credibility enhancement schemes and the impact across counties. While activities initiated and conducted by transnational institutions exert exogenous forces, an institutional background implies endogenous forces in the shaping of the current reporting regimes and in determining their impact.

CHAPTER 3 LITERATURE REVIEW

The purpose of this chapter is to validate the role of accounting and credibility enhancement mechanisms in dealing with the issue of climate change mitigation, at both the country and company levels, as described in the extant research literature. Carbon emissions research at the country and company levels occupy divergent research fields and inform distinctive audience groups. In this chapter I review, compare, contrast, and synthesize these different streams of literature to inform the research questions addressed in this thesis, and to provide a context for where my research questions are situated in the literature. To do so, I review the findings of two parallel empirical research fields: macroeconomic studies that inform the determinants of carbon emissions growth at the country level, and studies that examine the association between carbon disclosure, regulatory schemes, and carbon emissions at the company level. I also review the findings from the research fields that examine the motivation and outcomes of undertaking carbon assurance engagements and other credibility enhancement mechanisms, and the impact of components of carbon risks. However, while my review is comprehensive, it is not encyclopaedic, but rather it is more selective with the purpose of identifying the major themes and empirical evidence within the divergent research fields and how they are related to my specific research questions.

In recent times, there has been a strong focus on the issue of decarbonisation in the economy to break the nexus between economic growth and carbon emissions. In general, my review reveals that carbon emissions research at the country level suggests that emissions reduction cannot simply rely on breaking this nexus. While developed countries are found to have benefited from technological advancement and stringent environmental regulations and policies that result in a decline in energy intensity and emissions reduction, developing countries are found to be still shifting to more carbon intensive industries domestically that result in an increase in carbon emissions. Energy and environmental policies are important in the process of globalized production to encourage energy innovation. The role of accounting and credibility enhancement mechanisms for enforcing the accountability of countries' commitments has not explicitly been examined in the extant literature. In the context of environmental policy, normative approaches advocate that metrics and measurement promote regulatory efficiency, and monitoring and credibility enhancement mechanisms serve to build accountability. Accounting and credibility enhancement mechanisms therefore form an essential part of the efforts to reduce carbon emissions growth. However, there remains a lack of empirical evidence at the country level.

In contrast, in terms of carbon emissions at the company level the role of accounting and credibility enhancement mechanisms, in particular independent assurance engagements, has been more frequently examined. This field of literature finds that regulatory schemes significantly motivate carbon disclosures. And for companies that do disclose their carbon emissions, there is a negative relationship between emissions levels and companies' financial performance (when measured in terms of companies' valuations) (e.g., Matsumura et al., 2014; Clarkson, Li, Pinnuck, and Richardson, 2015; Griffin et al., 2017). However, the extent of impact of emissions levels on companies' financial performance varies across countries. There is empirical evidence showing that carbon assurance has a positive impact on mitigating information asymmetry through increased levels of emissions disclosures (e.g., Braam, de Weerd, Hauck, and Huijbregts, 2016). It has also been found that the benefits of carbon assurance extend to improved internal management through strategic planning, risk management, and internal control decisions (e.g., Power 1997; Casey and Grenier 2015; Steinmeier and Stich 2019). Yet, there is little empirical evidence regarding the effects of carbon disclosure and assurance on carbon emissions growth.

There has also been an increased focus on the role of lending policies put in place by financial institutions in driving companies' sustainable practices. While financial institutions have generally incorporated carbon risk assessment into their client profile evaluations, there is no evidence of a corresponding decline in lending to clients' carbon intensive projects (Banktrack, 2019).

Global efforts to combat climate change to address environmental sustainability are in the public interest. An important part of these efforts includes regulatory disclosures that supply metrics and measurement, and the accompanying monitoring and assurance mechanisms of these disclosures. Without truthful reporting it is difficult to hold countries and companies accountable for their actions. Without truthful reporting it also becomes difficult to assess the progress of global efforts to combat climate change. Nevertheless, research gaps have been identified at both the country and company levels in terms of the impact of accounting and credibility enhancement mechanisms on carbon emissions growth. The research questions in this thesis intend to fill the gap through providing a better understanding of the role of, and an empirical analysis of the benefits of, accounting and credibility enhancement mechanisms, including independent assurance engagements.

The remainder of this chapter is organised as follows. Section 3.1 reviews macroeconomic studies that inform the determinants of carbon emissions growth at the country level. Section 3.2 reviews studies that inform the development of carbon disclosure, carbon regulation, and the determinants of carbon emissions growth at the company level. Section 3.3 investigates the motivation discussed in the literature relating to engaging credibility enhancement mechanisms, including assurance engagements, and its association with carbon emissions growth. Section 3.4 discusses the definition and components of carbon risks, and section 3.5 summarizes and evaluates proxies for carbon risks and its association with the cost of debt financing.

3.1 Carbon Emissions Growth Research at the Country Level

Carbon emissions growth research at the country level has a long history. I commence my review by outlining the development of carbon emissions growth research at the country level in Section 3.1.1. Then I examine the literature specifically relevant to the determinants of carbon emissions growth at the country level in Section 3.1.2.

3.1.1 Development of Carbon Emissions Research at the Country Level

The extant literature covering country level carbon emissions growth primarily stems from macroeconomic studies investigating the nexus between environmental quality and economic growth. Economic growth and environmental quality have traditionally been viewed as conflicting goals. This traditional view is challenged by the Environmental Kuznets Curve (EKC) hypothesis, which projects an inverse-U-shaped relationship between a country's per capita income and its level of environmental quality. Pollution increases with an increased income in the early stages of development but decreases after a certain level of development has been reached (Grossman and Krueger, 1991, 1993). The EKC hypothesis is based on the rationale that, *"At higher levels of development, structural change towards information-intensive industries and services, coupled with increased environmental awareness, enforcement of environmental regulations, better technology and higher environmental expenditures, result in levelling off and gradual decline of environmental degradation (Panayotou, 1993, p.1)."*

Following the seminal work of Grossman and Krueger (1991, 1993) on the EKC hypothesis, several studies have empirically tested the validity of the EKC hypothesis and the causal links between country carbon emissions and income. These studies present mixed findings as to the validity of the EKC hypothesis. Some studies find that the relationship holds and there is a turning point in carbon emissions at a certain income levels (e.g., Apergis and Payne, 2009; Pao and Tsai, 2010; Hossain, 2011; Arouri, Youssef, M'henni, and Rault, 2012; He and Yao, 2017; Churchill, Inekwe, Ivanovski, and Smyth, 2018; Sarkodie and Strezov, 2018; Shahbaz, Zakaria, Shahzad, and Mahalik, 2018; Danish and Ulucak, 2020; Baloch, Ozturk, Bekun, and Khan, 2021). However, some studies find more than one turning point of carbon emissions at different income levels (e.g., Lorente and Álvarez-Herranz, 2016; Churchill et al., 2018), while other studies find only a monotonic relationship without a turning point (e.g., Richmond and Kaufmann, 2006; Hossain, 2011; Sharma, 2011; Arouri et al., 2012; Farhani and Ozturk, 2015; Zhu, Duan, Guo, and Yu, 2016; He and Yao, 2017; Churchill et al., 2018; Sarkodie and Strezov, 2018). The different results between the studies can be partly explained by differences in methodology. It appears that the methodology is both sensitive to the sample used (changes in the time period and the set of countries included) and omitted variable bias (e.g., Agras and Chapman, 1999; Coondoo and Dinda, 2002; Dinda and Coondoo, 2006; Akbostancı, Türüt-Aşık, and Tunç, 2009).

A related stream of research investigates the nexus between energy consumption and economic growth. These studies generally find that energy consumption is a key determinant of carbon emissions growth (e.g., Kraft and Kraft, 1978; Bentzen and Engsted, 1993; Altinay and Karagol, 2004; Soytas and Sari, 2006; Apergis and Payne, 2009).

From the two streams of studies discussed above, it is clear that economic growth and energy consumption have become two well established factors contributing to carbon emissions growth, and that the exact nature of the relationships is somewhat indetermined. When economic growth, energy consumption, and carbon emissions growth are examined simultaneously under a single modelling framework, it is found that the relationship between economic growth and energy consumption is complementary. While both are important determinants of carbon emissions growth, energy consumption demonstrates a stronger long-run impact than economic growth (e.g., Ang, 2007; Soytas, Sari, and Ewing, 2007; Apergis and Payne, 2009; Pao and Tsai, 2010).

In line with the explanation of the EKC hypothesis, a further stream of literature examines the impact of globalisation in terms of trade openness on carbon emissions growth. Trade openness is viewed as a critical factor that could impact environmental quality through scales[53], composition[54], and technique[55] effects (Antweiler, Copeland, and Taylor, 2001; Copeland and Taylor, 2004). The scale effect predicts that trade openness causes an expansion of economic activity which leads to an increased total amount of pollution generated. The technique effect

[53] The scale effect refers to the expansion of production and its consequent increase in emissions.
[54] The composition effect refers to output mix changes over the course of economic development.
[55] The technique effect captures the improvements in the state of technology that affect emissions through production and process efficiency.

contends that trade openness enhances productivity, which may lead to a fall in pollution per unit of output. The composition effect gives rise to contrasting arguments: on the one hand, trade damages the environment in poor countries due to exploitation of differences in environmental regulations (the pollution haven hypothesis); on the other hand, trade may increase the demand for a cleaner environment and a reduced share of emissions intensive industries as national income rises (factor endowment hypothesis). Consistent with the contrasting hypotheses, some studies find a positive influence while others find a negative effect of trade openness on carbon emissions growth (e.g., Hossain, 2011; Sharma, 2011; Zhu et al., 2016; Churchill et al., 2018). The studies do demonstrate that attention should be focused on identifying and controlling for developing countries where economic growth relies largely on the scale effect and still lacks stringent environmental policies to regulate carbon emissions growth (Farhani and Ozturk, 2015; He and Yao, 2017).

Meanwhile, a stream of studies assessing the impact of demographic factors on carbon emissions find that urbanization is an influencing factor in that it alters the pattern of direct energy consumption in transportation and indirectly impacts energy consumption in the production of goods (e.g., Parikh and Shukla, 1995; York, Rosa, and Dietz, 2003; Cole and Neumayer, 2004; Liddle and Lung, 2010). While urbanization increases with economic growth, it exhibits a positive impact on carbon emissions growth in the short-term, and a negative effect in the long-term (e.g., Hossain, 2011; Sharma, 2011; Sarkodie and Strezov, 2018). Thus, such demographic factors as urbanization appear to be key control variables in the modelling framework of carbon emissions growth that might mitigate some of the concerns over omitted variable bias (e.g., Fan, Liu, Wu, and Wei, 2006; Dhakal, 2009; Sharma, 2011; Sadorsky, 2014).

In sum, the development of carbon emissions research at the country level has been centred around streams of literature that examine the nexus between economic growth, energy consumption, and carbon emissions growth, with extensions of this literature being found to further account for globalization and demographic factors. In the next Section, I discuss the empirical findings relating to the determinants of carbon emissions growth at the country level in the context of the above streams of the research literature.

3.1.2 Determinants of Carbon Emissions at the Country Level

Research examining the determinants of country level carbon emissions study either a single country (e.g., Ang, 2007; Soytas et al., 2007; Soytas and Sari, 2009; Halicioglu, 2009) or a group of countries. In the context of this thesis, where different groups of countries are exposed to different accounting and credibility enhancement mechanisms prescribed under the UNFCCC[56], I mainly focus on studies that describe the determinants of carbon emissions growth using a region or a group of countries as the sample of interest. I provide a summary of the studies reviewed towards the end of this Section in Table 3-1.

Consistent with the discussion in the previous section, the studies in general find a positive and significant impact of economic growth on carbon emissions growth, but present mixed findings regarding the validity of the EKC hypothesis. That is, whether the curve is an inverted-U shape or otherwise (i.e., monotonic, or N-shape).

[56] Details were explained previously in Chapter Two, page 22-25.

Using a panel of countries, the EKC hypothesis is generally found to hold in developed countries. For example, Richmond and Kaufmann (2006) find support for the EKC hypothesis using a panel of 20[57] Organisation for Economic Co-operation and Development (OECD) developed countries. Danish and Ulucak (2020) and Baloch et al. (2021) further examine 18 (Asia-Pacific Economic Cooperation) APEC and 27 OECD countries for the more recent time period of 1990-2017 and find an inverted U-shaped EKC curve, which reinforces the relevance of the EKC hypothesis in developed countries. The developed countries have a relatively greater capability to shift away from carbon-intensive industries, as well as more stringent environmental regulations and policies, and a higher awareness of environmental sustainability issues and better institutional quality. Consequently, the developed countries benefit from economic growth through globalization, financial development, and technology advancement. This results in a decline in carbon emissions growth and environmental degradation (Sarkodie and Strezov, 2018; Danish and Ulucak, 2020; Baloch et al., 2021).

Nevertheless, empirical results are mixed when countries are tested individually. Churchill et al. (2018) test 20 OECD countries for the period of 1870-2014 and find no evidence of the EKC hypothesis in 11 OECD countries, but an inverted U-shaped curve in Finland, France, Spain, U.K. and U.S., and an inverted N shaped curve in Denmark, and a N-shaped curve in Australia, Canada, and Japan. The N-shaped curve means that there exists a second turning point where emissions growth starts to pick up again at a certain income level. Meanwhile, Sarkodie and Strezov (2018) demonstrate an inverted N-shaped relationship between economic

[57] Countries include Australia, Austria, Belgium, Canada, Finland, France, Greece, Hungary, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, U.K., and U.S.

growth and carbon emissions growth for the U.S. and an inverted U shape for Australia.

The existence of a second turning point in carbon emissions growth suggests that economic growth does not correspond with a sustained carbon emissions reduction in the long-term. Without proper environmental regulations and energy policies that enhance energy innovation and counter technique obsolescence, increases in income level can be further associated with environmental degradation (Lorente and Álvarez-Herranz, 2016).

In the developing countries, distinctive results are generated regarding the validity of the EKC hypothesis. Richmond and Kaufmann (2006) find no support of the EKC curve for a panel of 16[58] developing (non-OECD) countries. In contrast, Apergis and Payne (2009) examine six central American countries[59] using data from 1971- 2004, and Pao and Tsai (2010) use data for the BRIC[60] countries for a similar time period (1971-2005), and both provide empirical evidence that supports the EKC hypothesis in developing countries. These mixed results can be at least partly explained by the evidence resulting from varied findings at the individual country level. For instance, Hossain (2011) assesses 9 newly industrialized countries for the period 1971-2007 and finds a significant negative long-term effect of economic growth only in South Africa and Turkey, but a positive impact in China, Philippines, Thailand, Brazil, and Malaysia. Arouri et al. (2012) find support for the EKC hypothesis for a panel of 12 Middle East and North African (MENA) countries from

[58] Countries include Argentina, Bangladesh, Brazil, Chile, China, Columbia, Egypt, India, Indonesia, Malaysia, Mexico, Nigeria, Pakistan, Peru, Thailand, and Turkey.
[59] Countries include Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama.
[60] Countries include Brazil, Russian Federation, India, and China.

1981 to 2005 and in a single country Jordan, but not for the remainder of the MENA countries when tested individually.

In the least developed countries, in which a fully-fledged industrial economy has not been attained, evidence of a monotonic relationship is more likely. Neither Farhani and Ozturk (2015) nor Sarkodie and Strezov (2018) find support for the EKC hypothesis in Tunisia and Ghana for a similar period (1971- 2013). While Tunisia is seen as maintaining economic growth through attracting foreign investment that leads to an increase in carbon emissions, Ghana is seen as still largely relying on agriculture and land-use which are classified as the second contributor of carbon emissions.

In the case of fast-developing countries, such as China, a decline in carbon emissions at the current state of economic growth is expected, based on the EKC hypothesis. However, China has been ranked in the world's top carbon emitters with an emissions growth rate at 13 percent for the period of 2002-2007 (Shan et al., 2018). This could possibly be explained by weaker environmental policies and industrial regulations being put in place during this period which made China a haven for the high-energy and carbon-intensive industries of the developed countries (He and Yao, 2017; Sarkodie and Strezov, 2018).

In fact, for such fast growing and newly industrialized countries, energy consumption plays a vital role that modifies the relation between economic growth and carbon emissions growth. Pao and Tsai (2010) find that for the fast-developing BRIC countries which rely heavily on carbon-intensive industries, environmental degradation has a causal impact on economic growth, and may persistently exacerbate environmental quality that will result in reduced productivity in the long-term. The lack of a reciprocity effect from economic growth to carbon emissions in the long-term casts doubt on the validity of the EKC hypothesis, when long-term economic growth corresponds with a decrease in emissions growth.

Hossain (2011) employs a panel data of 9 newly industrialized countries[61] for the period 1971-2007 and shows that energy consumption has a significant positive impact on carbon emissions growth and that this impact is more prominent in the long-term. This implies that higher energy consumption over time due to the expansion in production of industrial output to fuel rapid economic development in the sample countries gives rise to greater carbon emissions and thus puts more pressure on the environment. It is then considered essential to apply energy conservation policies to combat long-term environmental degradation.

Using a broader range of 93 countries from 1980 to 2006, Narayan and Popp (2012) disaggregate the data into regional panels and present evidence of the marginal effects of energy consumption on economic growth across the panel data. However, the evidence varies substantially with different signs and magnitudes at the individual country level. This suggests that energy conservation polices may be country specific. For the G6[62] countries, it has been found that a reduction in energy consumption does not lead to a fall in economic growth, but rather corresponds with a decline in carbon emissions for France, U.K., and the U.S., while the effect for Canada is stagnant, and there is an increase in Italy and Japan.

In a related vein, it is claimed that the connection between local activity and global emissions has been weakened by the emergence of global production and consumption patterns (Aichele and Felbermayr, 2012; Fernández-Amador, Francois, Oberdabernig, and Tomberger, 2017). In the OECD countries, it has been found that

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[61] These countries are Brazil, China, India, Malaysia, Mexico, Philippines, South Africa, Thailand, and Turkey.
[62] This includes Canada, France, Italy, Japan, UK, and USA.

in the long-term, globalization, accompanied by financial development and energy innovation, reduces carbon emissions (Baloch et al., 2021). Nevertheless, institutional quality in terms of the regulatory environment plays a critical role that enhances the EKC hypothesis in terms of economic growth and carbon emissions growth (Danish and Ulucak, 2020). Indeed, globalization in terms of trade openness has served to apply a contrasting effect on carbon emissions growth. The sign of the association cannot be estimated *a priori* because of two conflicting arguments[63] (Copeland and Taylor, 2004). Adopting quantile regression modelling to test data from 5 ASEAN[64] countries for the period 1981-2011, Zhu et al., (2016) find trade openness has a negative influence; while both Hossain (2011) and Churchill et al., (2018), who investigate 20 OECD[65] countries for the period 1870-2014, find a positive effect of trade openness on carbon emissions. Sharma (2011) employs a global panel of 69 countries for the period 1985-2005 and find that trade openness has a positive association with carbon emissions growth for the middle-income and low-income panels, but a negative association for the high-income panel.

Developing countries with a stronger desire to develop their economies, but with weaker environmental policies and industrial legislation, are found to be at a disadvantage in terms of environmental sustainability. Farhani and Ozturk (2015) examine the role of financial development and trade openness in terms of carbon emissions in Tunisia. Their study suggests that due to the weak environmental,

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[63] The pollution haven effect suggests that the tightening of pollution regulation will influence plant location decisions and trade flows. The pollution haven hypothesis states that a reduction in trade barriers will lead to a shifting of pollution intensive industry from countries with stringent regulations to countries with weaker regulations.

[64] Association of South East Asian Nations which includes Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

[65] The list of countries includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, U.K., and U.S.

economic, and industrial policies and regulation, carbon intensive trade and industries have shifted to the developing countries and result in an emissions increase. He and Yao (2017) examine the pollution haven hypothesis and EKC hypothesis across 29 provinces in China for the period 1995-2008. Results suggest that China's fast paced economic development is associated with the transfer of 'dirty' industrial production from developed countries, resulting in an acceleration in environmental degradation.

Additionally, urbanization, which is viewed as a normal good that increases with income levels, seems to mitigate carbon emissions growth in the long-term (Hossain, 2011; Sharma, 2011; Sarkodie and Strezov, 2018). Sarkodie and Strezov (2018) indicate that urbanization has a positive impact in the short-term but a negative impact in the long-term. This implies that urban residents, who are more aware of environmental issues, are willing to pay for a cleaner environment compared to countryside residents with lower-income levels. This trade-off effectively contributes to the preservation of environmental sustainability.

In summary, prior studies examining the nexus between economic growth, energy consumption, and carbon emissions over two decades using a diverse range of data, namely, single country or region and groups of countries, provide mixed findings with regard to the EKC hypothesis. It appears that the methodology is both sensitive to the sample used, including changes in the time period and the set of countries and an omitted variable bias. While economic growth and energy consumption are robust determinants of carbon emissions growth, the EKC hypothesis is yet to be universally supported.

The weak support for the ECK hypothesis means that, in all probability, that limited reliance can be placed on economic growth as a means of reducing carbon emissions growth to adequately achieve the TPA commitments. In the context of the TPA, while there has been a unanimous effort by countries to commit to disclosure and to holding themselves to account, a research gap exists as to whether, and to what extent, accounting and credibility enhancement mechanisms relating to emissions at the country level impacts on carbon emissions. It may be that accounting and credibility enhancement mechanisms are part of the mix of environmental policies and regulations that can play a key role in preventing environmental degradation.

TABLE 3-1 Summary Table of Selected Studies Assessing the Nexus between Economic Growth, Energy Consumption and Carbon Emissions and the Determinants of Carbon Emissions Growth

Authors	**Journal**	**Sample and Period**	**Methodology**	**Variables**	**Results**
Richmond and Kaufmann (2006)	Ecological Economics	20 developed countries and 16 developing countries (1973–1997)	Panel Co-integration test	CO2, EC, GDP	Energy consumption and per capita GDP have a positive impact on carbon emissions. Results show limited support for the EKC hypothesis for the developed countries, and no support for the developing countries.
Apergis and Payne (2009)	Energy Policy	Six central American countries (1971–2004)	Panel unit root test	CO2, EC, GDPpc,	Energy consumption and income have a positive and statistically significant impact on carbon emissions in the short-term. Results support the EKC hypothesis. There is bidirectional causality between energy consumption and emissions in the long-term equilibrium.
Pao and Tsai (2010)	Energy Policy	BRIC countries (1971-2005)	Panel Co-integration test	CO2, EC, GDPpc,	Energy consumption has a significant and short-term impact on carbon emissions. Results show a long-term equilibrium relationship between carbon emissions, energy consumption, and income, and support the EKC hypothesis.
Hossain (2011)	Energy Policy	9 Newly industrialised countries (1971-2007)	Panel unit root and co-integration test	CO2, EC, GDPpc, TO, UR	Trade openness, income have a positive effect, urbanization has a negative effect on carbon emissions in the short-term. Impact of energy consumption on carbon emissions is more significant in the long-term.

Authors	Journal	Sample and Period	Methodology	Variables	Results
					Panel results support the EKC hypothesis, but individual country analyses present mixed findings.
Sharma (2011)	Applied Energy	69 countries (1985-2005)	Multivariate dynamic panel data model (GMM)	CO_2, EC, GDPpc, TO, UR	Trade openness, income and energy consumption have positive effects, while urbanization has a negative effect on carbon emissions in the income panels. Energy consumption and income are significant determinants of carbon emissions for the global panel. Results do not support the EKC hypothesis.
Narayan and Popp (2012)	Economic Modelling	93 countries (1980- 2006)	Panel unit root, cointegration, and long-term Granger causality tests	CO_2, EC, GDP	Energy consumption in the long-term negatively causes real GDP for the G6 countries (except for Germany), meaning that for increases in energy consumption, real GDP falls. The trend of carbon emissions is observed in decline for the U.S., France, and the U.K. and stagnant for Canada, but as increasing for Japan and Italy with the implementation of energy conservation policies.
Arouri et al. (2012)	Energy Policy	12 Middle East and North Africa (MENA) countries (1981-2005)	Panel unit root and co-integration test	CO_2, EC, GDPpc,	Energy consumption has a positive and significant impact on carbon emissions. EKC hypothesis is supported at regional level but not at the country-level.
Sadorsky (2014)	Energy Economics	16 emerging countries (1971-2009)	Autoregressive distributed lag model	CO_2, EC, GDPpc, UR, POP	Energy consumption and economic growth are robust determinants of carbon emissions. Urbanization is positive but statistically insignificant for carbon emissions.

Authors	Journal	Sample and Period	Methodology	Variables	Results
Farhani and Ozturk (2015)	Environmental science and Pollution Research	Tunisia (1971-2012)	Unit root test, ARDL cointegration, Granger causality test	lnCO2, lnGDP, lnEC, lnFD, lnTO, lnURB	Results do not support EKC. Trade openness Granger causes emissions increase, support pollution haven hypothesis.
Lorente and Álvarez-Herranz (2016)	Environmental Science and Pollution Research	17 OECD countries (1990-2012)	Two Instrumental variables: age dependency ratio (higher ratio results in lower growth rate and GDP_{PC}), inflation index for consumer prices to address endogeneity in EKC	GHGpc, GDPpc, RENEW, RDD, RENEW* GDPpc, AGEDR, INFLATION	Evidence of N-shaped EKC curve. Without proper environmental regulations in place, there exists a second turning point in the EKC curve where an increase in income levels corresponds with environmental degradation.
Zhu et al. (2016)	Economic Modelling	5 ASEAN Countries (1981-2011)	Panel quantile regression model	CO2, EC, GDPpc, POP, FDI, TO, INDS, FD	Energy consumption has a positive while trade openness has a negative influence on carbon emissions. Results do not support the EKC hypothesis for the 5 countries as a whole, but the effect of economic growth is negative and significant in the uppermost quantile, suggesting economic growth can mitigate emissions increases in high-emissions ASEAN countries.
He and Yao (2017)	Emerging Markets	29 provinces of China (1995-2008)	Panel smooth threshold regression model	SO2, Soot, Dust, GDPpc, FDI/GDP	EKC hypothesis depends on the type of pollutant emissions. Results show that foreign direct investment corresponds with domestic “dirty”

Authors	Journal	Sample and Period	Methodology	Variables	Results
	Finance and Trade				production, thus supporting the pollution haven hypothesis.
Stern and van Dijk (2017)	Climate Change	151 countries (1990, 2000, 2010)	Beta convergence approach, nonlinear generalized method of moments	$PM_{2.5}$ exposure, GDP_{PC}, growth rate of $PM_{2.5}$, growth rate of GDP_{PC}, mean summer, winter temperature, annual precipitation, mean national elevation, population density, Legal origin, centrally planned, Malaysia, Singapore, and Indonesia, spatial lag of DV, EKC turning point	A small positive effect for economic development on the atmospheric concentrations of $PM_{2.5}$. There is a negative time effect, unrelated to income increases, and stronger in Code law countries, on $PM_{2.5}$. Pollution growth rate in other countries strongly affects pollution growth in other countries.
Churchill et al. (2018)	Energy Economics	20 OECD countries (1870-2014)	Cross-sectional dependence, panel unit root and cointegration tests, panel long run estimates	CO2, GDPpc, TR, POP, FD	Trade openness has positive influence on carbon emissions for panel data. Panel results support the EKC hypothesis. However, country specific results present mixed findings. Five countries (Finland, France, Spain, U.K., and U.S.) exhibit inverted U shaped EKC relationship, 3 countries (Australia, Canada, and Japan) have N shaped curves, 1 country (Denmark) presents an inverted N shaped curve. No EKC evidence is found for the remainder of 11 OECD countries.

Authors	Journal	Sample and Period	Methodology	Variables	Results
Sarkodie and Strezov (2018)	Journal of Cleaner Production	4 countries (1971-2013)	Pooled Mean Group Autoregressive Distributed Lag estimator model	CO2, GDPpc, EC, UB, EI, BIOC, EF, HOUC, EGIMP	Results support the EKC hypothesis in Australia and China but not in Ghana. The U.S. data demonstrates an inverted N shaped relationship. There is a paradigm shift and structural change from high energy intensive and carbon intensive industries to services and information intensive industries in Australia and the U.S. China's EKC curve has been supported by its economic development, technological advances, and environmental awareness in most of the provinces. Nevertheless, legislation must further be implemented and enforced across provinces to further reduce carbon emissions.
Shahbaz et al., (2018)	Energy Economics	France (1955-2016)	Unit root test with sharp and smooth breaks, bootstrapping ARDL counds testing approach	CO2pc, real FDIpc, real GDPpc, CONSpc, real domestic credit to the private sector per capita and R&D for energy innovations	Evidence of an inverted U shape of the EKC curve in France. Increase in foreign direct investment increases carbon emissions, supporting the pollution haven hypothesis. Presence of a reciprocity effect between foreign direct investment and carbon emissions.
Danish and Ulucak (2020)	Business Strategy and the Environment	18 APEC countries (1992-2015)	Panel unit root, LM bootstrap panel cointegration test, panel long-term estimator	LnCO2, LnY, LnY2, RE, NRE, institutional quality	Institutional improvement contributes to a reduction in carbon emissions. Unidirectional causal relationship between institutional quality and carbon emissions. Institutional quality enhances formation of an inverted U-shaped EKC curve in APEC countries.

Authors	Journal	Sample and Period	Methodology	Variables	Results
Baloch et al., (2021)	Business Strategy and the Environment	27 OECD countries (1990-2017)	Pooled mean group autoregressive distributed lag estimator	LnGHGpc, LnFD, Ln GDP, LnGDP2, index of globalization	EKC hypothesis is supported for OECD countries. Financial development, globalization, and energy innovation have significant negative effects on carbon emissions in the long-term, no evidence of significance in the short-term.

3.2 Carbon Emissions Research at the Company Level

The role of accounting and assurance in terms of carbon emissions at the company level has been frequently examined in the academic literature. In my review of the major carbon emissions research at the company level, I use a similar research framework to that suggested by Clarkson, Li, Richardson, and Vasvari (2008) and classify extant environmental research into three broad categories. In Section 3.2.1 I review studies that examine the value relevance of carbon emissions disclosure; in Section 3.2.2 I review studies that examine the relationship between environmental regulation and carbon emissions disclosure; and in Section 3.2.3 I review studies that examine the relationship between carbon disclosure and carbon emissions.

3.2.1 Value Relevance of Carbon Disclosure

In this Section, I review studies that examine the disclosure effects relating to carbon emissions levels[66] (Chapple et al., 2013; Matsumura et al., 2014; Clarkson et al., 2015; Griffin et al., 2017; Choi and Luo, 2020; Griffin et al., 2020). As the value relevance of carbon emissions disclosure is not a focus of this study, I discuss below only major studies that present empirical evidence that varies across countries and suggest implications regarding the influence of the strength of regulatory schemes.

[66] This group of studies has been progressively evolving from first examining disclosures of environmental liabilities (Barth and McNichols, 1994; Barth, McNichols, and Wilson, 1997; Cormier and Magnan, 1997; Campbell, Sefcik, and Soderstrom, 1998, 2003; Hughes, 2000). Second, environmental/CSR disclosures (Blacconiere and Patten, 1994; Konar and Cohen, 2001; Johnston, Sefcik, and Soderstrom, 2008; Stanny and Ely, 2008; Dhaliwal, Li, Tsang, and Yang, 2011; Clarkson et al., 2015; Plumlee, Brown, Hayes, and Marshall, 2015). This has led to an examination of the current disclosure effects of carbon emissions levels. The previous two streams of studies have not been detailed in this review for the purposes of this thesis.

Regulatory schemes increase the value relevance of environmental reporting[67] (Hughes, 2000; Johnston et al., 2008). In general, carbon disclosure studies find a negative association between company share prices and carbon emissions levels. However, the results vary considerably, implying that the market's perception of carbon emissions are heterogeneous across different institutional settings. For instance, Chapple et al. (2013) examine 58 Australian listed companies in the year 2007, anticipating that the ETS and estimate per tonne carbon price[68] would be between AUD$17and AUD$26. Using a sample of U.S. companies reporting to CDP over the 2006-2008 period, Matsumura et al. (2014) present evidence of a penalty applicable to firm values of US$212 per tonne. Clarkson et al. (2015) examine the EU companies that participated in the EU ETS from 2006 to 2009 and estimated that there was firm valuation penalty effect of €75 of uncovered emissions[69] per tonne. However, Griffin et al. (2017) find a comparable figure of US$79[70] as the result using the extended period of 2006-2012.

However, more recently and by using 228 Canadian listed companies in 2006-2018, Griffin et al. (2020) find a surprisingly positive effect of GHG emissions on share price. This effect is more pronounced for high carbon intensity companies, demonstrating a contrasting institutional landscape for Canada[71]. Meanwhile, in an

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[67] Hughes (2000) document that there is an increase in value relevance of nonfinancial pollution (SO_2) proxy for electric utilities that are targeted by the passage of a stringent environmental legislation. Johnston et al. (2008) extends Hughes (2000)'s study and present further evidence as to the value relevance of the SO_2 emissions allowances trading system in which emissions reporting in the U.S. is mandatory.

[68] This projected carbon price reflects a penalty effect on market capitalization between of 6.57% and 10.08 %.

[69] This represents a penalty effect on market capitalization of 3.15%. Uncovered emissions refer to carbon emissions that exceed a company's allocated carbon allowances under the EU ETS.

[70] This represents approximately one half of 1 percent of market capitalization.

[71] Another study by Richardson and Welker (2001) also documents a positive relation between social disclosures and environmental disclosures in annual reports and the cost of equity capital for a sample of Canadian companies.

international setting, Choi and Luo (2020) continue to corroborate the penalty effect of GHG emissions in terms of firm valuations. They examine 1,748 of the world's largest companies in 28 countries over the period 2008-2015 and their results reinforce that the penalty effect is more evident in countries with emissions trading schemes and stringent environmental regulations. The effect then becomes weaker with better company corporate governance and where institutional backgrounds are embedded with high uncertainty avoidance and long-term orientations. The value decreasing effect of GHG emissions is supported in the global panel of countries and can be attributed to the fact that the sample companies consist of over half (51.77 percent) in the U.S., 26.15 percent in the EU and only 3.26 percent in Canada. While Griffin et al. (2020) indicate that more stringent regulation is associated with a positive relation between GHG emissions and company values, Choi and Luo (2020) present evidence to the contrary, specifically, they show a more pronounced negative relation.

3.2.2 Environmental Regulation and Environmental Disclosure

Regulation plays a prominent role in molding the institutional context and boundary conditions for studies of environmental disclosure.

There is a stream of research relating to regulation as an impetus for increased environmental disclosures, and I include in this review that research whose arguments or results are most relevant to this thesis. Bebbington and Thy (1999) investigate the effects of the introduction of mandatory environmental reporting in Denmark. They find that the quality of information disclosed in the first year is questionable, but that quality increased in the second year. In Canada, Brouhle and Harrington (2009) present evidence of an increase in repeated voluntary disclosure when a regulatory threat is anticipated. In the Australian context, Cunningham and Gadenne (2003) find increased voluntary environmental disclosures in annual reports post implementation of the National Pollutant Inventory (NPI). Assessing the requirements included in Section 299 of the Australian Corporations Law and conducting content analyses of the annual reports of listed companies over three consecutive years, Cowan and Gadenne (2005) show that companies disclose a higher level of positive environmental information in the voluntary sections than was disclosed in the statutory sections of annual reports. Similarly, Overell, Chapple, and Clarkson (2008) present evidence indicating that best practice environmental reporting may not be adequately achieved without increased mandatory guidelines. Furthermore, Kim and Lyon (2011) find that while a future regulatory threat and stronger enforcement of environmental laws increase participation in a voluntary reporting program, participants make selective disclosures of positive environmental information, but withhold negative environmental information. That is, they report emissions reduction at the project level despite an increase in their entire corporate emissions profile over time. This kind of selectivity in reporting undermines the credibility and effectiveness of the disclosure program. These findings correspond with concerns regarding the reliability of voluntary environmental disclosure raised in Berthelot, Cormier and Magnan (2003)'s review of the environmental disclosure literature, and align with a request for more guided regulatory environmental disclosures by the limiting of discretion.

Rankin, Windsor, and Wahyuni (2011) do not find evidence supporting the positive impact of trading under EU ETS on Australian companies[72]' proactive decisions to improve the quality of GHG emissions disclosures. In an international setting, Freedman and Jaggi (2005, 2011) and Gallego-Álvarez, Rodríguez-Domínguez, and García-Sánchez (2011) find that the ratification of the Kyoto protocol significantly improved companies' emissions disclosures. That is, companies from countries that have ratified the protocol are more likely to publicly disclose greater GHG emissions information than those from countries that have not.

Meanwhile, using the CDP database where the world's largest companies' response rates to the climate change questionnaires have been steadily improving (Kolk, Levy, and Pinkse, 2008), a series of studies continue to find that ratification of the Kyoto protocol acts as a proxy for GHG regulations and prompts companies' carbon disclosures (Stanny and Ely, 2008; Luo, Lan, and Tang, 2012; Stanny, 2013). In addition, these studies present evidence of the stickiness (consistency over time) of carbon disclosures (Stanny and Ely, 2008; Stanny, 2013), as well as the spillover effects of a regulatory threat in motivating industry-wide carbon disclosures, and highlight the role of government in synthesizing emissions reduction efforts. In other words, companies in countries with more stringent environmental regulations are less likely to engage in selective carbon disclosure (Marquis, Toffel, and Zhou 2016), and have a greater commitment to reduce their carbon emissions (Reid and Toffel, 2009).

[72] Australian companies that have sites subject to the EU ETS are required to report their emissions to that jurisdiction. EU ETS represents indirect regulation of these participating companies regarding internal emissions disclosure policies.

3.2.3 Environmental Disclosure and Environmental Performance

Research that examines the relationship between environmental disclosure and environmental performance generally draw on two well-established but competing conceptual frameworks. These are signaling (voluntary disclosure) theory and legitimacy (social and political) theory. The signaling theory contends that companies with superior environmental performance make greater disclosure in order to differentiate themselves from peer companies with poor performance (Li, Richardson, and Thornton, 1997; Clarkson et al., 2008). Signaling theory predicts a positive association between environmental disclosure and environmental performance. In contrast, at least for a group of researchers, legitimacy theory posits that companies practice symbolic compliance with societal norms and expectations, while their underlying interest is, in fact, not aligned with environmental protection (Gray, Kouhy, and Lavers, 1995; Cho and Patten, 2007). Therefore, it is expected that there is a negative association in terms of relation between environmental disclosure and environmental performance.

Prior studies primarily using cross-sectional analysis based on single year data collected from high polluting industries, or in one (commonly the U.S.) or a few other countries, generate mixed findings. On the one hand, employing data from 198 firms in the U.S. registered with the Investor Responsibility Research Center Environmental Profiles Directory in 1994, Al-Tuwaijri, Christensen, and Hughes (2004) use a mandatory disclosure setting and a quantifiable environmental performance measure (ratio of toxic waste recycled to total toxic waste generated), and document that good environmental performers disclosure more pollution-related environmental information than do poor performers. They also show that past disclosure sets the lower bound for management’s environmental performance.

These results have been supported by Clarkson et al. (2008)'s study which uses data from 191 firms from five of the highest polluting industries in the US in 2003 and finds a positive association between environmental performance and the level of discretionary disclosures in environmental reports and related web disclosures.

Freedman and Jaggi (2005) compare 395 coal-fired plants in 1990 and 415 in 1998, but they find only weak support for a positive association between pollution disclosure and pollution emissions for utility companies. When extending the sample to include Canada, India, Japan and the EU countries, Freedman and Jaggi (2011) find a statistically insignificant relation between carbon emissions performance and carbon disclosure. These results lead to calls for mandatory disclosure requirements to ensure more extensive and reliable environmental disclosures.

On the other hand, using data from 100 U.S. firms in 2002, Cho and Patten (2007) size matched groups that operate in environmentally sensitive and non-sensitive industries and that have better versus poor environmental performance, and find evidence that is consistent with their prediction based on legitimacy theory. That is, poorer environmental performance leads to higher levels of disclosure. Specifically, poorer environmental performers disclose higher levels of non-monetary environmental information in the non-environmentally sensitive group, while poorer performers in the environmentally sensitive group disclose higher levels of monetary environmental information. Kim and Lyon (2011) extend the sample period and adopt data from 98 investor-owned electric utilities over 1995-2003. Their results show that voluntary participants within the reporting program are engaged in selective reporting, thus using participation as a legitimating tool to mask their poor carbon performance. Participants increased carbon emissions over time but they reported reductions, while nonparticipants reduced carbon emissions over time. De Villiers and van Staden (2006) display similar results when investigating the top 100 listed companies and mining companies during the period 1994-2002 in a developing country, specifically, South Africa. Companies perceive general voluntary disclosures to be less threatening and will continue to make these symbolic disclosures but they will reduce specific disclosures when facing legitimacy threats. Mining companies reduce specific disclosures more than the top-100 industrial companies. Assessing 51 Australian companies in mining and manufacturing sectors reported to the National Pollutant Inventory (NPI) in the years 2002 and 2006, Clarkson, Overell, and Chapple (2011) further present evidence supporting the socio-political theory that high polluting companies make more environmental disclosures in total. However, contrary to predictions of both voluntary disclosure and socio-political theories, these companies are also more likely to rely on hard (objective and verifiable) disclosure items (of GRI index) in reporting.

A growing body of research that encompasses conducting multiple country analyses seems to provide more consistent and more positive results. Luo and Tang (2014) collect data for 474 firms across Australia, the U.K., and the U.S. for the year 2010 and provide evidence in support of the signalling/voluntary disclosure hypothesis, namely, that superior carbon performers are likely to disclose more carbon information to distinguish themselves from poor performers. Focusing on the electricity generating sector, Alrazi, de Villiers and van Staden (2016) examine 205 companies from 35 countries in 2007 and find statistically insignificant results regarding the relation between environmental performance and environmental disclosures. However, there is evidence that U.S. companies with lower emissions, i.e., with better environmental performance, are likely to disclose more emissions information than higher emissions companies, i.e., with poor environmental performance. In addition, companies in countries with a high environmental commitment and participation in ETS are likely to disclose a higher level of quality environmental information.

Adopting a larger sample of 1,607 companies from 45 countries over the period 2006-2014, Hassan and Romilly (2018) identify that there is one-way causation from environmental performance to economic performance, and, to a lesser extent, to environmental disclosure. However, there is no evidence of reverse causation. Using a more restricted sample of 361 firm-year observations from the S&P 500 companies over 2014-2015, Bui, Houqe, and Zaman (2020) again substantiate signalling theory and provide evidence that better environmental performers disclose more information to differentiate themselves from the poorer performers to achieve a competitive advantage.

The above-mentioned studies that assess the relationship between environmental performance and environmental disclosure contribute to the literature covering the determinants of environmental disclosure. There are a growing number of studies that investigate the impact of environmental disclosure on environmental performance, which however, in total, report inconsistent findings.

In Kim and Lyon's (2011) study, they compare reported emissions with actual emissions to determine the effect of a voluntary reporting program. The results indicate that a voluntary GHG reporting requirement is not associated with underlying carbon performance. That is, participation in a voluntary reporting program is not effectively related with emissions reduction. In fact, an examination of the impact of varied disclosure requirements provides mixed findings. Matisoff

(2012) shows that participation in the Chicago Climate Exchange (CCX) is associated with total CO_2 emissions reduction, while disclosure to CDP is not. However, both CCX and CDP participation is associated with an increase in CO_2 intensity. Employing the same dataset of US fossil fuel power plants over the period 1994-2007, Matisoff (2013) finds that state reporting requirements have no impact on either total carbon emissions or carbon intensity, while CDP participants increased their carbon intensity as compared with non-participants. Aggregating 1,230 listed manufacturing companies' emissions at the country level during the period 1998-2011, Apergis, Eleftheriou, and Payne (2013) present evidence that R&D expenditures yielded carbon reduction across Germany, France, and the U.K. in the post IFRS mandatory adoption year.

Qian and Schaltegger (2017) examine 284 of the Global 500 companies over the period 2008-2012. The results indicate that changes in carbon disclosure levels are positively associated with subsequent reduction in total and Scope 1[73] carbon emissions intensities, suggesting that carbon disclosure drives changes in companies with a view to achieving carbon performance improvement. Nonetheless, using a simultaneous equation model, Hassan and Romilly (2018) confirm carbon emissions level as one of the determinants of environmental disclosures. However, they find no evidence of environmental disclosures having an impact on environmental performance.

In summary, an array of studies has established the existence of a penalty effect for carbon emissions levels (environmental performance) on company's economic performance and that this supports establishing regulatory reporting

[73] As defined by the GHG protocol (2004), Scope 1 refers to direct GHG emissions which arise from sources that are owned or controlled by the company.

schemes in terms of companies' carbon disclosures[74]. However, two questions remain largely unexplored: 1) What is the impact of the strength of regulatory schemes on carbon emissions levels? and 2) What are the effects of carbon disclosure on carbon emissions levels?

[74] A stream of studies that examine the effect of requiring disclosures (but not in the area of carbon disclosures) present evidence consistent with disclosure changing behaviour. For instance, Bae, Wilcoxen, and Popp (2010) find that data processing efforts improves information provided and contribute to the intended outcome of reducing health risks. Christensen, Floyed, Liu and Maffett (2017) present evidence that mandatory social-responsibility disclosures in financial reports adds incremental real effect of decrease in mining-related citations and injuries and reduction in labor productivity. Christensen, Floyd, and Maffett (2020) contend that disclosure regulation motivates hospitals to reduce charges due to the concern over perceived overcharging.

TABLE 3-2 Summary Table of Selected Studies Assessing the Relation between Environmental Performance and Environmental Disclosure

Author	**Journal**	**Sample and Period**	**Dependent Variables**	**Independent Variables**	**Conclusions**
Al-Tuwaijri, Christensen, and Hughes (2004)	Accounting, Organisations and Society	US, 198 firms included in 1994 IRRC Environmental Profiles Directory, cross-section	Economic performance, environmental performance, environmental disclosure	Past environmental disclosure, environmental exposure, environmental concern, report channel, EPA participation, environmental committee, unexpected earnings, profit margin, market-to-book growth, visibility, SIZE.	Use quantifiable environmental performance measure (ratio of toxic waste recycled to total toxic waste generated) and the mandatory disclose setting and find that good environmental performers disclose more pollution-related environmental information than do poor performers. Past disclosure sets the lower bound for management's environmental performance.
Clarkson, Li, Richardson, Vasvari (2008)	Accounting, Organisations and Society	US, 191 firms from five most polluting industries in 2003, as reported by the EPA in 2005, cross-section	Voluntary environmental disclosure (web based)	Environmental performance proxy using pollution discharge data from US EPA TRI database, favourable media coverage (J-F coefficient), the amount of debt or equity capital, Tobin Q, stock price volatility, ROA, LEV, SIZE, NEW, CAPIN	Supports the prediction from economic based voluntary disclosure theory and find a positive association between environmental performance and the level of discretionary disclosures in environmental reports or related web disclosures.
Cho and Patten (2007)	Accounting, Organisations and Society	U.S., 100 firms in 2002, *t*-test means	Environmental performance, environmental disclosure	Size matched groups. Separate firms that operate in environmentally sensitive industries (ESI) from those that do not; distinguish between better and poorer environmental performers (use KLD ratings)	Supports the prediction derived from legitimacy theory and find that poorer environmental performance leads to higher levels of disclosure. Specifically, poorer environmental performers disclose higher levels of non-monetary environmental information in the non-ESI group; poorer performers in the ESI group disclose higher levels of monetary environmental information

Author	Journal	Sample and Period	Dependent Variables	Independent Variables	Conclusions
					than both their counterparts in the ESI and non-ESI groups.
de Villiers and van Staden (2006)	Accounting, Organisations and Society	South Africa, Top-100 listed companies and companies in the mining industry during 1994-2002	Classified general and specific environmental information disclosure	Compare average disclosure items across the top 100 and mining company groups	Finds evidence supporting legitimacy theory and find that companies perceive general disclosures to be less threatening and will continue to make these symbolic disclosures but will decrease specific disclosures when facing legitimacy threats. Mining companies reduced specific disclosures more than the top-100 industrial companies.
Clarkson, Overell, and Chapple (2011)	Abacus	Australia, 51 companies, in Mining and Manufacturing industries, reported to the NPI in both 2001-2 and 2005-6	Environmental disclosure	Environmental performance (pollution propensity), TA, NEW, CAPIN, Janis-Fadner coefficient, FIN, Tobin's Q, ROA, LEV, Stock price volatility	Finds evidence supporting socio-political theory that poorer environmental performers (high polluting companies) are associated with higher level of environmental disclosures in total. However, in contrast with both voluntary disclosure and socio-political theories, companies with poor environmental performance are also associated with more hard (objective and verifiable) environmental disclosures.
Freedman and Jaggi (2005)	Advances in Public Interest Accounting	U.S., 395 coal-fired plants in 1990 and 415 coal-fired plants in 1998	Environmental time of disclosure	Level of CO_2 emissions, ROE, TA, Beta	Provides weak support for a positive association between pollution disclosure and pollution emissions for utility companies.

Author	Journal	Sample and Period	Dependent Variables	Independent Variables	Conclusions
Freedman and Jaggi (2011)	Journal of International Financial Management and Accounting	510 firms in selected industries from EU, Canada, India, Japan, and U.S listed in Forbes Magazine published in 2005	GHG disclosure index	SIZE, country dummy, industry dummy	Results indicate insignificant association between carbon emissions performance and carbon disclosure, thus calling for mandatory disclosure requirements to ensure more extensive and reliable environmental disclosures.
Kim and Lyon (2011)	Journal of Environmental Economics and Management	US, 98 investor-owned electric utilities over 1995-2003	Participation in the Department of Energy's Voluntary Greenhouse Gas Registry	CO_2 emissions, CO_2 emissions intensity, Sierra subscription, Electric operating revenue, Heat rate, Energy generation capacity, Fraction of hydro and nuclear, LCV scores, Renewable Portfolio Standards, Growth in generation, Fuel switch saving, Enforcement	Voluntary participants engaged in selective reporting: participants increased carbon emissions over time but reported reductions, nonparticipants reduced carbon emissions over time.
Apergis, Eleftheriou, and Payne (2013)	Ecological Economics	1,230 listed manufacturing firms in Germany, France, and the U.K. during 1998-2011, threshold autoregressive model	Per capita CO_2 emissions	R&D, per capita GDP, oil prices, trade openness	R&D expenditures yielded carbon reduction across the 3 countries in the post-IFRS mandatory adoption year.

Author	Journal	Sample and Period	Dependent Variables	Independent Variables	Conclusions
Matisoff (2012)	Environmental and Resource Economics	U.S., 691 power plants over 1994-2007, Difference-in-difference	CO_2 emissions, CO_2 emissions intensity, electricity output	Program participation, total state energy programs, publicly traded, state electricity restructuring, Sierra subscription, per capita energy consumption, firm revenue, plant capacity, year of construction, firm growth rate, average regulatory penalties, coal % electricity generate, green group membership	Comparing participation to the Chicago Climate Exchange (CCX) and CDP, the study finds that CCX is associated with total CO_2 emissions reduction, while CDP is not. Both CCX and CDP participation is associated with an increase in CO_2 intensity.
Matisoff (2013)	Energy Policy	U.S., 960 fossil fuel power plants over 1994-2007, Difference-in-difference	CO_2 emissions, CO_2 emissions intensity, electricity output	Program participation, publicly traded, state electricity restructuring, Sierra subscription, per capita energy consumption, firm revenue, plant capacity, year of construction, firm growth rate, average regulatory penalties, coal % electricity generate, green group membership	Comparing the effectiveness of a state-based mandatory carbon reporting program and CDP. The state reporting requirements do not impact either total carbon emissions or carbon intensity. CDP participants increased their carbon intensity as compared with non-participants.
Luo and Tang (2014)	Journal of Contemporary Accounting & Economics	474 firms in Australia, the U.K., and the U.S. in 2010	Carbon disclosure	Carbon performance (carbon intensity, sector-mean adjusted carbon intensity, weighted emissions reduction index, equally weighted reduction index, SIZE, ROA, LEV, country dummy, carbon intensive sector dummy	Supports the voluntary disclosure hypothesis and finds that superior carbon performers are likely to disclose more carbon information to distinguish themselves from poor performers. To enhance consistency and comparability, carbon disclosure can be regulated by utilizing a standard format and content.

Author	Journal	Sample and Period	Dependent Variables	Independent Variables	Conclusions
Alrazi, de Villiers and van Staden (2016)	Accounting and Business Research	205 electricity generation firms in 35 countries in 2007	Overall environmental information, CO_2 emissions information	Environmental performance (carbon emissions, carbon intensity), country's environmental performance index, ETS, LEGAL, LAW, SIZE, ROA, LEV, Tobin's Q, stock price volatility, NEW, CAPIN, MEDIA, FOREIGN, LISTING	This study finds statistically insignificant results in terms of a relation between environmental performance and environmental disclosures. U.S. firms with lower emissions are likely to disclose more emissions information than higher emissions firms. Firms in countries with a high environmental commitment and participation in ETS are likely to disclose higher levels of environmental information.
Qian and Schaltegger (2017)	The British Accounting Review	284 of Global 500 firms over the period 2008-2012, Change model	ΔTotal emissions intensity $_{(t+1)}$, ΔScope 1 emissions intensity$_{(t+1)}$	ΔCarbon disclosure$_t$, ΔSIZE$_t$, ΔROA$_t$, ΔLEV$_t$, ΔLIQUIDITY$_t$, ΔSales growth$_t$, ΔNEW$_t$, ΔCAPIN$_t$, ΔR&D$_t$, Δ High - environmental exposure industries	Changes in carbon disclosure levels are positively associated with a subsequent reduction in total and Scope 1 carbon emissions intensities. This study presents evidence from an 'outside-in' management view that carbon disclosure drives changes in companies to achieve carbon performance improvements.
Hassan and Romilly (2018)	Business Strategy and the Environment	1,607 firms from 45 countries over the period 2006-2014, Granger causality tests	Economic performance, environmental performance (GHG emissions), Environmental disclosure score	SIZE, LEV, CAPIN, No. of full-time directors on board, CEO, % women on board, GHG reduction policy, Implementation of efficient energy use initiatives, carbon-intensive industry indicator, GDP per capita, Kyoto protocol, corporate governance at country level	Environmental performance, measured as the GHG emissions levels, has one-way causation to economic performance, and to a lesser extent, environmental disclosure, but no evidence of reverse causation.

Author	Journal	Sample and Period	Dependent Variables	Independent Variables	Conclusions
Bui, Houqe, and Zaman (2020)	The British Accounting Review	361 firm-year observations over 2014-2015	Carbon disclosure (CDP disclosure index)	Carbon performance (carbon intensity, change and reduction in carbon intensity), CG, Climate governance, Board responsibility, Executive incentives, Frequency of carbon reporting, Horizon of carbon information, Environmental committee, Board (diversity, size, independence), CEO, Executive compensation, SIZE, ROA, LEV, Tobin's Q, NEW, CAPIN, Environmental sensitive industry, Litigation sensitive industry	Supports signalling theory and provides evidence that better environmental performers disclose more to differentiate themselves and to achieve competitive advantage. While traditional corporate governance measures are not significantly associated with carbon disclosure, climate governance (the frequency of reporting to the board and the time horizon of carbon information) has a significant positive influence on carbon disclosure, which suggests its effectiveness in reducing managerial discretion regarding in carbon disclosure.

3.3 Carbon Assurance Engagements and other Credibility Enhancement Mechanisms

Accounting and related credibility enhancement mechanisms are important to benchmark performance and build accountability at both the country and company levels. While the UNFCCC has been the transnational body that put emphasis on the credibility of reported information through expert reviews, assessments and stocktakes, there is little research regarding the range and impact of credibility enhancement mechanisms at the country level.

At the company level, the past decade has witnessed that a global trend of an increasing number of companies provide nonfinancial information in the form of Extended External Reporting[75] (EER) and therefore an increased demand[76] for independent assurance of nonfinancial information (KPMG, 2020). In the meantime, extant research regarding assurance of EER has flourished, with the investigation of issues ranging from determinants and consequences of assurance, managerial and professional capture, types of assurance providers, scope and level of assurance engagements, wording of assurance reports and the lack of regulation and assurance standards (Venter and van Eck, 2021). These studies mainly focus on independent assurance engagements, which is one of the mechanisms encapsulated under the theme of credibility enhancement mechanisms.

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[75] EER "encapsulates many different forms of reporting, including, but not limited to, integrated reporting, sustainability reporting and other reporting by entities about environmental, social and governance matters" (IAASB, 2020).

[76] According to KPMG (2020), 51% of N100 companies obtain independent assurance of nonfinancial information, compared to 38% in 2011, 42% in 2015, and 45% in 2017; and an underlying trend of 71%, among the world's 250 largest companies (G250) undertake independent assurance engagements, compared to 46% in 2011, 63% in 2015 and 67% in 2017.

Independent audits[77] add necessary credibility for participants in capital markets (Healy and Palepu, 2001; Khurana and Raman, 2004). Likewise, the independent assurance of nonfinancial reports is also found to enhance the relevance of nonfinancial information and alleviate information asymmetry, making it valuable to information users (Simnett, Vanstraelen, and Chua, 2009b; Dhaliwal, Li, Tsang, and Yang, 2011; Casey and Grenier, 2015; Cheng, Green, and Ko, 2015; Cohen and Simnett, 2015; Cuadrado-Ballesteros, Martínez-Ferrero, and García-Sánchez, 2017; Martínez-Ferrero and García-Sánchez, 2017; Clarkson, Li, Richardson, and Tsang, 2019; Chen, Letmathe, and Soderstrom, 2020; Krasodomska, Simnett, and Street, 2021; Pinnuck, Ranasinghe, Soderstrom and Zhou, 2021; Venter and van Eck, 2021).

Moreover, research into nonfinancial report assurance demonstrates that assurance enhances the credibility and reliability of reported information (Pflugrath, Roebuck, and Simnett, 2011; Moroney, Windsor, and Aw, 2012, Zhou, Simnett, and Green, 2016). Braam et al. (2016) find that assurance plays a significant and incremental role in explaining the nature and variation in the level of environmental reporting. Birkey, Michelon, Patten, and Sankara (2016) document that assurance can increase report users' perceptions of the credibility of information disclosed and enhance the environmental reputation of a company. Ballou, Chen, Grenier, and Heitger (2018) argue that assurance improves nonfinancial reporting quality through restatements in terms of the identification of errors and methodological updates. Du and Wu (2019) show that assurance adds credibility to nonfinancial reporting by generating a lower incidence of future corporate social responsibility related

[77] Audit is a subset of assurance and relates to financial information, whereas assurance includes audit and relates to non-financial information (IAASB, 2013).

misconduct. Enhanced credibility of nonfinancial reporting helps to address investors' concerns that companies are simply engaging in impression management (Cho and Patten, 2007) or greenwash[78] (Holder-Webb, Cohen, Nath, and Wood, 2009; Lyon and Maxwell, 2011; Lyon and Montgomery, 2015; Marquis et al., 2016). Greenwash is commonly seen as a mere public relations practice (Cho and Patten, 2007; Holder-Webb et al., 2009) or as for "managerial or professional capture[79]" and leads to "rational myths[80]", as seen through a neoinstitutional lens[81] (O'Dwyer and Owen, 2005, 2007; Boiral and Gendron, 2011).

Further, assurance of nonfinancial reporting serves as an organisational control mechanism to promote strategic integration, and it extends its benefit to internal management through strategic planning, risk management and internal control decisions (Power, 1997; Gray, 2000; O'Dwyer, 2011; O'Dwyer, Owen, and Unerman, 2011; Ballou, Casey, Grenier, and Heitger, 2012; Casey and Grenier, 2015; Steinmeier and Stich, 2019). Datt, Luo, and Tang (2020) show that a company's motives to improve carbon management mechanisms drive its assurance decisions. By distinguishing the internal motive of achieving operational control (operational benefits) from the external motive of meeting market requirements and enhancing the company image (market benefits), Praiogo, Castka, and Searcy (2020) contend that a company's motives alone are important in achieving the desired benefits. In the meantime, Steinmeier and Stich (2019) report a positive association

[78] "Greenwash encompasses a range of communications that mislead people into adopting overly positive beliefs about an organization's environmental performance, practices, or products" (Lyon and Montgomery, 2015).
[79] Management on the demand side, and assurance providers on the supply side, can both engage assurance to meet their own commercial objectives by limiting the scope of engagement and minimizing their potential liabilities.
[80] Conformity to institutional norms entails argument concerning the "ceremonial and superficial adhesion" to rational institutional structures and beliefs to achieve organizational legitimacy.
[81] Please refer to the Section 2.2.3 for discussion on the neoinstitutional theory.

between assurance and nonfinancial investment efficiency, implying that there are benefits emanating from assurance in improving the information available for managerial decision-making.

Nevertheless, the benefit of assurance as a credibility enhancement mechanism is context specific (Venter and van Eck, 2021). Coram, Monroe, and Woodliff. (2009) and Shen, Wu, and Chand (2017) find that assurance of non-financial disclosures affects stock prices only when the non-financial performance is positive, potentially reflecting the presence of impression management or greenwashing. Similarly, Pflugrath et al. (2011) state that the enhanced credibility of nonfinancial information from independent assurances is present for companies in the mining industry but not for companies in the retail industry. They speculate that the identified industry effect could arise because companies in the mining industry have greater incentives to misstate nonfinancial information. However, Radhouane, Nekhili, Nagati, and Paché (2020) provide evidence that the perceived credibility of nonfinancial information depends on the level of assurance for French companies in environmentally sensitive industries. Brown-Liburd and Zamora (2015) find that investors place a premium on nonfinancial assurance when managers are compensated for their nonfinancial performance and when companies make higher-than-industry-median nonfinancial investments. Cheng et al. (2015) document the interaction effects associated with the strategic relevance of nonfinancial indicators and assurance on nonprofessional investors' investment decisions. The assurance has a stronger positive effect on investors' willingness to invest in a company when the nonfinancial indicators have higher strategic relevance compared to lower strategic relevance. Dilla, Janvrin, Perkins, and Raschke (2019) show that assurance on environmental information affects the decisions of investors with strong (not weak) environmental responsibility views. Nishitani, Haider, and Kokubu (2020) report that third-party comments, but not independent assurance, on environmental reports are associated with higher firm value for Japanese manufacturing companies.

The purpose of reporting emissions data is important for both external decision-making and for internal management (e.g., Dhaliwal et al., 2011; Dhaliwal, Radhakrishnan, Tsang, and Yang, 2012; Cohen and Simnett, 2015). To ensure the quality of reported emissions data is maintained it must be reliable and credible. As an alternative to independent assurance, there are internal audit, third-party comments and corporate governance mechanisms that monitor regulatory compliance and enable the provision of advice and the evaluation of the strategies and activities undertaken by companies (Cohen, Krishnamoorthy, and Wright, 2004, 2008; Viscelli, 2013; Trotman and Trotman, 2013; Soh and Martinov-Bennie, 2015, 2018, Nishitani et al., 2020). This echoes the tenet of combined assurance that coordinates the assurance of management, internal assurance providers, and external assurance providers to ensure the quality of information used for internal management and external reporting is maintained (Decaux and Sarens, 2015; Zhou, Simnett, and Hoang 2019; Hoang and Phang, 2020).

3.4 Carbon Risk

The failure of climate change adaption and mitigation is perceived as one of the most impactful global risks (World Economic Forum, 2019). Climate risk is industry specific and affects all companies within a sector (Labatt and White, 2007). Nevertheless, climate risk's financial implications for businesses are also determined by decisions made at the company level. Consequently, climate risk is also company specific (Labatt and White, 2007).

While corporate climate-related risks comprise both physical and transitional risks, carbon risk is defined as "nonphysical climate change-related factors facing assets and companies and primarily encompasses policy and legal, technology, market and economic factors as well as reputational risks" (WRI and UNEP-FI, 2015). Carbon risk refers to the monetary constraints of GHG imposed on companies by regulatory or market-driven mitigation measures (Carbon Trust, 2006).

A company relies on carbon-based inputs and generates carbon outputs which are subject to an array of factors that can affect its performance financially. The financial risks derive from uncertainty in the general business environment in which a company is located (Aragón-Correa and Sharma, 2003). The probability and distribution of uncertain factors constrain the capacity of management decisions. The carbon-related constraints on the input dimension include the availability of fossil fuel resources, the rate of change in technical developments, government related measures, international political developments, and changes in consumer preferences. Apart from direct physical impact, the output dimensions consist of the implications relating to global environmental protocols, carbon trading prices, and taxes, as well as changes in insurance contract conditions and consumer preferences.

These carbon constraints restrict companies' abilities to maintain financial performance and sustain long-term growth (Busch and Hoffman, 2007; Hoffman and Busch, 2008). Following the ratification of TPA, the necessity for companies to assess, manage, and disclose carbon risks has become more prominent than ever before, i.e., during the global transition to a lower carbon economy (TCFD, 2017).

Specifically, carbon risks relate to strategic, operational, compliance, and reporting risks (COSO, 2013; Subramaniam et al., 2015). First, the key to the transition to reduce emissions requires an assessment of a company's strategic positioning in the carbon context. A company needs to incorporate responses to climate change among its strategic options (Hoffman, 2005; Kolk and Pinkse, 2005). In the changing landscape of sustainability, a company needs to proactively consider its market positioning in line with changing consumer demands (e.g., green product) and technology to gain a competitive advantage and to manage stakeholder communications and improve investor relations. Second, a company is expected to factor in its carbon footprint and energy usage to improve its operational systems in the process of procurement, manufacturing, and waste management (COSO, 2013). Third, companies face a growing number of regulatory mechanisms that result in direct (through emissions trading systems) and indirect carbon costs (through energy price increases and disclosure requirements) (Subramaniam et al., 2015). Fourth, pressures from the capital markets increasingly drive companies to be more transparent in meeting their triple bottom line as the market in general perceives companies' sustainability reporting as creating value and reducing uncertainty with regard to future cash flows and profitability (Ioannou and Serafeim, 2012).

3.5 Carbon Risk and Debt Contracting

The global debt market with outstanding debt securities at US$126.97 trillion at the end of Q3 2019 (Bank of International Settlement (BIS), 2020) is much larger in size than the global equity market where total market capitalization stood at US$85.65 trillion at the end of Q3 2019 (World Federation of Exchanges (WFE) 2020). Total debt has grown rapidly by three-quarters since the 2008 financial crisis (McKinsey & Co, Inc., 2018). This notable increase is accounted for almost equally by the increase in the global debt of governments and nonfinancial companies. Debt financing, as compared to equity financing, carries with it the benefits of tax savings, a commitment to efficient operations by management, and the engagement of lenders with monitoring (Kraus and Litzenberger, 1973; Jensen and Meckling, 1976; Jensen, 1986; Van Binsbergen, Graham, and Yang, 2010).

Several studies that assess the relation between the capital market and carbon performance found in general that the equity market responds negatively to the level of emissions disclosed (e.g., Matsumura et al., 2014; Clarkson et al., 2015; Griffin et al., 2017). A growing number of stock exchanges require listed companies to disclose carbon related information in response to investor demands for business transparency (KPMG, 2017). Increasing attention has been paid to the role of the debt market in responding to, and motivating, climate change mitigation (e.g., Chen and Gao 2012; Chapple et al., 2013; Jung et al., 2018).

A greater number of carbon constrained companies (with higher carbon risks) face higher default risks resulting from greater uncertainty surrounding future cash flows. Carbon constrained companies can incur higher costs of regulatory compliance, physical damages, emissions output concerns, and reputational damage associated with environmentally irresponsible business conduct (Thompson, 1998;

Clarkson, Li, and Richardson, 2004; Labatt and White, 2007; Chen and Gao, 2012; Weber, 2012; Subramaniam et al., 2015). As a counterparty, lenders' credit risks are influenced by the borrowers' default risks (Allen and Saunders, 2004; Weber, 2012). Lenders can mitigate the impact of a borrower's carbon risks through negotiating debt contracting terms, debt maturity and the price of debt (Chapple et al., 2013; Chava, 2014; Fernández-Cuesta, Castro, Tascón, and Castaño, 2019; Herbohn, Gao, and Clarkson, 2019; Lemma et al., 2020).

In fact, over time banks and other financial institutions have strengthened lending policies and practices to incorporate carbon-related risks into their credit decisions. This is because the community of financial institutions believes that borrowers' good environmental management reflects the good business management of both the lenders and the borrowers. Banks and other financial institutions have thus implemented more systematic environmental risk assessment policies, but still mainly focus on regulatory compliance, and at a more general level (Thompson, 1998; Coulson and Monks, 1999; Thompson and Cowton, 2004; Busch and Hoffmann, 2007; Cogan et al., 2008).

A few earlier studies on the relation between broader scope sustainability, general environmental risk, and the cost of debt found that lenders paid specific attention to low-quality borrowers which face higher spreads, shorter maturities and which are more sensitive to the impact of environmental performance (Goss and Roberts, 2011; Schneider, 2011). Companies also benefited from improved environmental management through a reduced cost of capital (Sharfman and Fernando, 2008).

Several studies directly assess the relation between carbon risks and the cost of debt across different institutional settings. Focusing on the U.S. electric utility industry, Chen and Gao (2012) find a positive relation between carbon risk and the cost of debt. Using Australian data, Jung et al. (2018) present further evidence as to the positive relation between carbon risk and the cost of debt. In addition, this relation is mitigated through companies' carbon risk awareness[82].

Using data from developing countries, Kumar and Firoz (2018) and Lemma et al. (2020) find on the one hand that higher carbon risk is associated with a higher cost of debt in India and lower debt maturity in South Africa, respectively. They also find that higher quality disclosures alleviate the inverse relation between carbon risk and debt maturity. On the other hand, Zhou et al. (2018) exhibit a U-shaped relation between carbon risk and the cost of debt financing, and that the relation is accentuated though increased media attention. Due to a lack of emissions reporting data in China, this study adopted an ordinal variable that is based on the carbon pollution violation of a company and its corresponding penalties. The results indicate that there is an inverse relation between carbon risk and the cost of debt for companies not receiving any penalty prior to a company receiving an order to rectify excessive carbon emissions. However, when a company receives an order to make rectification due to excessive carbon emissions, and pays a fine due to carbon violation, or suspends its operation, the inverse relation becomes positive. Results from this study is also consistent with prior research that shows financial institutions pay more/only attention to low quality borrowers when banks or other financial institutions are at an early stage of incorporating carbon-related policies into their credit evaluations.

[82] The primary measure of carbon risk awareness is an indicator established by a response to the CDP questionnaire. Alternative proxies include the communication of carbon risk awareness through channels other than the CDP, e.g., the sustainability reports, annual reports, and corporate website, and the annual cash investment in property, plant and equipment scaled, by lagged total assets.

3.6 Summary and Conclusions

Carbon emissions research at the country level has generally focused on the determinants of carbon emissions. Two of the most established contributing factors are economic growth and energy consumption. Arguments that derive from these two contributing factors further consider the mobility of goods production and population that result in changes of carbon emissions. These are trade openness and urbanization. Carbon emissions reporting and policy research has to date centred on a theoretical framework that adopts a normative approach to prescribe administrative functions (refer to Chapter Two for discussion). Little empirical evidence has been provided as to whether reporting and credibility enhancement mechanisms modify the growth patterns for carbon emissions.

Carbon emissions research at the company level is fruitful in directly assessing the economic impact of carbon disclosures, and in identifying regulatory schemes to motivate carbon disclosures. However, there remains a scarcity of research that informs the area of research into the impact of carbon disclosures on carbon performance.

In addition, research on credibility enhancement mechanisms related to carbon disclosures is at its infancy, with most of the studies to date having attempted to understand the determinants and motivation behind assurance decisions. More recent research that directly assesses the impact of carbon assurance finds a positive association with the level of carbon disclosures and internal management (e.g., Casey and Greiner, 2015; Braam et al., 2016).

The concept of carbon risk encompasses several aspects and prior literature mainly uses carbon intensity as a proxy for carbon risk. The role of financial institutions in addressing the issue of climate change mitigation is far from being conclusive.

With reference to policy implications, my thesis examines the impact of regulatory disclosure schemes and credibility enhancement mechanisms using different accounting proxies across multi-level institutional settings. As such, the results provide an in-depth and comprehensive investigation into of the role of carbon reporting and credibility enhancement mechanisms in the transition to a lower carbon economy.

CHAPTER 4 STUDY ONE

4.1 Introduction

In this study I examine whether and to what extent systematic variations in carbon reporting schemes across countries, and the presence of a credibility enhancement mechanism, help facilitate a reduction in carbon emissions growth. Climate change mitigation is perceived as the most impactful risk to business and society for the years to come (World Economic Forum, 2016). At the end of 2015, in order to address this global risk and prevent its "severe, widespread and irreversible impacts" (IPCC, 2014), 189 countries signed TPA in an attempt to help stabilize the climate. TPA marks a milestone in attempts to reduce GHG emissions and facilitate the transition to a lower-carbon economy (UNFCCC, 2016).

Upon ratification of TPA, 189 countries are obliged to specify long-term carbon reduction targets leading into 2030 and to conduct a stock take in 2023 and every two years thereafter to assess collective progress. To hold countries accountable, TPA emphasizes the transparency framework encompassing reporting and credibility enhancement mechanisms, which is a prerequisite to the evaluation and management of climate risk and carbon emissions (UNFCCC, 2016). Without credibility enhancement mechanisms, the accuracy and reliability of the information reported is in question. Without reporting of accurate and reliable carbon emissions data, countries' abilities to regulate and achieve carbon emissions targets is in jeopardy. Currently, however, systematic variations exist across carbon-related reporting schemes at the country level in terms of scope, nature, target entity, reporting location, and geographical and industry coverages (KPMG et al., 2016;

TCFD, 2017). This has, in turn, raised concerns over the accuracy, reliability, consistency, and comparability of reported carbon emissions information across countries (TCFD, 2017).

Extant carbon reporting literature highlights the role of government and regulatory intervention to address climate change issues and to motivate carbon disclosures (e.g., Berthelot et al., 2003; Brouhle and Harrington, 2009; Kim and Lyon, 2011). Emerging carbon credibility enhancement research informs us that independent credibility enhancement mechanisms on carbon disclosures improves the credibility of the emissions information (e.g., Simnett et al., 2009b; Moroney et al., 2012; Zhou et al., 2016; Ballou et al., 2018), and that the process of engaging credibility enhancement mechanisms may also induce disclosures of more accurate and reliable emissions information through enhanced reporting systems (Braam et al., 2016). However, none of the empirical evidence has been compiled at the country level. That is, little is known regarding carbon emissions reporting and credibility enhancement mechanisms when countries are the reporting entities per se.

To bridge this knowledge gap, my study highlights the unique empirical setting created under TPA. I factor in the systematic variations to measure the strength of a country's reporting schemes and examine the presence of an independent expert team review as the credibility enhancement mechanism. Public interest theory and modern disclosure regulation research argue for economy-wide cost savings and a positive information transfer and spillover effects arising from regulatory disclosures (Coffee, 1984; Easterbrook and Fischel, 1984; Mahoney, 1995; Rock, 2002). In line with this argument, a toolbox prescribed from the global administrative law literature suggests that publication of metrics and measurements enables performance benchmarking, and that the establishment of independent expert reviews ensures policy implementation with regard to carbon emissions mitigation (Esty and Porter, 2005; Esty, 2006). Hence, I hypothesize that both the strength of carbon reporting schemes and the presence of independent expert team reviews which enhance the credibility of the reported information have a negative relation with a country's GHG emissions growth.

The GHG emissions data is collected from the UNFCCC GHG inventory database and includes Annex I[83] (41) and non-Annex I[84] (82) countries that report emissions in two or more years during 1990-2014. The starting year, 1990, is the earliest available inventory year in the database and serves as the base year stipulated in most countries' reduction targets. A multivariate first differences approach is used to account for confounding factors and to examine the effects of the strength of reporting schemes as well as independent expert team reviews in reducing GHG emissions growth over different time horizons (i.e., 5-, 10- and 15-year).

The multivariate results demonstrate that both the strength of carbon reporting scheme and in-country expert team reviews are associated with modest, but non-trivial, reductions in GHG emissions growth. While the strength of reporting schemes is statistically significant over a 10-year time horizon, there is a persistent curbing effect associated with credibility enhancement mechanisms throughout 5-, 10-, and 15-year horizons. The results highlight the importance of

[83] Parties include the industrialized countries that were members of the OECD in 1992, plus countries with economies in transition, including the Russian Federation, the Baltic States, and several Central and Eastern European States.
[84] Mostly developing countries and include groups of countries that are vulnerable to the adverse impact of climate change or rely heavily on fossil fuel production and thus are more vulnerable to the impact of transition to lower carbon economies.

credibility enhancement mechanisms in ensuring the accuracy and reliability of emissions information reported, and this, in turn, helps to facilitate GHG emissions reduction in terms of a country's target achievements.

The contributions of my study are fourfold. First, the results show that both the strength of carbon reporting schemes and credibility enhancement mechanisms are negatively associated with GHG emissions growth, and thus serve as mitigating factors for GHG emissions growth. Extant country level carbon emissions literature primarily focuses on investigating the key determinants that contribute to a country's carbon emissions growth (e.g., Cropper and Griffiths, 1994; Grossman and Krueger, 1995; Stern, 2000; Sharma, 2011; Kasman and Duman, 2015; Rafiq, Salim, and Nielsen, 2016), while to date the mitigating factors remain largely unexplored. This study adds to the current body of knowledge as to whether and to what extent the efforts made to improve accounting for GHG emissions attribute to slowing down emissions growth at the country level.

Second, the extant literature focuses on company level evidence regarding regulatory disclosures (e.g., Lambert et al., 2007; Doidge, Karolyi, and Stulz, 2009; Ammer, Holland, Smith, and Warnock, 2012). Little is known as to whether and to what extent regulatory disclosures induce socially desired behavior and whether and to what extent such benefits aggregate at a macroeconomic level (Leuz and Wysocki, 2016). Given a country's commitment to reduce GHG emissions and to stabilize the climate, company level research alone is not adequate to understand the issue of climate change, which demands national and transnational attention. This study emphasizes the role of accounting in terms of GHG emissions at the country level and presents empirical evidence as to how emerging forms of regulatory disclosures impact on publicly desired outcomes.

Third, this study individually measures the strength of a country's carbon-related reporting schemes on a yearly basis. The measure encompasses a series of factors, including regulatory type, scope, nature, geographical scope, industry sector, and disclosure location. Prior carbon emissions research mainly uses dummy variables to indicate whether a company is subject to any regulatory scheme (e.g., Rankin et al., 2011; Luo, Lan, and Tang, 2012; Stanny, 2013). Cross-country corporate social responsibility studies often adopt a broad scope legal system index developed to proxy for systematic variations across countries (Simnett et al., 2009b; Dhaliwal et al., 2012; Zhou et al., 2016). Grauel and Gotthardt (2016) employ a perception-based measure to depict the strength and enforcement of environmental policies. However, my study directly accounts for yearly released carbon-related reporting schemes in force during the sample period and contributes to the literature by disaggregating the effects of carbon reporting schemes from that of broad scope institutional factors.

Lastly, this study considers the independent expert team reviews initiated by the UNFCCC as a credibility enhancement mechanism for country level GHG emissions reporting, and thus extends the discussion of carbon credibility enhancement mechanisms at the country level. A country's carbon-related disclosure reduces information asymmetry between the country and the UNFCCC/public. The effectiveness of achieving the desired outcome depends on the accuracy and reliability of the information provided. Esty and Porter (2005) contend that a statistically robust and data-driven approach enables performance benchmarking and outcome tracking. Results from this study substantiate the role of credibility enhancement mechanisms in improving carbon inventory reporting systems at the country level and help countries to better manage emissions reduction.

The remainder of this study is organized as follows. Section 2 develops the hypotheses. Section 3 describes the research methodology. Section 4 presents the descriptive results and the tests of the hypotheses. Section 5 reports the sensitivity analyses. Section 6 provides the results of the additional analyses, and Section 7 concludes the study.

4.2 Hypotheses Development

4.2.1 The Relation Between the Strength of Carbon Reporting Schemes and a Country's Carbon Emissions Growth

Following the IPCC Guidelines for National Greenhouse Gas Inventories, countries have been constructing national reporting systems, of which government devised reporting schemes have become an essential component. These reporting schemes vary considerably in terms of national GHG emissions coverage. In the meantime, a range of legislative and exchange listing rules in the various countries have required reporting entities in all or specified industries to disclose carbon related information in their annual reports or specified disclosure documents. Due to systematic variations across countries, the strength of carbon-related reporting schemes varies significantly across countries and it is anticipated that there are differential effects on carbon emissions growth related to carbon disclosures arising from diversified reporting systems.

Ratified countries are required to regularly report GHG emissions data to the UNFCCC and this substantiates global administrative law scholars' insistence that measurement and its publication enables performance benchmarking and outcome tracking (Esty and Porter, 2005; Esty, 2006). Central to the UNFCCC's policy making is the aim of steering the world away from global warming. The reporting process allows the UNFCCC to evaluate the effectiveness of its policies and their implementation at the country level.

The costs borne by countries in their determination to tackle climate change issues are tremendous[85] (Barrett, 2007; UNFCCC, 2016). Observed from submitted national inventory reports, carbon reporting schemes developed in countries like Australia, Canada, the United States, and the European community are indispensable components of their respective national inventory systems. Annual data collected through these reporting schemes is "an important component of the overall inventory development process in comparing and verifying certain inventory estimates in the national inventory reporting" (National Inventory Report: Canada, 2017). In competing for limited national resources and country level priorities, the strength of the reporting schemes demonstrates a country's efforts, and signals to the public its willingness to fulfil its commitment in stabilizing the climate.

Climate change mitigation is a global public good which demands aggregate effort across countries. The mitigation costs exceed the amount that could be covered through private actions, and therefore government input is necessary, yet the benefits take years to materialize. Without an efficient and effective reporting framework, attaining the articulated GHG reduction targets at the country level becomes more difficult (US EPA, 2008). Consistent with the predictions from public interest theory, it is conjectured that more stringent reporting schemes that provide more accurate and reliable information may help policymakers to identify and implement policies to overcome market failures relating to the undersupply of climate change mitigation, and to reduce negative externalities associated with GHG

[85] The direct costs include but not limited to, large shifts in domestic policies, restructure of the public administrative framework, search for more efficient and cost-effective energy sources, change in behavior of millions of companies and households and potential loss in economic competitiveness.

emissions increases. The first hypothesis posits that the strength of carbon reporting schemes facilitates carbon reduction:

H1: An increase in the strength of carbon reporting schemes is negatively associated with a country's carbon emissions growth.

4.2.2 The Relation Between the Presence of Independent Expert Team Reviews and a Country's Carbon Emissions Growth

To ensure the effectiveness of its policymaking and the benchmarking of its reporting countries' performance, UNFCCC has established a credibility enhancement mechanism which involves recruiting international technical expertise to assess, in-country, the implementation of a country's commitments and provide professional advice aimed at facilitating such implementation. The aim of the review is to provide a thorough and comprehensive technical assessment of the reported information and make recommendations. Countries' subsequent NCs summarize the follow-up requirements and the measures needed to address the recommendations.

For Annex I countries, an in-country expert team review is initiated by the Secretariat and conducted on a NC with a field visit to the country normally within one to three years after a country's submission of the NC[86]. During the review, the completeness and transparency level of reported information in NCs is assessed, and recommendations are provided regarding the reporting systems. For non-Annex I countries, their NCs are compiled and synthesized on a regular basis, but this is done without systematic technical analysis. Starting from their first biennial update report

[86] Annex I counties are required to prepare NCs every four years after their ratification of the UNFCCC. There were no official due dates for the submission of the first two NCs. The submission due dates for the third to sixth NCs were 30 November 2001 (third), 1 January 2006 (fourth), 1 January 2010 (fifth), and 1 January 2014 (sixth).

(by December 2014), non-Annex I countries' reports are then subject to international consultation and analysis.

"Accurate, consistent and internationally comparable data on GHG emissions is essential for the international community to take the most appropriate action to mitigate climate change, and ultimately to achieve the objective of the Convention" (UNFCCC, 2016). By formulating a reporting mechanism to collect countries' national inventories, the UNFCCC places emphasis on the reliability of the reported data. The reliability of information disclosed predominantly depends on the quality of a country's reporting system. Submitted under the guidelines of the UNFCCC, country communications are subject to technical reviews by the international expert review teams. The teams consist of skilled experts who are selected on an ad hoc basis from the UNFCCC roster of experts recommended by member countries and international organizations. The aim of the technical review is to provide a thorough and comprehensive technical assessment of the reported information, particularly the national inventory, thus assisting the reporting country in the construction and improvement of its carbon reporting framework.

The adoption of environmental credibility enhancement mechanisms was originally conceived as a "management tool" (Power, 1997). Without accurate and reliable reporting of GHG emissions data, a country cannot effectively manage to reduce emissions, and the UNFCCC cannot benchmark countries' progress towards commitment or evaluate its policy implementation (Esty and Porter, 2005). The GAL's toolbox suggests that monitoring and credibility enhancement mechanisms are an essential component in the transparency framework formulated under the UNFCCC. Regular reviews of the reported information and the in-country reporting systems serve to hold countries more accountable for their actions and enhance the credibility of the UNFCCC's decision-making.

Proxies for the quality of nonfinancial information assurance present challenges (Cohen and Simnett, 2015). The fact that countries have been consistently addressing the recommendations made by the international expert teams in their subsequent NCs and formulate practices to improve the reporting systems and meet reduction commitments highlights the effectiveness of the independent reviews. This evidence is consistent with the expert review's objective to serve as a credibility enhancement mechanism to verify and monitor a country's performance in meeting its reduction targets. The second hypothesis holds that:

H2: The number of expert team reviews is negatively associated with a country's carbon emissions growth.

4.3. Research Methods

4.3.1 Research Model

To test the hypotheses described in the preceding section, I use a percentage change differenced fixed effect model which incorporates variables to control for potential confounding factors that have been identified in previous research (e.g., Sharma, 2011; Sadorsky, 2014; Farhani and Ozturk, 2015; Zhu et al., 2016; Churchill et al., 2018). Furthermore, using a percentage change differenced model is also consistent with the tenet of the study to investigate the growth rate, i.e., the rate of change, in the level of GHG emissions using country level data instead of the static level. The changes are calculated over three periods: 5 years, 10 years, and 15 years[87].

A key concern regarding the model is the impact of confounding omitted variable bias[88]. While this concern cannot be completely eliminated, I believe that the use of panel data and a percentage change differenced[89] model to account for all between-country omitted variables that are time invariant, or persistent in nature, and potentially unobservable (Graham, Li, and Qiu, 2012; Ahmed and Duellman, 2013) can alleviate much of this concern because, in effect, each country serves as its own control for unobserved time invariant institutional factors. This model, to a certain extent, also addresses the concern over a lack of segregation of the impact of the strength of the reporting schemes with that of the strength of environmental regulations concurrently in force. While the percentage change differenced model does control for fixed country effects it, however, does not control for potential confounding factors that are time variant. In this respect, I have included a set of control variables for potential confounding factors that are time variant and that are found to have explanatory power with respect to GHG emissions in prior studies.

[87] The time horizons chosen is for the purpose to assess and observe the effect of the strength of the reporting schemes in short-, mid- and long- terms. The impact of a regulatory scheme may take years to become effective. The regulatory scheme remains in force unless being revised or overturned through a legislative decision. The fist sensitivity analysis conducted in this study presents results of the effects in additional time horizons (refer to the Section 4.5.1).

[88] A variable that is correlated with both GHG emissions and either the strength of the reporting schemes or the expert team reviews has been omitted. This will in turn bias the results by attributing the effect of the missing variables to the estimated effects regarding the two hypotheses tested.

[89] A differenced approach is employed instead of conventional fixed effect indicators to minimize sample loss. The number of observations per country, especially for the Non-Annex I countries which reported GHG inventory data, is not as complete as that of the Annex I countries. Therefore, including country indicators would jeopardize the large sample justification (Wooldridge, 2016).

The percentage change[90] differenced model[91] to be estimated by ordinary least square is:

$$\%\boldsymbol{\Delta}_{\mathbf{i}} GHGPC_{j,t} = \beta_0 + \beta_1 \Delta i REP\_IND_{j,t} + \beta_2 \sum_{i=0}^{n} TEC\_REV\, j,t + \beta_3 \%\boldsymbol{\Delta}_{\mathbf{i}} GDPPC_{j,t} + \beta_4 \%\boldsymbol{\Delta}_{\mathbf{i}} EGU_{j,t} + \beta_5 \%\boldsymbol{\Delta}_{\mathbf{i}} EPC_{j,t} + \beta_6 \boldsymbol{\Delta}_{\mathbf{i}} TRD_{j,t} + \beta_7 \boldsymbol{\Delta}_{\mathbf{i}} URB_{j,t} + \beta_8 \boldsymbol{\Delta}_{\mathbf{i}} ROL_{j,t} + \varepsilon, \quad (1)$$

Where the variables are as defined in Appendix A and described below.

4.3.1.1 Measuring Country's Carbon Emissions Growth

The data needed to measure a country's carbon emissions in a given year is sourced from the UNFCCC database. The study uses the GHG total without land use, land-use change, and forestry[92] (LULUCF) series (in kt CO2 equivalent) divided by the total population for country *j* in year *t*, as its dependent variable which is denoted as *GHGPCj,t*.

GHG total without LULUCF is chosen instead of the GHG total with LULUCF because of the potential reversibility and non-permanence of carbon stocks resulting from human activities (IPCC, 2014). The measure is deflated by a country's total population in year *t* to obtain a per capita measure to control for the

[90] The percentage change form is adopted instead of absolute change as the notion of percentage change is consistent with the logarithm form used in prior country level emissions studies (e.g., Sharma, 2011; Saidi and Hammami, 2015; Kasman and Duman, 2015; Rafiq et al,. 2016). The percentage change form is chosen (over the log change form) as it is calculated as the rate of growth that is the focus of the study. Unreported sensitivity analysis results from the log change model are qualitatively similar to that from the percentage change model.
[91] First differencing methodology used in the empirical tests is similar to fixed effects modelling in that it attempts to address the problem of omitted variables in panel data. In fact, in the special case where there are only two periods, the first differencing and fixed effects are numerically equivalent methods. The key point to both first differencing and fixed effects are that they are "within" estimators. As such, including the year fixed effects in the first differencing change model may result in overcontrolling for changes in the variables included in the regression model, and generate findings that make little sense in that they are either very difficult to interpret or non-robust.
[92] As defined under the UNFCCC, any process, activity, or mechanism which removes a GHG from the atmosphere is referred to as a "sink". The LULUCF are human activities that impact the terrestrial sinks. It achieves GHG mitigation through the increase in the removal and the decrease of emissions of the accumulated carbon stocks.

effect of total population growth on a country's emissions, which is consistent with prior country level emissions studies (e.g., Sharma, 2011; Sadorsky, 2014; Farhani and Ozturk, 2015; Zhu et al., 2016; Churchill et al., 2018).

The growth rate of the GHG emissions per capita in percent change over the period t+*i* (i=5,10,15) from year *t* for *country j* is calculated as:

$$\%\Delta iGHGPC_{jt} = (GHGPC_{j,t+i} - GHGPC_{j,t}) / GHGPC_{j,t}, \qquad (2)$$

In effect, the model coefficients indicate how the growth rates[93] in GHG emissions per capita in percentage terms are associated with a unit change in the independent variables.

4.3.1.2 Measuring the Strength of the Carbon Reporting Schemes

To test hypothesis H1, it is necessary to construct a relative measure of the strength of countries' different reporting schemes. A country's reporting scheme may consist of multiple reporting instruments[94] in a given year. I use an index that specifically accounts for systematic variations in countries' reporting instruments across six factors to assess its strength, as outlined in the next paragraph[95]. For each country *j* in year *t*, the score across the six factors is summed to give a total index

[93] The hypothesis on credibility enhancement mechanisms follows the argument that more credible carbon disclosures resulting from the undertaking of credibility enhancement mechanisms has the potential to facilitate more informed decision making on carbon emissions reduction. This is reflected in the dependent variables constructed using the rate of change between year t+i (i=5, 10, 15) and year t, which measures the subsequent carbon emissions growth. The subsequent carbon emissions growth is all termed in the thesis as carbon emissions growth.

[94] For example, stock exchange listing rules and government regulatory reporting requirements for a given country in a given year serve to enforce different reporting instruments, but all of them demand carbon information.

[95] In general, prior research uses dummy variable to indicate the regulatory pressure and participation in the ETS (Rankin et al., 2011) and/or ratification of the Kyoto Protocol (Luo et al., 2012;), and whether a company has a facility that is subject to EPA regulation (Stanny, 2013), or the existence of any Corporate Social Responsibility regulations (Dhaliwal et al. 2012; Ott, Schiemann, and Günther, 2017).

score out of 13[96] for each instrument - where a higher (lower) score indicates a stronger (weaker) reporting scheme. If a country has multiple instruments, the scores are then added together and this variable is denoted as $REP\_IND_{j,t}$.

The reporting instrument index follows the KPMG et al.'s (2016) Carrots and Sticks and the TCFD's (2017) reports and integrates not only the schemes that directly request GHG emissions reporting, but also the legislation or listing requirements that demands reporting of the Corporate Social Responsibility/non-financial information encompassing the environmental aspect. The carbon-related reporting schemes are listed and categorized in Appendix C.

The index is coded as follows:

1) the regulatory type (equals 3 for legislation; 2 for code of conduct/guidelines; 1 for initiatives; and 0 otherwise);
2) reporting scope (equals 2 for environmental information; 1 for sustainability information; and 0 otherwise);
3) reporting nature (equals 2 for mandatory; 1 for voluntary; and 0 otherwise);
4) geographical scope (equals 2 for national; 1 for sub-national; and 0 otherwise);
5) industry sectors (equals 2 for all;1 for specific; and 0 otherwise); and
6) location (equals 2 for report to regulator; 1 for annual report; and 0 otherwise) covered by the reporting instrument.

If there is no carbon-related reporting scheme entry in force in year *t*, a 0 score is assigned across the six factors. And the index for all the reporting

[96] As there are 6 categories that need to be factored into the reporting index, the raw scores of the index calculated in the sample range from 0 to 91. To compute the variable in the change form more consistently with other variables, this study divides the score of each reporting scheme passed by 13, which is the highest score allocated for the most stringent reporting schemes.

instruments in force in country j in year t is the sum[20] of the index calculated for each reporting scheme:

$$REP\_IND_{j,t} = \sum_{i=1}^{n} \frac{1}{13} (Type, Scope, Nature, Geographic, Industry, Location), \quad (3)$$

The change in the strength of a reporting scheme over the period t+i (i=5,10,15) from year *t* for country j is calculated as:

$$\Delta_i REP\_IND_{j,t} = REP\_IND_{j,t+\mathrm{i}} - REP\_IND_{j,t}, \quad (4)$$

In effect, the coefficient $\beta 1$ measures how many percentage points the growth rate in GHG emissions per capita changes when the reporting index increases by one unit. In line with hypothesis H1, I expect that an increase in the strength of carbon reporting schemes is negatively associated with a country's GHG emissions growth.

4.3.1.3 Measuring the Presence of In-country Expert Team Review

To test hypothesis H2, it is necessary to construct a measure of the credibility enhancement mechanisms provided in terms of the countries' reported GHG emissions. To proxy for the level of credibility enhancement mechanisms given, I use an indicator variable, *TEC_REVj,t*, that is equal to 1 for country *j* in year *t* when that country's submission of reported GHG emissions in that year is subject to an in-country expert team review[97] with an associated review report and, 0 otherwise (Simnett et al., 2009b; Moroney et al., 2012; Braam et al., 2016; Zhou et al., 2016).

[97] In-country expert team reviews are conducted on each NCs submitted to the UNFCCC. All the Annex I countries are required to submit NCs every four years since ratification of the UNFCCC. Hence, the years in which the in-country expert reviews conducted on the NCs are indicated as 1, and 0 otherwise.

I expect that the effect from reviews will be cumulative over time[98]. Consequently, the change in technical reviews over time is measured as the total number of expert reviews conducted for country *j* during the time period between year *t* and year *t*+i (i=5,10,15):

$$\sum_{i=0}^{n} TEC\_REV_{j,t}, \tag{5}$$

In effect, the coefficient $\beta 2$ measures how many percentage points the growth rate in GHG emissions per capita changes when the number of expert reviews increases by one over the relevant period. In line with hypothesis H2, I expect that an increase in the number of expert reviews is negatively associated with a country's GHG emissions growth.

4.3.1.4 Variables to Control for Time Variant Confounding Factors

A series of control variables that might impact growth rates in GHG emissions per capita are identified from prior studies. The evidence supports the notion that GDP growth is highly correlated with the carbon emissions trend[99] (e.g., Richmond and Kaufmann, 2006; Apergis and Payne, 2009; Pao and Tsai, 2010; Hossain, 2011; Sharma, 2011; Arouri et al., 2012; Farhani and Ozturk, 2015; He and Yao, 2017; Churchill et al., 2018; Sarkodie and Strezov, 2018; Shahbaz et al., 2018) and countries have endeavoured to decarbonize economic growth over the

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[98] A list of recommendations is included in the review report issued by the expert teams. In subsequent years countries will provide NCs indicating whether and which of the recommendations have been fully addressed. It sometimes takes several years for the formulation and implementation of proper practices and measures needed to address the recommendations. Therefore, the effects of the expert team reviews are cumulative over time in terms of improving a country's reporting systems and thus the accuracy and reliability of reported information.

[99] Several studies have extensively tested the EKC hypothesis that establishes an inverted U-shape relationship between different pollutants and per capita income. The studies, however, present inconsistent results (e.g., Grossman and Krueger, 1995; Jobert, Karanfil, and Tykhonenko, 2014). When including the square GDP per capita variable in an untabulated sensitivity analysis, the inferences with respect to the variables of interest that I identify remain unchanged.

past decade (Deloitte, 2017). To account for differences in countries' GDP growth, the variable $\%\Delta_i GDPPC_{j,t}$ is included and it measures the growth rate in GDP per capita ($GDPPC_{j,t}$) in constant 2010 U.S. dollars for each country.

A stream of research introduces energy consumption into the economic activity and emissions nexus, claiming that energy consumption, which leads to economic development through enhanced productivity, is an important determinant of carbon emissions (e.g., Kraft and Kraft, 1978; Bentzen and Engsted, 1993; Altinay and Karagol, 2004; Soytas and Sari, 2006; Apergis and Payne, 2009; Sharma, 2011; Sadorsky, 2014; Farhani and Ozturk, 2015; Zhu et al., 2016; Churchill et al., 2018). To account for energy consumption, the model includes the variables $\%\Delta_i EPC_{j,t}$, and $\%\Delta_i EGU_{j,t}$, which control for a country's growth rate for electric power consumption (in kWh per capita) and the country's growth rate for energy use (in kg of oil equivalent per capita), respectively.

International trade explains the movement of goods from one country to another for the purposes of consumption and the production process. Increases in consumption and production due to international trade are two of the sources of emissions pollution (Antweiler et al., 2001; Copeland and Taylor, 2004). To account for differences in trade growth between countries, the model includes the variable $\Delta_i TRD_{j,t}$ which measures the difference between the trade (as a percentage of GDP) of country *j* in year *t*+i (i=5,10,15) from year *t*, where trade is the sum of exports and imports of goods and services as a share of GDP.

Growing urban populations place constraints on urban resources and the environment, especially in developing countries where workers migrate in the course of seeking better jobs, education, and healthcare (Parikh and Shukla, 1995; York et al., 2003; Cole and Neumayer, 2004; Liddle and Lung, 2010; Sharma, 2011;

Sarkodie and Strezov, 2018). To account for urban populations, the model includes the variable $\Delta_i URB_{j,t}$ which is the difference between country *j*'s urban population as a percentage of its total population in year *t*+i (i=5,10,15) and that in year *t*.

The variable $\Delta_i ROL_{j,t}$ is also included in the model and it measures the change in the rule of law index for country *j* in year *t*+i (i=5,10,15) and that in year *t*. This index originates from Kaufmann, Kraay, and Mastruzzi (2009) and captures ''the perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.'' This variable ranges from a theoretical minimum of -2.50 to a maximum of 2.50, where the median value over all countries in Kaufmann et al. (2009) is 0.0 (Andersen, Hansen, and Markussen, 2006; Lamoreaux, Michas, and Schultz, 2015). The higher the increase in the index, the better the improvement of the legal enforcement system, and the more likely that a reporting scheme is effectively administered, either through public enforcement or private ordering[100] (Djankov, La Porta, Lopez-de-Silanes, and Shleifer, 2003; Shleifer, 2005).

4.3.2 Sample Selection

My sample selection process starts with all the reporting countries to the UNFCCC during the period 1990 - 2014. While data for the 43 Annex I countries is directly extracted in a consolidated form, the data for non-Annex I countries has been individually collected from their reported emissions summary tables. I also checked each of the biennial reports submitted from non-Annex I countries; any additional emissions data found was added to the sample. I drop 26 non-Annex I countries from the sample, because they had either no valid data or less than two

[100] Djankov et al. (2003) developed the enforcement theory of regulation that highlights the importance of strategies trade-offs when enforcing regulatory practices.

years of reported emissions[101] data. After excluding 305 country-year observations with missing information for the variables, a total of 123 countries (Annex I: 41; Non-Annex I: 82) with 1,600 (995 for Annex I countries and 605 for non-Annex I countries) country-year observations are included in the main analyses.

TABLE 4-1 Sample Selection

	Annex I		**Non-Annex I**	
	No. of countries	**No. of country-year obs.**	**No. of countries**	**No. of country-year obs.**
Sample with valid GHG data	43	1,032	127	873
Less missing control variable values	(2)	(37)	(45)	(268)
Final sample	41	995	82	605

All variables are defined in text and in Appendix A.

4.4 Results

4.4.1 Summary Statistics

Table 4-2 Panel A provides the summary statistics for the overall sample in the level form[102]. The mean of GHG per capita (without LULUCF), *GHGPC*, is 9.544 metric tonnes CO_2 equivalent, but there is also a large variation in GHG emissions per capita across countries and across years with the lowest and highest values being 0.220 metric tonnes and 46.284 metric tonnes, respectively, of CO_2 equivalent. These values are similar to that reported in Sharma's (2011)[103] study. The mean score of the *REP_IND* is 0.485, which means that on average, countries in a given year score a little over 6 out of 13 on the index for the strength of the

[101] To calculate the dependent variable, specifically, the growth rate in GHG emissions, a country needs have reported emissions for at least two years.
[102] Instead of showing each variable in the percentage changed differenced form (as constructed in the regression model (1), the summary statistics report each variable in their original values for convenient interpretation of the results.
[103] Sharma (2011) partitioned a total of 69 countries over the period 1985-2005 into three groups: high income, middle income, and low income. The mean value for GHG emissions in the high-income group was 9.343 metric tonnes per capita in CO_2 equivalents.

reporting scheme. It is evident, however, that more than half of the countries have scores of zero for this variable, which means that a large portion of the countries in the sample have nil carbon reporting instruments in place. The mean value for *TEC_REV* is 0.129, which indicates that about 13% of the sample country-year observations are subject to an in-country expert team review by the UNFCCC. In other words, credibility enhancement on reported GHG emissions at the country level cannot be described as a routine occurrence. The mean value of *GDP per capita* is $20,566.88 in constant 2010 US dollars[104], but as expected there is a large variation across countries with a minimum and maximum values of US$172.79 and US$111,968.32, respectively.

Table 4-2, Panel B presents the mean comparison of independent variables for high and low emissions countries. The country-year observations are partitioned into high and low emissions groups based on the median value of 8.703 metric tonnes CO_2 equivalent per capita. The results show that, countries with high GHG emissions levels are associated with a greater amount of energy usage (*EGU*, t = -30.582, p< 0.001), a higher-level electric power consumption (*EPC*, t = -21.043, p< 0.001), a larger urban population (*URB*, t = -20.561, p< 0.001), but also somewhat unexpectedly, a higher score on the legal enforcement system variable (*ROL*, t = -21.890, p< 0.001).

The univariate results with respect to my two hypotheses show that observations with high emissions levels are associated with more stringent reporting schemes (*REP_IND*, t = -6.527, p< 0.001) and are more likely to be subject to an

[104] Sharma (2011) partitioned a total of 69 countries over the period 1985-2005 into three groups: high income, middle income, and low income. The mean value for GDP per capita was $20,853.98 in constant 2000 US dollars for the group of high-income countries.

in-country expert review (*TEC_REV*, t = -5.332, p< 0.001). While this is contrary to my hypotheses, it is not an unexpected result given that these are univariate tests.

TABLE 4-2 Summary Statistics

Panel A: Full Sample

	n	Mean	Std.	Min	Q1	Median	Q3	Max	Skewness
GHGPC	1,600	9.544	6.066	0.220	5.553	8.703	12.263	46.284	1.202
REP_IND	1,600	0.485	0.962	0.000	0.000	0.000	0.846	7.000	2.619
TEC_REV	1,600	0.129	0.336	0.000	0.000	0.000	0.000	1.000	2.209
GDPPC	1,600	20566.881	21090.282	172.793	3828.814	11275.471	35409.653	111968.322	1.347
EGU	1,600	3002.482	2289.621	125.792	1413.043	2557.363	4019.702	18178.143	1.950
EPC	1,600	5521.353	5873.213	32.751	1977.491	3935.334	6661.832	54799.174	3.405
TRD	1,600	86.734	50.747	0.274	53.491	75.538	109.311	382.291	1.964
URB	1,600	66.303	17.756	10.442	55.101	68.326	79.080	100.000	-0.575
ROL	1,600	0.486	1.066	-2.131	-0.400	0.594	1.501	2.100	-0.215

Panel B: Means Comparison by Emissions Group

	Full sample		High emissions group		Low emissions group			
	n	Mean	n	Mean	n	Mean	*t*-value	*p*-value
REP_IND	1,600	0.485	800	0.640	800	0.330	-6.527	0.001
TEC_REV	1,600	0.129	800	0.174	800	0.085	-5.332	0.001
GDPPC	1,600	20566.882	800	30730.261	800	10403.532	-21.994	0.001
EGU	1,600	3002.483	800	4393.251	800	1611.712	-30.582	0.001
EPC	1,600	5521.352	800	8256.302	800	2786.443	-21.043	0.001
TRD	1,600	86.734	800	87.811	800	85.656	-0.849	0.396
URB	1,600	66.303	800	74.422	800	58.184	-20.561	0.001
ROL	1,600	0.486	800	0.998	800	-0.025	-21.890	0.001

Panel A reports the sample description. Panel B presents the means comparison between high and low emissions groups. All variables are defined in text and in Appendix A.

The results in Table 4-2, Panel B, also show that there are systematic differences between high and low emissions countries, such as legal enforcement systems (*ROL*), that may drive the rationale behind emphasizing reporting and reviews for countries in the high emissions group. Therefore, the formal tests of my hypotheses rely on the fixed-effect multivariate model that tests the rate of change for panel observations and controls for the systematic differences in confounding factors between countries and over time.

4.4.2 Pearson/Spearman Correlations

Table 4-3 Panel A provides the results of both Pearson and Spearman correlations of the variables used in this study in level form. The variables *GDPPC* (0.574), *EGU* (0.755), *EPC* (0.547), *URB* (0.554) are highly correlated with *GHGPC,* which is consistent with the tenet from voluminous economic studies that these factors have a strong impact on emissions levels (e.g., Grossman and Krueger, 1991; Suri and Chapman, 1998; Apergis and Payne, 2009; Hossain, 2011; Arouri et al., 2012; Churchill et al., 2018; Sarkodie and Strezov, 2018). The two variables of interest, namely, *REP_IND* (0.191) and *TEC_REV* (0.144) also show a significant correlation with *GHGPC*. This might be because the high-income counties that are associated with high emissions levels have greater incentives and resources to formulate reporting schemes to regulate environmental activities, and because developed countries that are normally Annex I countries according to the UNFCCC are subject to reviews conducted by international expert teams.

TABLE 4-3 Correlations between GHGPC and Other Country-Level Variables

Panel A: Variables in Level Form

	GHGPC	**REP_IND**	**TEC_REV**	**GDPPC**	**EGU**	**EPC**	**TRD**	**URB**	**ROL**
GHGPC	1.000	0.250	0.179	0.681	0.874	0.793	0.020	0.588	0.580
REP_IND	0.191	1.000	0.232	0.455	0.338	0.406	0.040	0.342	0.359
TEC_REV	0.144	0.217	1.000	0.266	0.241	0.262	0.038	0.161	0.238
GDPPC	0.574	0.344	0.226	1.000	0.822	0.885	-0.002	0.735	0.901
EGU	0.755	0.231	0.194	0.695	1.000	0.943	0.057	0.667	0.714
EPC	0.547	0.233	0.183	0.703	0.909	1.000	0.064	0.689	0.799
TRD	0.092	-0.022	0.028	0.174	0.111	0.061	1.000	-0.121	0.054
URB	0.554	0.302	0.169	0.587	0.604	0.522	0.062	1.000	0.633
ROL	0.526	0.307	0.236	0.808	0.626	0.611	0.130	0.635	1.000

Panel B: Variables in Rate of Change Form for a 1-year Horizon

	A	B	**C**	D	E	F	G	H	I
A. $\%\Delta_1$GHGPC	1.000	-0.038	-0.078	0.457	0.688	0.544	0.100	0.156	-0.002
B. Δ_1REP_IND	-0.020	1.000	0.102	-0.039	-0.047	-0.029	0.037	0.061	0.080
C. $\sum_1$ TEC_REV	-0.034	0.094	1.000	-0.004	-0.077	-0.068	0.076	-0.043	0.049
D. $\%\Delta_1$GDPPC	0.249	-0.002	0.026	1.000	0.419	0.492	0.142	-0.004	0.068
E. $\%\Delta_1$EGU	0.323	-0.026	-0.028	0.500	1.000	0.593	0.078	0.135	-0.008
F. $\%\Delta_1$EPC	0.162	-0.014	-0.028	0.416	0.552	1.000	0.117	0.156	-0.021
G. Δ_1TRD	-0.029	0.013	0.032	0.028	0.036	0.089	1.000	-0.019	-0.047
H. Δ_1URB	0.085	0.026	-0.063	0.088	0.155	0.174	-0.007	1.000	-0.056
I. Δ_1ROL	-0.047	0.038	0.033	0.057	-0.035	-0.006	-0.038	-0.054	1.000

Table 4-3 reports the Pearson (bottom) and Spearman (top) correlations between GHGPC and other country-level variables. Panel A presents the variables in level form. Panel B presents the variables in rate of change form for a 1-year horizon.
All variables are defined in text and in Appendix A.

The Spearman correlation results are consistent with that of the Pearson correlation. The high correlation between some of the variables in the level form does not raise potential multicollinearity concerns as none of the control variables are highly correlated with the two variables of interest[105]. Also, the results of the Pearson correlation when using the rate of change variables (Panel B) do not return any values greater than 0.55.

4.4.3 Regression Results

The analyses are conducted for the 5-, 10-, and 15- year time horizons over the sample period 1990-2014. Due to the calculations of the rate of change and difference variables in the models, the number of observations is reduced from 1,600 in the full sample to 1,069, 757 and 474 in models (1)- (3) respectively. The Adjusted R-squared increases from 57.69 percent in model (1), 75.64 percent in model (2) and then it drops slightly to 74.69 percent in model (3). This suggests that the models could reasonably explain the growth rates in GHG emissions per capita.

4.4.3.1 Testing of Hypotheses

In H1, it is conjectured that the strength of a country's carbon reporting schemes is negatively related with its emissions growth. β_1, the coefficient of the variables of interest, namely, $\Delta_5 REP\_IND$ and $\Delta_{15} REP\_IND$, show negative signs as expected, but they are not statistically significant. $\Delta_{10} REP\_IND$ (β_1 = -0.009, *t*= -2.13) is negatively associated with the dependent variable $\Delta_{10} GHGPC$ at the 5 percent significance level. The effect size suggests that a unit increase in the strength

[105] High collinearity between variables may cause imprecise parameter estimates and larger standard errors. However, multicollinearity is not a concern if the collinearity is confined to control variables only, as the estimated parameters and standard errors on the variables of interest would not be affected. Furthermore, if a parameter estimate is found to be statistically significant it is not *because*, but rather *despite* multicollinearity issues (Wooldridge, 2016).

of the reporting scheme is related with a 0.9 percentage points decrease in GHG emissions growth over the 10-year time horizon.

Hypothesis 2 posits that international expert teams' in-country reviews, as prescribed by the UNFCCC as the credibility enhancement mechanism, facilitates a country's carbon reduction. The coefficient of $\sum TEC\_REV$ is negatively significant over the 5-, 10-, and 15- year time horizon models. The findings for β_2 are consistent for Models (1), (2) and (3) and suggest that one additional expert team technical review is associated with a 1.5 percentage point (β_2= -0.015, t= -2.92), 2.1 percentage point (β_2= -0.021, t= -6.54), and 1.9 percentage point (β_2= -0.019, t= -5.23) reduction in a country's GHG emissions growth over the 5-, 10, and 15- year time horizons.

In terms of effect sizes, both the two variables of interest demonstrate a modest, but non-trivial, curbing effect on GHG emissions growth rates compared to the traditional determinants of carbon emissions found in macroeconomic studies. This is as expected. Unlike being a direct driver of GHG emissions, such as power consumption and energy use, a country's reporting scheme and credibility enhancement mechanisms have an indirect effect which improves the accuracy and reliability of information and assists policymakers to identify and implement practices to reduce GHG emissions. Nevertheless, I consider the effects sizes to be not-trivial, especially if one considers that a large proportion of countries reported percentage growth rates in GHG emissions that are in the single digit range.

In sum, the regression results provide partial support of H1 as the reporting index (*ΔREP_IND*) is moderately effective over the 10-year time horizon analysis, indicating that any carbon-related reporting instruments take years from the time they come into effect until they eventually slow down a country's emissions.

However, this curbing effect does not persist until the 15-year horizon. Contrary to expectations, the long-term effect of reporting schemes is not significant. This might be due to the dynamic nature of a country's institutional environment. As the differenced model accounts for time-invariant institutional factors, other factors that are changing over time are not captured in the model. There is also the possibility that existing reporting schemes might result in lost capacity due to harboring the advancement of new technologies in the interests of reducing the cost of generating energy from renewable sources, and this could lead to a demand for new reporting schemes. With regard to H2, the presence of an expert team review as the credibility enhancement mechanism ($\sum TEC\_REV$) for country's reported carbon information demonstrates a persistent effect on curbing GHG emissions per capita growth over the 5-, 10-, and 15- year time horizons, indicating that it takes a few years for a country to improve its reporting system and perform better in terms of reducing emissions.

Based on the findings relating to the main hypotheses, both the statistical significance and economic magnitude of the $\sum TEC\_REV$ variable (which is twice that of the *ΔREP_IND*) in the base models highlight the importance of the effect of credibility enhancement on the reported carbon information. Consistent with the second hypothesis, a UNFCCC prescribed expert team review is effective not only for assessing reported information but also for facilitating emissions reduction. It seems that in-country expert reviews induce countries to comply with the IPCC's reporting standards and improve their reporting systems to be better able to manage and reduce GHG emissions. While regulating carbon-related reporting has the potential to slow down carbon emissions at the country level (as evidenced in the 10-year horizon model), the reported information provides little help with combating environmental degradation if there are no proper safeguards in place for reporting procedures or the verification of reported information.

TABLE 4-4 The Impact of Carbon Reporting Schemes and Credibility Enhancement Mechanisms on Carbon Emissions Growth

	Dep. Var. =		
	%Δ_5GHGPC (1)	**%Δ_{10}GHGPC (2)**	**%Δ_{15}GHGPC (3)**
ΔREP_IND	-0.008	-0.009**	-0.005
	(-1.37)	(-2.13)	(-0.91)
ΣTEC_REV	-0.015***	-0.021***	-0.019***
	(-2.92)	(-6.54)	(-5.23)
%ΔGDPPC	0.276***	0.100***	0.075***
	(10.95)	(8.11)	(5.68)
%ΔEGU	0.625***	0.631***	0.460***
	(14.88)	(22.77)	(11.43)
%ΔEPC	0.002	0.024	0.107***
	(0.06)	(1.30)	(4.40)
ΔTRD	0.000	0.000	-0.001***
	(-1.23)	(0.02)	(-3.22)
ΔURB	0.009***	0.010***	0.011***
	(3.17)	(7.35)	(7.10)
ΔROL	-0.015	0.050***	0.040***
	(-0.59)	(3.13)	1.87
Constant	-0.045***	-0.050***	-0.088***
	(-5.33)	(-5.30)	(-5.33)
Observations	1,069	757	474
Adjusted R-squared	0.5769	0.7564	0.7469

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 4-4 Presents regression results for Equation (1) using %ΔGHGPC as the dependent variable. The dependent variables are the percentage change of GHGPC[106] over a 5-year horizon in Column (1), the percentage change of GHGPC over a 10-year horizon in Column (2), and the percentage change of GHGPC over 15-year horizon in Column (3).
All variables are defined in text and in Appendix A.

4.5 Sensitivity Analyses

To address some of the limitations identified from the main analyses, namely, the use of a single reporting scheme database, the use of a moderately unbalanced

[106] A sensitivity test to include the change in population as one of the control variables of the regression model was also ran. Untabulated regression results show qualitatively similar findings on the variables of interest. The coefficients of the population variable stay significantly positive across the models. The adjusted R-squared for the regression models remain at approximately 55 percent. This is significantly lower for the 10- and 15- year horizon of the main analyses where the adjusted R-squared increase to around 75 percent.

panel data, and the measure of strength of a country's legal enforcement system, a series of sensitivity analyses is conducted.

4.5.1 Additional Time Horizons

In the main analyses, the 5-, 10-, and 15- year time horizons are chosen as conventional cut-off points. In the first sensitivity analysis, additional year horizons are tested to identify the starting point when the variables of interest start to become effective. Using the same base model, the rate of change variables are calculated using i = 1,2,3,4…8,9…13,14,15 to complement the main analysis and investigate the trend of effect.

Figure 4-1 below shows the coefficients of both the variables *ΔREP_IND* and $\sum TEC\_REV$ extracted from regression results of running the base model over the 1- to 15-year time horizons, respectively. The reporting scheme index becomes statistically significant over the 7- year horizon and stays effective until the 12th year time horizon. The expert review variable starts to take effect during the 3rd year time horizon and remains statistically negative at the 1 percent significance level throughout. As observed from the trend analysis, the economic magnitude of the coefficient for expert team reviews (approximately -0.02) is in general double that of the coefficient for the reporting instrument index (approximately -0.01). This result provides further evidence that the reporting index is effective in curbing approximately 1 percentage point of emissions growth per capita from the 7th year since it came into effect until the 12th year. And an in-country expert team review is associated with approximately a 2 percentage points decline in per capita emissions growth 3 years continuously until the 15th year after the review.

FIGURE 4-1 The Coefficient of *Δ*REP_IND and *Σ*TEC_REV over 1- 15-year Horizons

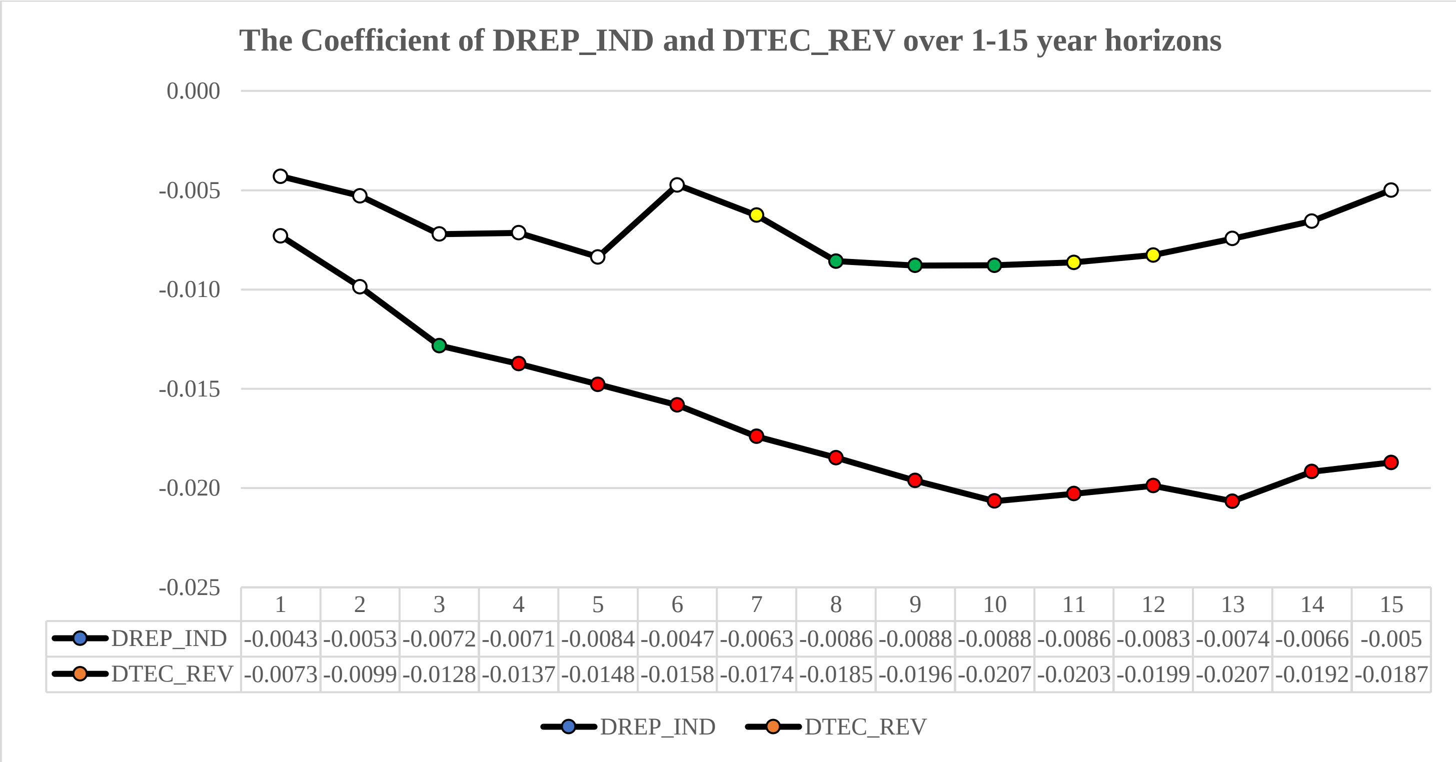

Figure 4-1 Presents the coefficients of the *Δ*REP_IND and *Σ*TEC_REV in relation to GHG emissions change over 1 to 15- year time horizons.
Yellow, Green, Red denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

4.5.2 Alternative Measure for the Strength of Environmental Regulations

To ensure that the results from using the Carrot and Stick sustainability reporting instrument database is robust to alternative measures, I use The Climate Change Laws of the World database to derive an alternative measure for the strength of a country's reporting scheme. The Climate Change Laws of the World database is established by Grantham Research Institute on Climate Change and the Environment and Sabin Center for Climate Change Law based on several years of data collection. This database covers country level climate change laws and policies of 197 countries worldwide. Climate change laws and policies[107] are separately grouped to distinguish between a country's legislative and executive portfolios in relation to regulations. In addition, it also collects climate litigation cases from 25 major economies, but not including the United States (U.S.). The number of climate change litigation cases in the U.S. is extracted from the Sabin Center / Arnold & Porter Kaye Scholer database. The testing model is then adapted from the base model as

$$\%\Delta_i GHGPC_{j,t} = \beta_0 + \beta_1 \Delta_i CCLaw_{j,t} + \beta_2 \Delta_i CCPolicy_{j,t} + \beta_3 \Delta_i Litigation_{j,t} + \beta_4 \sum_{i=0}^{n} TEC\_REV_{j,t} + \beta_5 \%\Delta_i GDPPC_{j,t} + \beta_6 \%\Delta_i EGU_{j,t} + \beta_7 \%\Delta_i EPC_{j,t} + \beta_8 \Delta_i TRD_{j,t} + \beta_9 \Delta_i URB_{j,t} + \beta_{10} \Delta_i ROL_{j,t} + \varepsilon, \quad (6)$$

[107] The laws and policies cover the government regulations that demand for carbon emissions reporting (e.g., NGER, Renewable Energy (Electricity) Act 2000, and Carbon Farming Initiative in Australia, GHGRP in Canada) which are also covered by the *REP_IND* in the thesis, whereas the *REP_IND* covers more comprehensive sources that demand for carbon-related disclosures, for example, exchange listing requirements (ASX listing rules, corporate governance principles and recommendations in Australia) or corporations act (Corporations Act 2009 in Australia).
Correlations between *CCLaw* and *REP_IND* is 0.5678, and between *CCPolicy* and *REP_IND* is 0.4622.

$\varDelta_i CCLaw_{j,t}$: defined as the difference between the number of climate change laws in country *j* in year *t*+i (i=5,10,15[108]) and that in year *t*. $\varDelta_i CCPolicy_{j,t}$: defined as the difference between the number of climate change policies in country *j* in year *t*+i (i=5,10,15) and that in year *t*. $\varDelta_i Litigation_{j,t}$: defined as the difference between the number of climate change litigation cases initiated in country *j* in year *t*+i (i=5,10,15) and that in year *t*. The regression results over different time horizons are presented in Table 4-5.

TABLE 4-5 The Effect of Environmental Regulation on Carbon Emissions Growth

	Dep. Var. =		
	%$\varDelta_5$GHGPC (1)	**%$\varDelta_{10}$GHGPC (2)**	**%$\varDelta_{15}$GHGPC (3)**
$\varDelta$CCLaw	-0.007**	-0.006***	-0.004*
	(-1.97)	(-2.89)	(-1.85)
$\varDelta$CCPolicy	-0.000	0.001	-0.001
	(-0.10)	(0.35)	(-0.32)
$\varDelta$Litigation	0.000	0.000	0.000
	(0.53)	(1.02)	(0.90)
ΣTEC_REV	-0.014***	-0.021***	-0.018***
	(-2.68)	(-6.96)	(-5.10)
%$\varDelta$GDPPC	0.275***	0.101***	0.077***
	(10.94)	(8.20)	(5.82)
%$\varDelta$EGU	0.625***	0.634***	0.456***
	(14.89)	(22.88)	(11.28)
%$\varDelta$EPC	-0.000	0.023	0.109***
	(-0.01)	(1.22)	(4.49)
$\varDelta$TRD	-0.000	0.000	-0.001***
	(-1.18)	(0.12)	(-3.19)
$\varDelta$URB	0.009***	0.010***	0.010***
	(3.20)	(7.27)	(7.12)
$\varDelta$ROL	-0.018	0.047***	0.036
	(-0.73)	(2.89)	(1.62)
Constant	-0.042***	-0.045***	-0.081***
	(-4.79)	(-4.57)	(-4.77)
Observations	1,069	757	474
Adjusted R-squared	57.71	75.71	74.76

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 4-5 Presents regression results for Equation (6) using %$\varDelta$GHGPC as the dependent variable. The dependent variables are the percentage change in GHGPC over a 5-year time horizon in Column (1), the percentage change in GHGPC over a 10-year time horizon in Column (2), and the percentage change in GHGPC over a 15-year time horizon in Column (3).
All variables are defined in text.

[108] I also ran a sensitivity analysis to test the model (6) using additional time horizons (i.e. t+i, i=1,2,3,4…8,9,10…13,14,15) to detect statistical significance for the coefficients of Policy and Litigation variables over any of the other year horizons. Untabulated regression results find statistical insignificance on the coefficients of both the Policy and Litigation variables across different year horizons.

The coefficient of the variable *ΔCCLaw* is significant over the 5-, 10-, and 15-year time horizons, but that of the *ΔCCPolicy* remains statistically insignificant. The passage of one more climate change law leads to a 0.7, 0.6 and 0.4 percentage point reduction in a country's emissions over 5, 10, and 15 years, respectively, taken from the date that the law became effective. This substantiates the argument that more stringent carbon regulations are more likely to curb GHG emissions growth.

4.5.3 Annex I Countries versus Non-Annex I Countries

The current sample collected from the UNFCCC database presents unbalanced panel data. This is largely due to the inconsistent patterns of reporting from the non-Annex I countries. The requirements relating to UNFCCC reporting and monitoring for Annex I and non-Annex I countries vary substantially and it is necessary to partition the two groups of countries into separate panels. Table 4-6 presents the regression results from the base model. The coefficient of *ΔREP_IND* (β_1 = -0.033, t= -1.96) remains significantly associated with GHG emissions for non-Annex I countries over the 10-year time horizon, but not significant for the Annex I countries. The coefficients of the variable $\sum TEC\_REV$ [109] stay robust over the 5-, 10-, and 15- year time horizons for the Annex I countries. Taken together, the results could suggest that while more stringent reporting schemes could to some extent aid developing countries improve carbon transparency and better manage carbon emissions growth, credibility enhancement mechanisms are helpful for developed countries to achieve emissions reduction.

[109] The expert team review variable is omitted for the Non-Annex I group as there have been no in-country expert team reviews conducted within the sample period.

4.5.4 Alternative Pollutant Emissions Measures

In the main analysis, GHG emissions extracted from the UNFCCC database exclude the LULUCF sector, which acts as a 'carbon sink' that removes carbon emissions from the atmosphere. However, when countries are setting their emissions reduction targets, the LULUCF sector is included in the calculation of the total GHG emissions. Moreover, prior macroeconomic country level studies use CO_2 per capita as the measure for emissions (e.g., Sharma, 2011; Arouri et al., 2012; Sadorsky, 2014; Zhu et al., 2016; Churchill et al., 2018). Two alternative measures for emissions employed in sensitivity analyses are then: GHG total with LULUCF and CO_2 per capita.

Table 4-7 displays regression results of the base model using alternative measures for carbon emissions growth. Results from Panel A suggest that $\sum TEC\_REV$ is related with 2.1, 6.2 and 16.9 percentage points decrease of CO_2 per capita throughout 5, 10 and 15- year time horizons. In the meantime, a unit increase in the strength of carbon reporting schemes (*ΔREP_IND)* is associated with an approximate 2 percentage points decrease in total GHG emissions with LULUCF across different year time horizons.

TABLE 4-6 The Impact of Carbon Reporting Schemes and Credibility Enhancement Mechanisms on Carbon Emissions Growth Between Annex I and Non-Annex I Countries

Panel A: Annex I Countries

	Dep. Var. =		
	$\%\Delta_{5}$GHGPC (1)	**$\%\Delta_{10}$GHGPC (2)**	**$\%\Delta_{15}$GHGPC (3)**
ΔREP_IND	-0.001	-0.003	-0.002
	(-0.43)	(-0.83)	(-0.57)
ΣTEC_REV	-0.006**	-0.013***	-0.021***
	(-2.27)	(-3.94)	(-5.91)
$\%\Delta$GDPPC	0.172***	0.141***	0.118***
	(10.34)	(9.69)	(7.71)
$\%\Delta$EGU	0.635***	0.533***	0.447***
	(23.45)	(16.45)	(10.15)
$\%\Delta$EPC	0.025	0.064**	0.041
	(0.97)	(2.50)	(1.50)
ΔTRD	0.000	0.000**	-0.001***
	(-0.11)	(-2.31)	(-5.81)
ΔURB	0.005***	0.004***	0.004***
	(3.27)	(2.94)	(2.83)
ΔROL	0.026*	0.028*	0.024
	(1.84)	(1.73)	(1.17)
Constant	-0.053***	-0.076***	-0.060***
	(-11.39)	(-7.01)	(-3.29)
Observations	790	585	380
Adjusted R-squared	0.7666	0.7527	0.7123

Panel B: Non- Annex I Countries

	Dep. Var. =		
	$\%\Delta_{5}$GHGPC (1)	**$\%\Delta_{10}$GHGPC (2)**	**$\%\Delta_{15}$GHGPC (3)**
ΔREP_IND	-0.034	-0.033*	-0.015
	(-1.40)	(-1.96)	(-0.58)
$\%\Delta$GDPPC	0.302***	0.058**	0.029
	(4.87)	(2.41)	(1.12)
$\%\Delta$EGU	0.623***	0.679***	0.363***
	(6.00)	(10.68)	(3.77)
$\%\Delta$EPC	0.011	-0.015	0.135***
	(0.14)	(-0.46)	(2.75)
ΔTRD	0.000	0.001	0.001
	(-0.74)	(1.59)	(0.70)
ΔURB	0.009	0.018***	0.026***
	(1.11)	(4.79)	(5.66)
ΔROL	-0.015	0.100***	0.076
	(-0.22)	(2.77)	(1.37)
Constant	-0.031	-0.029	-0.131***
	(-1.31)	(-1.44)	(-3.49)
Observations	279	172	94
Adjusted R-squared	0.5131	0.7659	0.8159

Table 4-6 Presents regression results of Equation (1) using $\%\Delta$GHGPC as the dependent variable. Panel A reports the results for the Annex I countries group. Panel B presents the results for the Non-Annex I countries group. The dependent variables are percentage change in per capita GHG emissions over 5, 10, 15- year time horizons in Columns (1)- (3), respectively.
All variables are defined in text.

TABLE 4-7 The Impact of Carbon Reporting Schemes and Credibility Enhancement Mechanisms on Carbon Emissions Growth using Alternative Carbon Emissions Measures

Panel A: Carbon Dioxide Emissions

	Dep. Var. =		
	%⊿$_5$CO2	**%⊿$_{10}$CO2**	**%⊿$_{15}$CO2**
	(1)	**(2)**	**(3)**
⊿REP_IND	-0.004	-0.074	0.019
	(-0.75)	(-5.60)	(0.49)
ΣTEC_REV	-0.021**	-0.062***	-0.169***
	(-4.75)	(-6.56)	(-10.08)
%⊿GDPPC	0.192***	0.364***	0.845***
	(8.59)	(6.74)	(7.80)
%⊿EGU	1.209***	1.011***	1.247***
	(32.60)	(12.81)	(9.79)
%⊿EPC	-0.185	0.013**	-0.232
	(-5.96)	(0.20)	(-2.00)
⊿TRD	0.000	-0.001**	-0.001***
	(-0.74)	(-1.63)	(-1.57)
⊿URB	0.015***	0.034***	0.031***
	(6.04)	(6.37)	(2.89)
⊿ROL	0.064*	-0.043*	-0.288
	(2.93)	(-0.94)	(-3.28)
Constant	-0.024***	-0.011***	0.042***
	(-3.13)	(-0.73)	(1.52)
Observations	1,048	740	459
Adjusted R-squared	0.7580	0.5332	0.5874

Panel B: Carbon Emissions Measures including Carbon Sink

	Dep. Var. =		
	%⊿$_5$GHGSPC	**%⊿$_{10}$GHGSPC**	**%⊿$_{15}$GHGSPC**
	(1)	**(2)**	**(3)**
⊿REP_IND	-0.027**	-0.021**	-0.020*
	(-2.51)	(-2.50)	(-1.67)
ΣTEC_REV	-0.002	0.006	0.006
	(-0.26)	(0.95)	(0.76)
%⊿GDPPC	0.308***	0.173***	0.130***
	(6.38)	(6.90)	(4.42)
%⊿EGU	0.777***	0.694***	0.550***
	(9.65)	(11.83)	(5.70)
%⊿EPC	-0.057	0.048	0.077
	(-0.88)	(1.23)	(1.36)
⊿TRD	-0.001	0.000	0.000
	(-1.68)*	(-1.14)	(-0.14)
⊿URB	0.027***	0.004	0.003
	(5.02)	(1.14)	(0.76)
⊿ROL	0.032	0.049	0.052
	(0.69)	(1.46)	(1.08)
Constant	-0.083***	-0.144***	-0.218***
	(-5.52)	(-7.34)	(-5.91)
Observations	1,026	723	456
Adjusted R-squared	0.3175	0.4716	0.3492

Table 4-7 Presents regression results of Equation (1) using alternative dependent variables. Panel A reports the results using the percentage change in CO2 as the dependent variable. Panel B presents the results using GHG emissions including carbon sink. The dependent variables are the percentage change in CO2 and GHGSPC over 5, 10, 15- year time horizons in Columns (1)- (3).
All variables are defined in text.

4.6 Additional Analyses

4.6.1 Test for The Kyoto Protocol First Commitment Period

TPA is not the first international agreement that requires responsible parties to set emissions reduction targets and publicize their progress. Prior to TPA, the Kyoto Protocol successfully brought together 36 industrialized countries to work towards their reduction targets and the first commitment period began in 2008 and ended in 2012. The additional analysis utilizes this unique empirical setting to further examine the effect of the strength of carbon reporting schemes and in-country expert reviews in facilitating the meeting of countries' emissions reduction targets. Following Ioannou, Li, and Serafeim's (2016) study, the dependent variable of target completion is calculated as the percentage of a given target that is completed at the end of the five-year horizon (2008-2012). And the target difficulty is added into the base model as a control variable to indicate the discretion allowed in setting the target.

The revised regression model is constructed as below,

$$\begin{aligned} TargetComp = {} & \beta_0 + \beta_1 \Delta_i REP\_IND_{j,t} + \beta_2 \textstyle\sum_{i=0}^{n} TEC\_REV\ j,t + \beta_3 \text{TargetDiff} \\ & + \beta_4 \%\Delta_i GDPPC_{j,t} + \beta_5 \%\Delta_i EGU_{j,t} + \beta_6 \%\Delta_i EPC_{j,t} + \beta_7 \Delta_i TRD_{j,t} \\ & + \beta_8 \Delta_i URB_{j,t} + \beta_9 \Delta_i ROL_{j,t} + \varepsilon, \end{aligned} \tag{7}$$

Table 4-8 below presents the testing results. None of the variables of interest are statistically significant. The statistical power of the regression analysis is substantially reduced due to the restricted and small sample size of 34 observations.

TABLE 4-8 The Effect of Carbon Reporting Scheme and Credibility Enhancement Mechanisms on Carbon Target Completion

	TargetComp
⊿REP_IND	-1.073
	(-1.40)
ΣTEC_REV	-0.199
	(-0.17)
TargetDiff	-0.871
	(-0.18)
%⊿GDPPC	11.580
	(1.12)
%⊿EGU	-10.113
	(-1.06)
%⊿EPC	24.985
	(1.67)
⊿TRD	0.067
	(1.60)
⊿URB	0.169
	(0.32)
⊿ROL	-3.005
	(-0.66)
Constant	1.542
	(0.83)
Observations	34
Adjusted R-squared	0.2547

Table 4-8 Presents the regression results of Equation (7) using Target Completion as the dependent variable.
All the variables are calculated over the 5- year time horizon, which corresponds with the first commitment period of the emissions reduction targets set under the Kyoto Protocol.
All variables are defined in text.

4.6.2 Scientific Estimation of Country's Emissions

Country's GHG emissions data that is used in this study is self-reported to the UNFCCC. In general, compared to the Annex I countries, non-Annex I countries lack a good data infrastructure and a regular reporting system. Concerns are raised over the quality[110] of the data generated from these carbon reporting systems. While the Annex I countries accounted for more than 60 percent of the share of emissions in the 1990s, non- Annex I countries emitted more than 60 percent of global

[110] An increasing share of emissions have been reported from less developed statistical systems and a decreasing share of emissions are emitted from the activities which provide relatively accurate information.

emissions by the year 2012 (Janssens-Maenhout et al., 2019). I employ the EDGAR[111] database as a credible third-party source to further test the main analyses. While individual countries reporting to the UNFCCC exercise their discretion when choosing a different tiers method or different emissions factors for each emissions source, the EDGAR system estimates the country emissions using the same tier method for all countries and this enables homogeneous measurement and comparison of country-specified emissions. Thus, my model is modified as below,

$$\%\Delta_i EDG/GHGEDG_{j,t} = \beta_0 + \beta_1 \Delta_i REP\_IND_{j,t}{}^{112} + \beta_2 \sum_{i=0}^{n} TEC\_REV_{j,t} + \beta_3 \%\Delta_i GDP_{j,t} + \beta_4 \%\Delta_i EGU_{j,t} + \beta_5 \Delta_i TRD_{j,t} + \beta_6 \Delta_i URB_{j,t} + \beta_7 \Delta_i ROL_{j,t} + \varepsilon, \quad (8)$$

$\%\Delta_i EDG_{j,t}$ measures the difference between GHG emissions in year t+5, t+10, and t+15 and the GHG emissions in year t divided by the emissions in year t for country j. It is calculated as the percentage change in the emissions estimated using the EDGAR database for country j over the 5-, 10-, and 15- year time horizons.

$\%\Delta_i GHGEDG_{j,t}$ is calculated as the difference between GHG emissions calculated by the EDGAR database and that reported to the UNFCCC over the 5-, 10-, and 15- year time horizons divided by the emissions reported to the UNFCCC for country j in year t. This measures the percentage deviation of reported emissions from uniform scientific estimates for country j.

Columns (1)- (3) of Table 4-9 present results using the dependent variable $\%\Delta_i EDG_{j,t}$. The coefficients of *REP_IND* are statistically significant over

[111] It provides scientific estimations of global emission inventory, applies calculation methodology consistently across countries and completes the emissions trends for non-Annex I countries.
[112] Definition of independent variables can be found in the main analyses section.

the 10- and 15- year time horizons, however, the signs are unexpectedly positive. That is, a unit increase in the strength of the carbon-related reporting framework is associated with 3.8 percent points increase in GHG emissions over a 10- year time horizon and a 7.8 percentage point increase over a 15- year time horizon. On the other hand, the coefficients of *TEC_REV* are significantly negative, indicating that one additional in-country expert team review is associated with a 3 to 5 percentage point emissions reduction over the 5-, 10-, and 15- year time horizons.

Test results from Columns (4)-(6) in Table 4-9 show that one additional in-country expert team review is related with 12, 10 and 5 percentage points lower emissions levels in scientific estimations as compared with self-reported emissions over the 5-, 10- and 15- year time horizons, while no statistical significance has been observed for the variable of reporting index.

Results from use of the scientific estimation database that provides country-specific GHG emissions data corroborates observations in the main analyses. The in-country expert team reviews continue to play a key role in monitoring and ensuring the credibility of emissions reporting systems globally. However, the sign on the coefficient of the variable reporting index changes from negative using the UNFCCC database to positive using the EDGAR database and this implies inconsistency in the country-specific emissions data recorded in the two systems. Contrary to my expectations, the positive sign of *REP_IND* could possibly be explained first by the rationale behind the determination of the strength of the carbon-related reporting schemes. That is, the more stringent the schemes in place to collate and monitor the emissions activities within national boundaries, the higher the countries' historical emissions levels. And second, by the possibility of countries with higher emissions levels using their discretion to choose methods or emissions factors that result in lower reported data to the UNFCCC. If the second explanation holds, the importance of the credibility of the reported emissions information is thus highlighted. Proper verification and monitoring mechanisms need to be established at the transnational level to safeguard the self-reporting behavior of the committed countries and make them accountable for their actual carbon emissions growth.

In sum, the series of sensitivity and additional analyses complements my understanding from the base model results. First, additional year time horizons analysis helps to identify more specifically that the reporting instruments become effective from the 7th until the 12th year after they came into force and the in-country expert reviews take effect over the 3- year until the 15- year time horizons. Second, the presence of in-country expert review demonstrates a robust curbing effect on emissions growth using alternative emissions measures at the country level. Third, when using the number of climate change laws in force to proxy for the strength of environmental regulations, a consistent negative coefficient on the variable of interest used has implications for the relevance of environmental regulation in decelerating a country’s GHG emissions growth. Nevertheless, the mixed findings regarding the strength of carbon reporting schemes illustrates the complexity of the issues examined. Whether the strength of carbon reporting schemes has an impact on reducing a country’s emissions growth depends on the actions of the regulated entities.

TABLE 4-9 The Impact of Carbon Reporting Scheme and Credibility Enhancement Mechanisms on Carbon Emissions Growth using a Scientific Estimation Database

	Dep. Var. =					
	%Δ_5EDG (1)	**%Δ_{10}EDG (2)**	**%Δ_{15}EDG (3)**	**%Δ_5EDGGHG (4)**	**%Δ_{10}EDGGHG (5)**	**%Δ_{15}EDGGHG (6)**
ΔREP_IND	0.005	0.038**	0.078***	-0.046	0.014	0.026
	(0.36)	(2.33)	(4.17)	(-1.07)	(0.32)	(0.62)
ΣTEC_REV	-0.03***	-0.049***	-0.054***	-0.122***	-0.098***	-0.051*
	(-3.14)	(-4.30)	(-4.68)	(-3.54)	(-3.30)	(-1.94)
%ΔGDP	0.165***	0.099**	0.092**	0.476***	0.098	0.029
	(3.48)	(2.39)	(2.47)	(2.96)	(0.91)	(0.35)
%ΔEGU	0.000	0.000	-0.001**	0.001	0.002	0.001
	(0.13)	(0.16)	(-2.38)	(1.01)	(1.55)	(0.62)
ΔTRD	0.013**	0.019***	0.010**	0.124***	0.086***	0.041***
	(2.40)	(3.88)	(2.04)	(6.87)	(6.82)	(3.82)
ΔURB	0.613***	0.266***	0.177**	-0.774***	-0.970***	-0.425**
	(9.95)	(3.66)	(2.37)	(-3.69)	(-5.19)	(-2.52)
ΔROL	0.038	0.167***	0.091	0.185	0.525***	0.170
	(0.80)	(2.94)	(1.38)	(1.13)	(3.59)	(1.15)
Constant	-0.007	0.008	0.003	0.125**	0.150*	0.147
	(-0.44)	(0.22)	(0.06)	(2.20)	(1.67)	(1.31)
Observations	975	667	386	975	667	386
Adjusted R-squared	0.2425	0.1320	0.1586	0.0687	0.1048	0.0405

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 4-9 Presents regression results of Equation (8) using %ΔEDG and %ΔEDGGHG as the dependent variables. The dependent variables are the percentage change in EDG over a 5-year horizon in Column (1), the percentage change in EDG over a 10-year horizon in Column (2), the percentage change in EDG over a 15-year horizon in Column (3), the percentage change of the difference between EDG and GHG over a 5- year horizon in Column (4), the percentage change of the difference between EDG and GHG over a 10-year horizon in Column (5), and the percentage change of the difference between EDG and GHG over a 15- year horizon in Column (6).
All variables are defined in text.

4.7 Conclusions

This study provides empirical evidence to address the issue of whether, and considering how many years have elapsed since a country's reporting scheme came into effect for carbon-related reporting schemes, it is possible to identify an association of such reporting schemes with countries' emissions reductions, formulated across countries. Further, this study examines whether and to what extent the in-country expert reviews have an additional impact on curbing countries' GHG emissions growth.

I measure individually the systematic differences across the reporting schemes and employ reported GHG emissions data from 123 countries over the period 1990- 2014. Using a percentage change differenced model, this study finds that both more stringent reporting instruments and the presence of in-country expert team reviews are negatively associated with a country's emissions growth. An increase in the strength of reporting scheme helps to slow down the per capita emissions growth by approximately 1 percentage point after 10 years from when the strengthening of the reporting scheme came into effect. In-country expert team reviews start to curb per capita emissions growth by approximately 2 percentage points five years afterwards and the mitigating effect persists until the 15th year. The results highlight that increasing the accuracy and reliability of reported GHG emissions might be an important first step when it comes to identifying and implementing policies that work in the interests of reducing GHG emissions at the country level. Future research could investigate this issue at the multilevel to disentangle the interaction effects arising from both country and company level factors.

The importance of credibility enhancement mechanisms in terms of disclosed carbon information has been emphasized by the passage of the specified GHG assurance standard ISAE 3410[113]. As the quality of assurance for non-financial information is hard to measure (Cohen and Simnett, 2015), the question of whether credibility enhancement mechanisms induce management to improve the quality of reporting systems and ultimately of reported information, is still under-examined. The persistent curbing effects of expert team reviews at the macroeconomic level serves to add to the literature that covers the efficacy of the various forms of credibility enhancement on emerging forms of reporting at the country level.

The regulatory implications of this study span both the country and global levels. Given the moderate curbing effects of reporting schemes, countries might exercise caution in the planning and allocation of limited national resources. In view of the targets set by individual countries within specified timeframes, countries might take the initiative and plan a national level reporting system that eliminates double counting issues and standardizes reporting practices country-wide to save costs and to generate greater efficiency in the attainment of reduction targets. Further, UNFCCC, the global institution, could exert a greater effort when monitoring reporting procedures and verifying reported information to best assist member countries to realize emissions reduction targets. In so doing, the UNFCCC would fulfil its own mission to stabilize the climate.

[113] International Standard on Assurance Engagements: Assurance Engagements on Greenhouse Gas Statements (ISAE 3410) was released by the International Auditing and Assurance Standards Board (IAASB) in June 2012. The IAASB is an independent standard-setting body that works towards the convergence of international and national auditing standards and serves the public interest by promoting high quality auditing and assurance guidance.

CHAPTER 5 STUDY TWO

5.1 Introduction

This study examines whether the strength of carbon reporting schemes in the home and/or host countries, and the undertaking of a carbon assurance engagement, facilitates the curbing of companies' carbon emissions growth. This study also examines whether and to what extent the relation between the strength of carbon reporting schemes in the home and/or host countries and companies' carbon emissions growth is modified through the undertaking of a carbon assurance engagement.

Countries ratifying TPA have specified emission reduction targets to be achieved by 2030. The aggregate effort made in the interests of climate change mitigation pledged by 189 countries represents an unprecedented strategy to stabilize the climate within the 2 degrees Celsius' limit. Despite this there is an emissions gap[114] identified by scientists assessing countries' NDCs[115] (UNEP, 2015; Rogelj et al., 2016). While governments have been proclaiming their progress[116] at the country level, one way of closing the emissions gap is through effective enrolment of companies' efforts (KPMG, 2017).

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[114] The emissions gap arises between the aggregated commitments from all the ratified countries and the global goal of limiting climate change within 2 degrees Celsius.

[115] The EU member countries have pledged to reduce their domestic GHG emissions by at least 40 percent by 2030 compared to 1990. Canada is leading the non-EU developed economies by setting a goal of 30 percent emissions reduction, while Australia, Japan and the U.S. specify their goals in the range of 25-28 percent below 2005 levels by 2030. Among the developing big emitters, China has determined to lower its carbon dioxide emissions per unit of GDP by 60 to 65 percent and India is to reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 compared to the 2005 levels.

[116] Denmark, Germany, the Netherlands, Sweden, and the United Kingdom announced in Paris they cancelled carryover credits (by overshooting the 2008-2012 targets) from the first commitment period under Kyoto, while Australia decided to bank its credits for the second commitment period (The Guardian, 2015). More recently, Australia announced in December 2020 that it has abandoned a plan to use Kyoto carryover credits to achieve its emission reduction target set under TPA (Sydney Morning Herald, 2020).

Companies face a multitude of mandatory and voluntary carbon reporting schemes, and the requirements vary across countries (TCFD, 2017). On the one hand, companies are increasingly regulated and driven by mandatory requirements to report their emissions metrics (KPMG, 2017; TCFD, 2017). On the other hand, voluntary GHG disclosure has gained momentum over the last decade and it is fuelled primarily by large corporations that operate in multiple countries (e.g., Kolk et al., 2008; Depoers, Jeanjean, and Je´rˆome, 2016; TCFD, 2017). In preparing these reports the home country headquarters of MNCs collates emissions information from subsidiaries and facilities that they control worldwide, while the subsidiaries/facilities are regulatorily bounded by the carbon reporting schemes of different strengths prescribed by the various host countries.

Environmental protection has become an essential aspect of regional economic and trade blocs such as the ETS of the EU and the North American Commission for Environmental Cooperation under the NAFTA (Esty, 2006). International government cooperation in the area of environmental protection through open ratification, such as the Montreal Protocol for the Ozone Protection, the Kyoto Protocol and currently the TPA, has grown. The rise in cooperation contributes to global standardization of MNCs' environmental policies (Christmann, 2004), but the environmental impact of international trade raises concerns over corporations' exploitation [117] of differences in the strength of environmental regulations [118] (Copeland and Taylor, 2004; Cole and Elliott, 2005; Dam and Scholtens, 2008). There remains an empirical question as to whether and how the

[117] The pollution haven effect suggests that the tightening up of environmental regulation has an effect on companies' strategic plant locations (Cole and Elliott, 2005; Dam and Scholtens, 2008).
[118] Following the debate, a stream of research has been conducted to understand the emissions growth model at the country level (Cole, Elliott, and Fredriksson, 2006; He and Richard, 2010; Jayanthakumaran, Verma, and Liu, 2012).

subsidiaries facing variations in cross-country institutional contexts effect the MNC's carbon emissions growth at the company level.

Current carbon disclosure research that views MNCs as a single organization does not adequately address its reporting complexity (Kostova and Roth, 2002; Comyns, 2018). Despite the trend of escalating emissions disclosures, reported emissions data is found to be incomplete in covering all operations at the company level (Liesen et al., 2015) and emissions reporting gaps exist at multi-levels (Haslam et al., 2014; TCFD, 2017). A single level research paradigm seems inadequate to accurately measure and understand the cross-level interaction effects arising from MNCs' operations residing in varied host countries (Aguilera-Caracuel et al., 2012, 2013; Aguilera-Caracuel et al., 2014; Grauel and Gotthardt, 2016). While both the psychology and management literatures have in general been advocating a multilevel methodology for the past decade (Dalton et al., 2012; Mathieu, Aguinis, Culpepper, and Chen, 2012; Aguinis, Gottfredson, and Culpepper, 2013; Aguinis and Glavas, 2019), its application to carbon emissions research remains limited.

An independent assurance engagement of a company's emissions reporting serves as a credibility enhancement mechanism that mitigates information asymmetry and helps to improve societal confidence in the reliability and completeness of carbon disclosures (Simnett et al., 2009a; Moroney et al., 2012; Braam et al., 2016), thus mitigating perceptions of 'greenwash' (Lyon and Maxwell, 2011). The process of engaging assurance providers may also induce companies to produce and disclose reliable and accurate emissions information through enhanced reporting practices (Braam et al., 2016). However, existing reporting schemes prescribe varied requirements[119] in terms of independent assurance of reported data (TCFD, 2017). Hence, companies' decisions relating to assurance are, to a certain extent, determined by the origins and strengths of the institutional frameworks they face (Simnett et al., 2009b; Grauel and Gotthardt, 2016; Zhou et al., 2016).

I collect 6,664 observations for 45 countries from the CDP[120] database for the period 2011-2017 and adopt a multilevel approach to examine the identified research questions which examine the strength of carbon reporting schemes and the undertaking of independent assurance engagements on carbon emissions growth. Multilevel regression results indicate that an increase in the strength of carbon reporting schemes in both the home and host countries are modestly effective in curbing Scope 1 emissions growth over the two-year horizon. The undertaking of an assurance engagement is significantly effective in reducing a company's Scope 1 emissions growth over the two-year horizon and demonstrates an enduring effect. This negative effect of assurance is more pronounced when the strength of carbon reporting schemes prescribed in a home and/or host country is weaker.

This study contributes to the operations of MNCs and the international business literature through the provision of empirical evidence regarding the differential impact of MNCs' environmental policies and assurance engagements on reported emissions data across diverse regulatory institutional contexts of subunits' host countries. The prior literature covering MNCs' environmental practices in various disciplines is contentious in relation to MNC's strategies when considering

[119] For instance, EU ETS requires all reported emissions to be verified by an independent third party. In Australia, NGER runs a risk-based system and reserves the right to inspect and conduct external audits of reported data. The reported data under the US GHG program is verified by the US EPA (which is the central agency for national inventory reporting to the UNFCCC).

[120] CDP is now a widely used and the most recognised carbon information database in academic research (e.g., Kolk et al., 2008; Matsumura et al., 2014; Depoers et al., 2016; Ioannou et al., 2016; Zhou et al., 2016; Griffin et al., 2017).

the strength of environmental regulations across countries (Christmann, 2004; Copeland and Taylor, 2004; Cole and Elliott, 2005). Institutional theory constructs the frameworks that enable investigations into heterogeneous institutional forces shaping the structure and practices of MNCs' subunits (Kostova and Roth, 2002). Based on this theoretical framework, this study disentangles and assesses complexity when there is a reporting of GHG emissions that occur at multi-levels.

This study also contributes to the carbon literature covering performance outcomes. Extant studies have primarily focused on the determinants of carbon disclosures and, in general, find that company size and environmental regulation have a positive impact on carbon disclosures (e.g., Stanny and Ely, 2008; Rankin et al., 2011; Cotter and Najah, 2012; Wegener, Elayan, Felton, and Li, 2013). A stream of studies assessing the factors associated with the level of environmental disclosures have identified companies as being selective in terms of content (e.g., Kim and Lyon, 2011). Another series of studies investigates the financial impact of carbon emissions and concludes there is an inverse relationship between a company's market value and the level of GHG emissions (Matsumura, et al., 2014; Griffin et al., 2017). This study extends this literature by providing multilevel evidence as to the performance outcome of carbon disclosures.

This study also presents findings concerning the effects of assurance on reported emissions across countries. Demand for assurance has escalated in recent years because of increasing nonfinancial information disclosures (KPMG, 2017). The approval of the International Standard on Assurance Engagements on GHG emissions (ISAE 3410[121]) highlights the demands from the business society and the public for a standardised and coherent approach to validate the credibility of companies' emissions data. It is recognised that the quality of assurance in terms of nonfinancial information is hard to examine due to its diversified themes and non-quantitative nature (Cohen and Simnett, 2015). However, in comparison to the range of nonfinancial information, GHG emissions data is more readily quantifiable and verifiable (Simnett and Nugent, 2007; Simnett, Nugent, and Huggins, 2009a). Results from this study shed light on companies' motivations for undertaking voluntary assurance engagements, by providing empirical evidence regarding the curbing effect of carbon assurance on carbon emissions growth.

Lastly, there are regulatory implications arising from the results reported using the multilevel models. Examination of GHG emissions reporting lends comprehensive insights into the reporting paradigms formulated at both the country and company levels. When formulating carbon reporting instruments at the country level, governments should focus attention on the fact that the emissions data gathered within their national boundaries is also part of the emissions data being aggregated by MNCs. Evidence found on the effect of assurance in different institutional contexts is useful for regulators when considering any requirements to mandate assurance of reported data at the company level.

The remainder of the study is organised as follows. Section 2 develops the main hypotheses. Section 3 constructs the multilevel models. Section 4 presents the

[121] International Standard on Assurance Engagements: Assurance Engagements on Greenhouse Gas Statements (ISAE 3410) was approved by the International Auditing and Assurance Standards Board (IAASB) in June 2012. The IAASB is an independent standard-setting body that works towards the convergence of international and national auditing standards and serves the public interest by promoting high quality auditing and assurance guidance.

main regression results, and reports sensitivity tests and additional analyses. Section 5 concludes the study.

5.2 Hypotheses Development

5.2.1 The Relation Between Carbon Reporting Schemes and Carbon Emissions Growth

Debates in financial reporting present divergent views when evaluating the justifications for financial disclosure regulations. On the one hand, opponents claim that the optimal level of disclosure is company specific and could be achieved under competing market forces as the private value of disclosure (benefiting from improvement of investment decisions, more efficient resource allocation and alleviation of agency problem) exceeds negative externalities (arising from reduced price efficiency and risk sharing as well as the spillover effects of misrepresentation) which could be addressed by competition and private ordering (Shleifer and Wolfenzon, 2002; Lambert et al., 2007; Leuz and Wysocki, 2008). On the other hand, disclosure regulation is considered justified based on the argument that in certain situations social value is greater than the private value of disclosure (Dye, 1990; Mahoney, 1995; Shleifer and Wolfenzon, 2002; Jorgensen and Kirschenheiter, 2007). This side of the argument fits well with the context of environmental reporting, where, as outlined in Chapter Two of this thesis, climate change mitigation is commonly deemed as an undersupplied global public good (Barrett, 2007).

The institutional approach has been extensively applied in international studies, in order to understand the effect of institutions on globalized securities markets and companies' financial disclosure incentives and practices (Ball, Kothari, and Robin, 2000; Fan and Wong, 2002; Leuz, Nanda, and Wysocki, 2003; Bushman, Piotroski, and Smit, 2004; La Porta, Lopez-de-Silanes, and Shleifer, 2008; Daske, Hail, Leuz, and Verdi, 2008; Leuz, 2010). Results from studies examining the carbon disclosure setting suggest that the institutional context has important implications in motivating company's carbon disclosures (Brouhle and Harrington, 2009; Rankin et al., 2011; Luo et al., 2012; Stanny, 2013). In particular, regulatory requirements directly benefit carbon transparency through the application of consistent standards that mitigate uncertainties, eliminate double counting and save on information search costs for society at large. Regulatory requirements also induce a company's voluntary reporting based on the arguments of anticipated upcoming legislation, self-regulation to deflect future scrutiny, and the cost synergy that results from compliance with regulatory reporting (Lyon and Maxwell, 2002; Solomon and Lewis, 2002; Engels, 2009).

To a lesser extent, there is evidence that consistent sustainability reporting can curb corporate misconduct and moderate its negative reactions to stock prices (Christensen, 2016); companies that are better at disclosing material sustainability issues outperform poor disclosing companies (Khan, Serafeim, and Yoon, 2016). Findings also support the view that higher levels of a company's GHG emissions has a negative impact on the company's value and share prices (Matsumura et al., 2014; Griffin et al., 2017). This gives rise to companies' incentives for slowing down their GHG emissions growth under a regulatory reporting regime and communicating their efforts in this regard externally.

While a country's reporting to the UNFCCC collates emissions data from a company's operations within national boundaries, a company's reporting (at least those that are multinational), and the related reporting to CDP, is of aggregated emissions data from its operations across countries. At the company level, the resulting institutional context demonstrates crossover relations. While Grauel and Gotthardt (2016) find that the national context is significantly relevant in explaining multinational companies' decisions with regard to carbon disclosure, Christmann (2004) presents evidence that many multinational companies are increasingly developing coherent global environmental policies to standardize subsidiaries' practices, and that such global policies inhibit exploitation of cross-country regulatory differences.

Subsidiaries located outside a home country are bounded in operations by the institutional context of the host country. Whether and how much the carbon performance at the company level is influenced by the subsidiaries in various host countries depends on the dispersion and constituency of the foreign subsidiaries and the extent to which the institutional contexts between the home and host countries are aligned (Kostova and Roth, 2002). In addition to a standardized practice established by a MNC, more stringent reporting schemes prescribed in the host countries that, in turn, more closely align the regulatory contexts between the home and host countries, could further contribute to a MNC' carbon emissions reduction. Collectively, carbon- related reporting schemes in foreign countries are expected to demonstrate a positive effect on curbing emissions growth. Thus, I hypothesize:

H1a: There is a negative relation between the strength of carbon reporting schemes formulated in the ***home*** *country and MNCs' carbon emissions growth at the company level.*

H1b: There is a negative relation between the strength of carbon reporting schemes formulated in the ***host*** *countries and MNCs' carbon emissions growth at the company level.*

5.2.2 The Relation Between Carbon Assurance and Carbon Emissions Growth

Companies seek independent assurance to enhance their sustainability reporting credibility through mitigated information asymmetry (Simnett et al., 2009b; Moroney et al., 2012; Carey and Simnett, 2015; Venter and van Eck, 2021), as well as to address societal concerns about selectivity in carbon disclosures. Existing reporting schemes prescribe varied requirements in terms of assurances of reported data. While independent verification is required under the EU ETS, the NGER in Australia exercises a risk-based system and preserves the right to require assurance of reported carbon information.

This supports the argument that the undertaking of carbon assurance enhances companies' carbon transparency through improved reporting systems. This aids in reducing the ability of those companies that have poor environmental performance being selective on their environmental reporting. Ballou et al. (2018) find that assurance improves nonfinancial reporting quality in terms of the identification of errors and methodological updates. Du and Wu (2019) document that assurance adds credibility to nonfinancial reporting by generating a lower incidence of future corporate social responsibility related misconduct. Moreover, assurance extends its benefits to internal decision making through strategic planning, risk management and internal control. Datt et al. (2020) show that a company's motives to improve carbon management mechanisms drive its assurance decisions. These motives alone are found to be important in achieving the desired benefits such as improving the information available for managerial decision making (Steinmeier and Stich, 2019; Praiogo et al., 2020).

This study therefore constructs the second hypothesis as, *H2: Carbon assurance engagements are negatively associated with carbon emissions growth at the company level.*

5.2.3 Modification of the Strength of Carbon Reporting Schemes on the Relation Between Decisions for Assurance and Carbon Emissions Growth

Prior research presents evidence that non-financial information disclosures benefit the capital markets across countries (Dhaliwal et al., 2012; Dhaliwal, Li, Tsang, and Yang, 2014). Both Simnett et al. (2009b) and Zhou et al. (2016) point out that such country level institutional factors as legal origins contribute in explaining a company's decision to purchase an assurance engagement. While La Porta, Lopez-de-Silanes, and Shleifer (2006) point out that mandating disclosures through standardized disclosure requirements (that facilitates private contracting) demonstrates a significant positive effect on securities markets across countries, Casey and Greiner (2015) find that there is a substitution effect of the strength of regulatory oversights on companies' decisions for assurance.

Financial disclosure regulations are not isolated from or independent of its institutional settings, as the effects of adoption of International Financial Reporting Standards (IFRS) are heterogenous across national institutional setting (e.g., Leuz, 2010, Brown, 2011; Brüggemann, Hitz and Sellhorn, 2013). The institutional setting modifies financial reporting quality and the auditing of financial statements between countries (Brown, Preiato, and Tarca, 2014; Preiato, Brown, and Tarca, 2015). More stringent investor protection regimes alone do not affect the earnings quality but need to be jointly considered with the quality of enforcement with regard to the application of proper accounting policies by auditors (Francis and Wang, 2008). The impact of carbon assurance engagements on the relation between the strength of carbon reporting schemes and company's carbon emissions growth may vary across divergent institutional contexts. It remains an empirical question whether the undertaking of carbon assurance engagements could further facilitate curbing of carbon emissions growth or have a substitution effect when the home and/or the host country's carbon reporting schemes are less stringent.

This study therefore predicts a non-directional hypothesis separately for the moderation effect of the undertaking of carbon assurance engagements as,

H3a: The negative relation between the strength of carbon reporting schemes in the ***home*** *country and company's carbon emissions growth is modified by the undertaking of a carbon assurance engagement.*

H3b: The negative relation between the strength of carbon reporting schemes in the ***host*** *country and company's carbon emissions growth is modified by the undertaking of a carbon assurance engagement.*

In sum, I hypothesize that there is a negative effect for both the strength of carbon reporting schemes and the undertaking of carbon assurance on carbon emissions growth. I further hypothesize that a carbon assurance engagement has a moderating effect on the association between the strength of carbon reporting schemes and carbon emissions growth.

5.3 Methodology

5.3.1 Research Design

Studies assessing nonfinancial reporting and assurance in an international setting normally adopt an OLS model and include country level indicators to control for institutional differences across countries (e.g., Simnett et al., 2009b; Dhaliwal et al., 2012, 2014; Ioannou and Serafeim, 2012; Zhou et al., 2016). Country level institutional factors have been found to explain considerably more variations in influencing corporate governance and disclosure practices than company characteristics (Doidge, Karolyi, and Stulz, 2007).

Earlier management research calls for research constructs to simultaneously consider theory, measurement, and analysis that traverses different levels (Roberts et al., 1978; Rousseau, 1985), as a single level research paradigm is deemed to be inadequate to understand behaviours occurring at either level (Porter, 1996; Hitt, Beamish, Jackson, and Mathieu, 2007). In fact, the adoption of a multilevel framework in both the psychology and management literatures have flourished in the past decade (e.g., Dalton et al., 2012; Mathieu et al., 2012; Aguinis et al., 2013; Aguinis and Glavas, 2019). In essence, what distinguishes a multilevel approach from the OLS model lies in its capability for measuring the cross-level interaction effects, whether and to what extent the lower-level relationship depends on a higher-level factor (Aguinis et al., 2013). In the presence of a nested data structure, a higher-level variable may exhibit direct and interactive influences on lower-level outcome variables, and observations within nested groups could be of greater similarity regarding certain variables compared to observations across groups (Bliese and Hanges, 2004). Gross errors arise from using OLS regressions to predict lower-level outcomes when observations are dependent due to clustering (Bliese and Hanges, 2004; Hox, 2010; Snijders and Bosker, 2012). Meanwhile, recent emissions reporting studies have started to use the multilevel research methodology to identify and measure the crossover effects with regard to the shaping and formation of a company's environmental management systems and disclosure practices through country level institutional forces (Aguilera-Caracuel et al., 2012, 2013, 2014; Grauel and Gotthardt, 2016).

5.3.2 Research Models

In CDP, companies disclose carbon emissions based on their operations in different geographical locations. Subunits of MNCs are simultaneously regulated by the reporting schemes in host countries and guided by MNCs' environmental policies. The decision on a carbon assurance engagement is made at the company level. My third set of hypotheses (H3a and H3b) examines the cross-level interaction between the reporting scheme strength at the country level and the assurance engagement at the company level. To disentangle the unique reporting structure, and to distinguish between the regulatory effects in the home and host countries, and to accurately measure the cross-level interaction effects, this study employs a multilevel research model:

$$D_nLSC(k)_{i,t} = \gamma_0 + \gamma_1\, REPHM_{j,t} + \gamma_2 REPHS_{j,t} + \gamma_3\, ASU_{i,t} + \gamma_4\, REPHMASU_{ij,t} + \gamma_5\, REPHSASU_{ij,t} + \gamma_6\, SIZE_{i,t} + \gamma_7\, ROA_{i,t} + \gamma_8\, LEV_{i,t} + \gamma_9\, NEW_{i,t} + \gamma_{10}\, CAPIN_{i,t} + \gamma_{11}\, CSRC_{i,t} + \gamma_{12}\, REDT_{i,t} + \gamma_{13}\, REDP_{i,t} + \textit{Year Fixed effect} + \textit{Industry Fixed effect} + \mu_{0,i}{}^{122} + e_{i,j}, \quad (9)$$

where the variables are as defined in Appendix B and described below.

5.3.2.1 Dependent Variables

$\boldsymbol{D_nLSC(k)_{i,t}}$

[122] The error term $\mu_{0,i}$ used in the model (9) represents clustering the data by country group. Companies reporting to CDP aggregate carbon emissions by subsidiary, while subsidiaries are regulated by reporting schemes formulated across countries. That is, per country group, the subsidiaries could be expected to demonstrate similar emissions growth patterns depending on the strength of the reporting schemes.

This variable measures the rate of change of all the subsidiaries' disclosed emissions in Scope 1[123], Scope 2[124], and the sum of both Scope 1 and Scope 2 (i.e., k = 1, 2, and 1+2) generated and/or purchased by a company i over 1- to 5-year horizons, and is calculated as the difference between the logarithm of a company's sum of all its subsidiaries' emissions in year t+ n (n = 1,2,3,4 and 5) and that in year t.

5.3.2.2 Variables of Interest

To test hypotheses H1a and H1b, it is necessary to construct a relative measure of the strength of each countries' different reporting schemes. A country's reporting scheme may consist of multiple reporting instruments[125] in a given year t. As I did for Study One, I develop an index that specifically accounts for systematic variations in countries' reporting instruments across six factors to assess its strength[126]. For each country j in year t, the scores across the six factors are summed to give a total index score out of 13 for each instrument - where higher (lower) scores indicate a stronger (weaker) reporting scheme. If a country has multiple instruments, the scores are then added together, and this variable is denoted as $\text{REPI}_{j,t}$.

Consistent with Study One as outlined in Section 4.3.1.2 of this thesis, the reporting instrument index follows KPMG et al.'s (2016) Carrots and Sticks and the

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[123] As defined by the GHG protocol (2004), Scope 1 refers to direct GHG emissions which arise from sources that are owned or controlled by the company.
[124] As defined by the GHG protocol (2004), Scope 2 GHG emissions are indirect emissions from sources that are owned or controlled by the company. Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by a company.
[125] For example, stock exchange listing rules and government regulatory reporting requirements for a given country each year put in force different reporting instruments, but all demand carbon information.
[126] Prior research in general uses an indicator variable to indicate the regulatory pressure: participation in the ETS (Rankin et al., 2011) and/or ratification of the Kyoto Protocol (Luo et al., 2012;), whether a company has a facility that is subject to EPA regulation (Stanny, 2013), and the existence of any Corporate Social Responsibility regulations (Dhaliwal et al., 2012; Ott et al., 2017).

TCFD's (2017) reports and integrates not only the schemes that directly request GHG emissions reporting information, but also the legislation or listing requirements that demand the reporting of Corporate Social Responsibility/non-financial information encompassing environmental aspects. The index is coded as follows: 1) the regulatory type (equals 3 for legislation; 2 for code of conduct/guidelines; 1 for initiatives; and 0 otherwise); 2) reporting scope (equals 2 for environmental information; 1 for sustainability information; and 0 otherwise); 3) reporting nature (equals 2 for mandatory; 1 for voluntary; and 0 otherwise); 4) geographical scope (equals 2 for national; 1 for sub-national; and 0 otherwise); 5) industry sectors (equals 2 for all;1 for specific; and 0 otherwise); and 6) location (equals 2 for report to regulator; 1 for annual report; and 0 otherwise) covered by the reporting instrument.

If there is no carbon-related reporting scheme entry in force in year *t*, a 0 score is assigned across the six factors. The index for all the reporting instruments in force in country *j* in year *t* is the sum[127] of the index calculated for each reporting scheme:

$$REPI_{j,t} = \Sigma_{13}\ (Type, Scope, Nature, Geographic, Industry, Location), n_i{=}1, \quad (10)$$

$\boldsymbol{REPHM_{j,t}}$

This variable measures the strength of the carbon reporting scheme in company *i*'s home country in year *t*, thus adopting the base reporting scheme index

[127] It is due to the nature of the regulatory schemes. Once a regulatory reporting instrument becomes effective, it remains in force unless a specific amendment is passed to announce its termination.

$\text{REPI}_{j,t}$ in company i's home country in year t weighted[128] by the percentage of emissions disclosed in the home country *j* over the total of emissions reported by the company *i* in year *t*. Based on H1a, a negative sign is expected on the variable.

$\boldsymbol{REPHS_{j,t}}$

This variable measures the strength of the carbon reporting scheme in company *i*'s host countries in year *t*. It is calculated as the sum of the base reporting scheme index $\text{REPI}_{j,t}$ in each of the host countries weighted by the percentage of emissions disclosed in the host country *j* over the total of emissions reported by the company *i* in year *t*. Based on H1b, a negative sign is expected on the variable.

$\boldsymbol{ASU_{i,t}}$

An indicator variable[129] that equals 1 when company *i* has an assurance engagement[130] undertaken in the year *t*, and 0 otherwise. Based on H2, a negative sign is expected on the coefficient of the variable.

$\boldsymbol{REPHMASU_{ij,t}}$

To test hypothesis H3a, an interaction term is constructed between two of the primary variables of interest $REPHM_{j,t}$ and $ASU_{i,t}$. It measures the strength of the home country *j*'s carbon reporting scheme when company *i* has an assurance

[128] The dependent variable measures the rate of change of a company's carbon emissions growth between year t+ n (n= 1,2,3,4,5) and year t, instead of the current year emissions levels. Variables on the RHS of the regression model are measured in current year t. Correlations between the IV host country reporting strength and both the Scope 1 and Scope 2 emissions (as reported in Table 5-4) are low, which reduces the concern of calculating the strength of host country reporting schemes by using the weighting of the percentage of emissions reported in the host countries to a company's reporting of total carbon emissions.
[129] This thesis uses an indicator variable for carbon assurance engagement. Future research could identify, and better understand companies' motives to choose, potential benefits arising from, and users' perceptions on the usefulness of various types of credibility enhancement mechanisms. In addition, emerging research (for example, Decaux and Sarens, 2015; Zhou, Simnett, and Hoang 2019; Hoang and Phang, 2020) examines combined assurance as a credibility enhancement mechanism for integrated reporting. It would be an interesting question to investigate in the future its impact on environmental performance (in line with the UN Sustainable development goals).
[130] Assurance provided with regards to the reported carbon emissions (both Scope 1 and Scope 2) include all owned and operated facilities by a company.

engagement undertaken in year *t*. Based on H3a, no sign is predicted on the coefficient of this variable.

$\boldsymbol{REPHSASU_{ij,t}}$

To test hypothesis H3b, an interaction term is calculated between two of the primary variables of interest $REPHS_{j,t}$ and $ASS_{i,t}$. It measures the weighted strength of the host country j's carbon reporting schemes when company *i* has an assurance engagement undertaken in the year *t*. Based on H3b, no sign is predicted on the coefficient of this variable.

5.3.2.3 Control Variables

The reporting year in the CDP lags 1 year behind the calendar year. This means for example that data disclosed by companies in CDP for the reporting year 2011 are emissions from the financial year 2010. Following prior research (e.g., Luo et al., 2012; Matsumura et al., 2014; Zhou et al., 2016; Griffin et al., 2017), this study takes into consideration the year lag and matches the CDP reporting year *t* with the company's financial reporting year t-1. All the company level financial control variables are collected from the Worldscope database and non-financial control variables are from the ASSET4 database.

$\boldsymbol{SIZE_{i,t}}$

Proxy for company size. The natural logarithm of total sales of company *i* reported for the year *t* (e.g., Matsumura et al., 2014; Griffin et al., 2020). Consistent with prior findings, larger companies are more likely to disclose carbon emissions and are associated with higher levels of carbon emissions and thus greater carbon emissions growth. This variable is expected to have a positive coefficient.

$\boldsymbol{ROA_{i,t}}$

Return on assets, a measure of financial performance, and specifically it measures the efficiency of assets in producing income (King and Lenox, 2001; Delmas, Nairn-Brich and Lim, 2015). It is calculated as net income before extraordinary items of company *i* for the year *t* divided by the average of total assets at the beginning and the end of the year *t* (Christensen, 2016). A company's return on financial resources may affect its social and environmental performance. On the one hand, a sustained improvement in environmental performance may lead to improved future financial performance (Clarkson, Li, Richardson, and Vasvari, 2011). On the other hand, more profitable companies are in a better position to expend on preparatory costs for carbon disclosures (Ott et al., 2017). In terms of carbon emissions levels, ROA is associated with higher carbon emissions (Delmas et al., 2015; Qian and Schaltegger, 2017; Busch, Bassen, Lewandowski and Sump, 2020). A positive sign is expected on the coefficient of the variable.

$\boldsymbol{LEV_{i,t}}$

Measured as the ratio of long-term debts of company *i* to the average of total assets at the beginning and the end of the year *t*. Highly indebted companies are more likely or expected to have an interest of keeping creditors informed (Freedman and Jaggi, 2005; De Villiers, Naiker, and Van Staden, 2011; Cotter and Najah, 2012). However, while trying to construct companies' emissions estimation models, Griffin et al. (2017) presents evidence that highly leveraged companies are less inclined to disclose to the CDP. Thus, no sign is predicted on the coefficient.

$\boldsymbol{NEW_{i,t}}$

An indicator for the age of the technology equipment a company uses. Calculated as the ratio of company *i*'s net property, plant and equipment by gross property, plant, and equipment at the end of the year *t*. It is expected that companies with newer (possibly cleaner) equipment or facilities tend to have better environmental performance, and engage in greater disclosures (Clarkson et al., 2008; Peters and Romi, 2015). A negative sign is anticipated for this variable's coefficient.

$\boldsymbol{CAPIN_{i,t}}$

Capital intensity, measured as the ratio of company *i*'s total capital expenditures to total sales during the year *t*. Similar to the argument above, companies with greater capital expenditures are more likely to invest in carbon efficient technologies, thus slowing down emissions growth. A negative sign is anticipated for the variable coefficient.

$\boldsymbol{CSRC_{i,t}}$

An indicator variable that equals 1 when company *i* has in place a sustainability committee as a subset or is appointed by the Board of Directors, 0 otherwise. While earlier research presents mixed findings on the relation between the presence of an environmental committee and environmental disclosure/ performance (Rankin et al., 2011; Rodrigue, Magnan, and Cho, 2013), Peters and Romi's (2015) highlights the role of an environmental committee in enhancing a company's environmental transparency. The variable is predicted to have a negative sign for the coefficient.

$\boldsymbol{REDT_{i,t}}$

An indicator variable that equals 1 when company *i* sets an emissions reduction target in the year *t*, and 0 otherwise. Countries bound by such international protocols as the Kyoto protocol and TPA are required to establish a specified reduction target which hold them accountable for emissions reduction (UNFCCC, 2012, 2015). A voluntarily determined target implies the company's willingness to both signal and reduce emissions and it may facilitate a company's effort towards achieving its target. Thus, a negative sign is expected for the coefficient of this variable.

$\boldsymbol{REDP_{i,t}}$

An indicator variable that equals 1 when company *i* has an established emissions reduction policy that is internally implemented in the year *t*, and 0 otherwise. A set target would not be effective without a proper policy implementation. That is, only through operational practice could a company's resources be directed to working towards target accomplishment (Matsumura et al., 2014). A negative sign is expected for the coefficient.

5.3.3 Sample Selection

Table 5-1 presents the sample selection process for my study. To match the sample period for the first study in the thesis, Study Two collects emissions data from CDP[131] 2011-2017. In total, 10,843 companies reported to CDP in the sample period. To first construct the dependent variable, I remove 516 observations with either no information on Scope 1 or Scope 2 emissions and 3,663 more observations are excluded due to missing information for one or more control variables. Therefore, the final sample is comprised of 6,664 observations.

[131] CDP is a voluntary disclosure database. In this regard, the sample of observations is restricted to companies which are more willing to pay attention to environmental issues and are concerned about their carbon footprint.

TABLE 5-1 Sample Selection

	Obs.
Companies reporting to CDP 2011- 2017	10,843
Less observations without emissions information	(516)
Less observations without information for control variables	(3,663)
Final sample	6,664

All variables are defined in text and in Appendix B.

5.4 Results

5.4.1 Descriptive Statistics

5.4.1.1 Summary Statistics

Table 5-2 shows summary statistics of the variables employed in the model. On average, the value of the reporting scheme index across the home countries is 1.674, with the lowest being 0 and the highest reaching 7. The mean value of the weighted reporting scheme index constructed across the host countries is 0.590, considerably lower than that in the home countries, with the lowest being 0 and the highest being 6.520. There is a large variation in the carbon emissions emitted for my sample observations. The Scope 1 *(LSC1*) emissions range from 0 (0.432) to 13,500m metric tonnes (23.327), with a mean value of 6,557,300 metric tonnes (12.101); and the Scope 2 (*LSC2*) emissions ranges from 0 (1.609) to 546m metric tonnes (20.117), with a mean value of 1,003,262 metric tonnes (12.084) on a yearly basis. 68.2 percent of the observations were independently assured. The adoption rate of carbon assurance increases steadily over the sample time period (58.3 percent in 2011, 64.5 percent in 2012, 65.3 percent in 2013, 69.5 percent in 2014, 72.5 percent in 2015, 73.2 percent in 2016 and 74.5 percent in 2017). This evidence substantiates market practitioners' claims regarding the escalation of assurance adoption rates (KPMG, 2015, 2017, 2020).

TABLE 5-2 Descriptive statistics

	n	Mean	Std.	Min	Max
LSC1	6,525[132]	12.101	2.839	0.432	23.327
Scope1	6,571	6557300	1.68×10^{8}	0.000	1.35×10^{10}
LSC2	6,383	12.084	2.014	1.609	20.117
Scope2	6,579	1003262	9941002	0.000	5.46×10^{8}
LSC12	6,664	13.137	2.299	1.511	23.365
Scope12	6,664	7456254	1.73×10^{8}	4.530	1.40×10^{10}
REPHM	6,664	1.674	1.359	0.000	7.000
REPHS	6,664	0.590	0.861	0.000	6.520
ASU	6,664	0.682	0.466	0.000	1.000
SIZE	6,664	15.778	1.418	3.892	20.002
ROA	6,664	0.050	0.073	-1.333	0.660
LEV	6,664	0.210	0.144	0.000	1.926
NEW	6,664	0.505	0.172	0.054	1.091
CAPIN	6,664	0.142	1.644	0.000	107.966
CSRC	6,664	0.924	0.264	0.000	1.000
REDT	6,664	0.756	0.430	0.000	1.000
REDP	6,664	0.889	0.314	0.000	1.000

All variables are defined in text and in Appendix B.

Overall, due to data collection techniques and restrictions, my sample mainly includes the larger companies[133]. This is as a result of the fact that CDP sends out questionnaires to the largest companies around the globe. Among my sample, 92.4 percent of the observations have a standalone sustainability committee (*CSRC*) appointed by the board of directors. In terms of emissions reduction, 75.6 percent of the companies set a specified reduction target (*REDT*) and 88.9 percent establish a reduction policy through operations (*REDP*).

5.4.1.2 Means Comparison Based on the Main Variables of Interest

Panel A of Table 5-3 categorises my sample observations based on the mean value[134] of the home country constructed reporting index. The low reporting index group includes the 3,543 the observations that emanate from a home country *j* with

[132] The no. of observations drops from 6,571 (*Scope1*) to 6,525 (*LSC1*) and from 6,579 (*Scope2*) to 6.383 (*LSC2*) due to the loss of the observations for the variables *Scope1* and *Scope2* with 0.000 value. The no. of observations for the variable *Scope12* (*LSC12*) is greater than the individual variables Scope1 and Scope2 because it is the sum of the Scope 1 and Scope 2 emissions. The variable *Scope12* drops only observations with 0.000 values for both the reported Scope 1 and Scope 2 emissions.
[133] The limitation of the sample from CDP database is further addressed in the Section 7.4.1.
[134] When partitioning the sample using the median value of the home country reporting index, the means comparison results are qualitatively similar.

a reporting index $REPHM_{j,t}$ lower than or equal to the mean value of 1.674 in the year *t*. The high reporting index group consists of the 3,121 observations that emanate from a home country *j* with a reporting index $REPHM_{j,t}$ higher than the mean value of 1.674 in the year *t*. In reviewing the means comparisons reported in Table 5-3 Panel A, the high reporting index group is associated with a significantly lower level of Scope 1 (*LSC1*, *t*= 4.106, *p*< 0.01) and Scope 2 (*LSC2*, *t*= 2.117, *p*< 0.05) emissions, and a subsequently lower level of disclosed Scope 1+2 emissions (*LSC12*, *t*= 4.363, *p*< 0.01), but interestingly is less likely to engage in carbon assurance (*ASU*, *t*= 8.573, *p*< 0.01). The assurance adoption rate is 72.8 percent for the low *REPHM* group and 63.0 percent for the high *REPHM* group. In summary, this supports the view that a MNC in a home country with more stringent carbon reporting schemes is less likely to undertake carbon assurance. This is consistent with the argument of a substitutional effect between the strength of carbon reporting schemes and the undertaking of carbon assurance.

In terms of company characteristics, companies that are based in countries with a high *home* country reporting scheme index are smaller in size (*SIZE*, *t*= 6.233, *p*< 0.01), generate higher returns on total assets (*ROA*, *t*= -2.706, *p*< 0.01), and use newer equipment in production (*NEW*, *t*= -10.701, *p*< 0.01), but also have higher leverage ratios (*LEV*, *t*= -5.705, *p*< 0.10) and are less likely to set an emissions reduction target (*REDT*, *t*=2.369, *p*< 0.01) and/or implement an emissions reduction policy (*REDP*, *t*= 6.575, *p*< 0.01).

Panel B of Table 5-3 categorizes the sample observations based on the mean value of the *host* country reporting index. The 2,252 companies with a host country reporting scheme index higher than the mean value of 0.590 are contained in the high reporting index group, while 4,412 companies are contained in the low reporting index group. The high reporting index group of companies generates significantly higher Scope 2 emissions (*LSC2*, t= -5.904, p< 0.01) but slightly lower Scope 1 emissions (*LSC1*, t=1.648, p< 0.01). The likelihood for this group of companies being independently assured is significantly higher (*ASU*, t= -6.157, p< 0.01). The assurance adoption rate is 65.8 percent in the low *REPHS* group, and 73.0 percent in the high *REPHS* group. The adoption rate is higher for companies based in host countries with more stringent reporting schemes[135].

In terms of company characteristics, this group of companies consists of larger companies (*SIZE*, t= -6.358, p< 0.01), which have lower leverage ratios (*LEV*, t=2.744, p< 0.01) and have more ageing equipment in use[136] (*NEW*, t=10.174, p< 0.01). In addition, in contrast with companies in the higher home country reporting index group, high host country reporting index group companies are more likely to have in place an emissions reduction target (*REDT*, t= -3.197, p< 0.01) and an implemented policy (*REDP*, t= -3.310, p< 0.01).

Panel C of Table 5-3 presents means comparison results based on companies' decisions on assurance. As compared to the non-assurance group, observations for the assurance group are associated with considerably higher levels of both Scope 1 (*LSC1*, t= -21.381, p< 0.01) and Scope 2 (*LSC2*, t= -22.451, p< 0.01) and subsequently the sum of Scope 1 and 2 (*LSC12*, t= -24.927, p< 0.01) emissions[137]. Notably, companies based in home countries with a higher reporting index are

[135] Interpretation of the difference of adoption rates in the host countries may not be as informative as for those in the home countries as a MNC's decision on carbon assurance is made at the head office in the home country.
[136] Untabulated industry analysis of the NEW variable indicates that the majority of industries – including Consumer Discretionary, Consumer Staples, Energy, Health Care, Industrials, Materials, and Utilities – have significantly older equipment in use in host countries with low reporting scheme indices.
[137] Companies with higher carbon emission levels are associated with a greater likelihood of undertaking carbon assurance (e.g., Datt, Luo, Tang, and Mallik, 2018).

significantly less likely to engage with carbon assurances (*REPHM*, t= 6.297, p< 0.01).

Observations from the assurance group are larger in size (*SIZE*, t= -24.703, p< 0.01) and have higher long-term debts (*LEV*, t= -3.145, p< 0.01). Their equipment in use is newer (*NEW*, t= -2.904, p< 0.01) but their capacity to acquire new fixed assets is modest (t= 1.977, p< 0.05). The assurance group in general has a significantly higher probability of appointing a separate sustainability committee (*CAPIN*, t= -8.765, p< 0.01), setting a reduction target (*REDT*, t= -19.461, p< 0.01), and formulating a reduction policy (*REDP*, t= -15.570, p< 0.01).

5.4.2 Pearson Correlation

Table 5-4 displays the Pearson correlation matrix for the regression models. As expected, there are high correlations between the level form of the dependent variables *LSC1* and *LSC12* (0.937), *LSC2* and *LSC12* (0.842), and *LSC1* and *LSC2* (0.678). Unsurprisingly, the interaction term *REPHMASU* is also highly correlated with *REPHM* (0.548) and *ASU* (0.594), and *REPHSASU* is highly correlated with *REPHS* (0.809)[138]. Consistent with prior studies (e.g., Brouhle and Harrington, 2009; Rankin et al., 2011; Luo et al., 2012; Stanny, 2013), company size is significantly positively related with emission levels: *LSC1* (0.443), *LSC2* (0.594), and *LSC12* (0.532). All the other variables have correlations less than 0.5 and therefore do not raise concerns over multicollinearity[139] issues.

[138] High correlation of the interaction terms with their main effects is by design, and is not a cause for concern (Wooldridge, 2016).
[139] High collinearity between variables may cause imprecise parameter estimates and larger standard errors. However, multicollinearity is not a concern if the collinearity is confined to control variables only, as the estimated parameters and standard errors on the variables of interest would not be affected. Furthermore, if a parameter estimate is found to be statistically significant it is not *because*, but rather *despite* multicollinearity issues (Wooldridge, 2016).

TABLE 5-3 Means Comparison

Panel A: Means comparison between the High and Low REPHM groups

	Full sample		Low REPHM		High REPHM			
	n	**Mean**	**n**	**Mean**	**n**	**Mean**	***t* value**	***p* value**
LSC1	6,525[140]	12.101	3,526	12.234	2,999	11.944	4.106	0.001
LSC2	6,383	12.084	3,420	12.133	2,963	12.027	2.117	0.017
LSC12	6,664	13.137	3,543	13.253	3,121	13.006	4.363	0.001
ASU	6,664	0.682	3,543	0.728	3,121	0.630	8.573	0.001
SIZE	6,664	15.778	3,543	15.879	3,121	15.662	6.233	0.001
ROA	6,664	0.050	3,543	0.047	3,121	0.052	-2.706	0.003
LEV	6,664	0.210	3,543	0.200	3,121	0.221	-5.705	0.001
NEW	6,664	0.505	3,543	0.484	3,121	0.529	-10.701	0.001
CAPIN	6,664	0.142	3,543	0.139	3,121	0.145	-0.162	0.871
CSRC	6,664	0.924	3,543	0.924	3,121	0.925	-0.283	0.778
REDT	6,664	0.756	3,543	0.767	3,121	0.742	2.369	0.009
REDP	6,664	0.889	3,543	0.913	3,121	0.862	6.575	0.001

Panel B: Means comparison between the High and Low REPHS groups

	Full sample		Low REPHS		High REPHS			
	n	**Mean**	**n**	**Mean**	**n**	**Mean**	***t* value**	***p* value**
LSC1	6,525	12.101	4,273	12.142	2,252	12.023	1.648	0.050
LSC2	6,383	12.084	4,187	11.980	2,196	12.281	-5.904	0.001
LSC12	6,664	13.137	4,412	13.141	2,252	13.131	0.162	0.872
ASU	6,664	0.682	4,412	0.658	2,252	0.730	-6.157	0.001
SIZE	6,664	15.778	4,412	15.701	2,252	15.928	-6.358	0.001
ROA	6,664	0.050	4,412	0.050	2,252	0.049	0.405	0.685
LEV	6,664	0.210	4,412	0.213	2,252	0.203	2.744	0.003
NEW	6,664	0.505	4,412	0.519	2,252	0.477	10.174	0.001
CAPIN	6,664	0.142	4,412	0.143	2,252	0.140	0.057	0.955
CSRC	6,664	0.924	4,412	0.926	2,252	0.922	0.552	0.581
REDT	6,664	0.756	4,412	0.744	2,252	0.779	-3.197	0.001
REDP	6,664	0.889	4,412	0.880	2,252	0.906	-3.310	0.001

[140] Please refer to the footnote 115 for explanation of the differences in the no. of observations for the variables *LSC1*, *LSC2* and *LSC12*.

Panel C: Means comparison between the ASU and Non-ASU groups

	Full sample		Non-ASU		ASU			
	n	**Mean**	**n**	**Mean**	**n**	**Mean**	***t* value**	***p* value**
LSC1	6,525	12.101	2,039	11.046	4,486	12.580	-21.381	0.001
LSC2	6,383	12.084	2,024	11.279	4,359	12.457	-22.451	0.001
LSC12	6,664	13.137	2,119	12.163	4,545	13.592	-24.927	0.001
REPHM	6,664	1.674	2,119	1.827	4,545	1.602	6.297	0.001
REPHS	6,664	0.590	2,119	0.506	4,545	0.629	-5.731	0.001
SIZE	6,664	15.778	2,119	15.176	4,545	16.058	-24.703	0.001
ROA	6,664	0.050	2,119	0.050	4,545	0.050	0.000	1.000
LEV	6,664	0.210	2,119	0.202	4,545	0.214	-3.145	0.001
NEW	6,664	0.505	2,119	0.496	4,545	0.509	-2.904	0.002
CAPIN	6,664	0.142	2,119	0.227	4,545	0.102	1.977	0.024
CSRC	6,664	0.924	2,119	0.877	4,545	0.946	-8.765	0.001
REDT	6,664	0.756	2,119	0.596	4,545	0.830	-19.461	0.001
REDP	6,664	0.889	2,119	0.787	4,545	0.937	-15.570	0.001

Panel A reports the results of the means comparison between the groups of high and low reporting strength index in the home countries. Panel B reports the results of the means comparison between the groups of high and low reporting strength index in the host countries. Panel C presents the results of the means comparison between the assurance and non-assurance groups.
All variables are defined in text and in Appendix B.

TABLE 5-4 Correlations between Carbon Emissions Growth, Reporting Scheme Strength, Assurance and Other Company Level Variables

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
A. LSC1	1.000															
B. LSC2	0.678	1.000														
C. LSC12	0.937	0.842	1.000													
D. REPHM	-0.095	-0.090	-0.109	1.000												
E. REPHS	0.006	0.102	0.043	-0.481	1.000											
F. ASU	0.242	0.275	0.289	-0.123	0.112	1.000										
G. REPHMASU	0.082	0.124	0.116	0.548	-0.247	0.594	1.000									
H. REPHSASU	0.076	0.158	0.113	-0.381	0.809	0.383	-0.122	1.000								
I. SIZE	0.443	0.594	0.532	-0.103	0.065	0.317	0.123	0.143	1.000							
J. ROA	-0.076	0.025	-0.050	0.011	-0.009	-0.007	0.009	-0.021	0.011	1.000						
K. LEV	0.234	0.119	0.220	0.005	-0.016	0.062	0.050	-0.015	0.009	-0.122	1.000					
L. NEW	0.113	-0.061	0.089	0.159	-0.119	0.034	0.141	-0.087	-0.150	0.011	0.212	1.000				
M. CAPIN	0.009	-0.054	-0.016	0.027	-0.001	-0.032	-0.016	-0.017	-0.136	-0.015	0.014	0.107	1.000			
N. CSRC	0.112	0.166	0.160	-0.024	0.018	0.145	0.084	0.046	0.151	-0.017	0.006	0.007	-0.057	1.000		
O. REDT	0.177	0.234	0.213	-0.121	0.059	0.292	0.127	0.115	0.258	0.025	0.052	-0.099	-0.049	0.239	1.000	
P. REDP	0.253	0.234	0.261	-0.129	0.063	0.258	0.101	0.114	0.267	-0.012	0.046	-0.080	-0.042	0.200	0.323	1.000

All variables are defined in text and Appendix B.

5.4.3 Regression Results

Table 5-5 shows the panel regression results for the main analyses for Scope 1, Scope 2, and the sum of Scope 1 and 2 emissions over the 1-, 2-, 3-, 4- and 5- year time horizons. As discussed in Section 5.3, multilevel methodology is adopted in this study to cluster the observations as per country group.

5.4.3.1 Scope 1 Emissions

Panel A discloses the test results for the rate of change of Scope 1 emissions over 1- 5 year time horizons. Both *REPHM* (-0.043, $p< 0.10$) and *REPHS* (-0.060, $p< 0.10$) are negatively related with the rate of change of Scope 1 emissions over the 2- year time horizon. *ASU* is consistently negatively associated with the rate of change of Scope 1 emissions over the 2- (-0.194, $p< 0.01$), 3- (-0.232, $p< 0.01$) and 4- (-0.208, $p< 0.05$) year time horizons. The interaction term *REPHMASU* is significantly positive over the 2- (0.073, $p< 0.01$) and 3- (0.081, $p< 0.01$) year time horizons. *REPHSASU* is significantly positive over the 2- (0.086, $p< 0.05$) and 3- (0.078, $p< 0.10$) year time horizons. The Scope 1 emissions growth rate slows down 2-, 3- and 4- years after a company’s decision to seek assurance by 19.4, 23.2 and 20.8 percent, respectively. A unit increase in the home country and host country reporting scheme index is associated with a 4 percent and a 6 percent decrease in a company’s emissions growth rate, respectively. In addition, while the presence of a reduction policy is associated with approximately a 10 percent reduction in Scope 1 emissions growth during the first- and second-year time horizons, the emissions reduction target has been driving the emissions reduction momentum more towards the mid-term. There is a decrease in Scope 1 emissions growth at 8.2 percent two years after target setting, and 15.3 percent in 3 years, 20.9 percent in 4 years and 20.6 percent in 5 years' time.

5.4.3.2 Scope 2 Emissions

Panel B discloses the test results for the rate of change of Scope 2 emissions over 1- 5 years' time horizons. *REPHM* is statistically significant over the 3- (-0.053, $p < 0.10$) and 5- (-0.091, $p < 0.10$) year time horizons. One of the interaction terms *REPHMASU* is modestly significant at the one-year time horizon (-0.030, $p < 0.10$). A unit increase in the reporting scheme index in the home country leads to a 3 percent decrease in a company's Scope 2 emissions growth one year after undertaking carbon assurance.

5.4.3.3 Scope 1+2 Emissions

Panel C discloses the test results for the rate of change in the sum of Scope 1 and Scope 2 emissions over 1- 5 years' time horizons. Over the 1- (-0.019, $p < 0.10$), and 3- (-0.075, $p < 0.01$), 4- (-0.057, $p < 0.10$), 5- (-0.095, $p < 0.05$) year time horizons, *REPHM* is significantly negative. *ASU* starts to become significantly negative in curbing the sum of the Scope 1 and Scope 2 emissions over the 2- year time horizon at 15.1 percent, and then it peaks at a rate of 28.7 percent at the 3- year time horizon, followed by a fallback back to 19.0 percent at the 4-year time horizon. The interaction term *REPHMASU* is significantly positive over the 2- (0.042, $p < 0.10$) and 3- (0.113, $p < 0.01$) year time horizons. Three years after the undertaking of a carbon assurance engagement, a company's Scope 1 and 2 emissions growth is reduced by 28.7 percent. Three years after an increase in the strength of the reporting index in a home country by a unit, companies have emissions growth slowing down by 7.5 percent. However, where a client company is based in a country with stringent carbon reporting schemes, the negative effects of carbon assurance on carbon emissions growth turns positive and accelerates carbon emissions growth, peaking at a 11.3 percent rate over a 3- year time horizon.

TABLE 5-5 The Impact of Carbon Reporting Schemes and Assurance on Carbon Emissions Growth

Panel A: Scope 1 emissions

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
REPHM	0.011	-0.043*	-0.021	-0.003	0.006
	(0.71)	(-1.95)	(-0.77)	(-0.07)	(0.11)
REPHS	-0.014	-0.060*	-0.044	-0.052	-0.040
	(-0.59)	(-1.78)	(-1.09)	(-1.03)	(-0.56)
ASU	0.000	-0.194***	-0.232***	-0.208**	-0.113
	(0.01)	(-3.09)	(-3.09)	(-2.16)	(-0.82)
REPHMASU	-0.001	0.073***	0.081***	0.063	0.017
	(-0.04)	(2.78)	(2.60)	(1.52)	(0.28)
REPHSASU	0.005	0.077**	0.078*	0.080	0.019
	(0.18)	(1.99)	(1.68)	(1.37)	(0.23)
SIZE	-0.005	-0.009	-0.009	-0.039**	-0.048*
	(-0.73)	(-0.87)	(-0.70)	(-2.16)	(-1.84)
ROA	0.102	0.300	0.591**	0.619*	0.877
	(0.73)	(1.50)	(2.15)	(1.69)	(1.59)
LEV	0.065	0.052	-0.027	-0.136	-0.303
	(0.91)	(0.51)	(-0.21)	9-0.78)	(-1.18)
NEW	0.031	0.030	0.104	0.332**	0.458**
	(0.50)	(0.35)	(0.90)	(2.15)	(2.11)
CAPIN	-0.001	0.007	-0.020	-0.171	-0.457
	(-0.09)	(0.10)	(-0.15)	(-0.94)	(-1.54)
CSRC	-0.014	0.036	0.096	0.120	0.253
	(-0.33)	(0.55)	(1.02)	(0.90)	(1.36)
REDT	-0.014	-0.082**	-0.153***	-0.209***	-0.206**
	(-0.59)	(-2.46)	(-3.62)	(-3.58)	(-2.40)
REDP	-0.099***	-0.105**	-0.068	-0.092	-0.104
	(-3.09)	(-2.41)	(-1.25)	(-1.24)	(-0.96)
constant	0.121	0.357*	0.307	0.827**	0.773
	(0.91)	(1.93)	(1.25)	(2.50)	(1.65)
Year	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Observations	4,840	3,641	2,659	1,777	1,100
Chi-square	33.31	49.33	59.11	67.2	44.66
Prob (Chi-square)	0.1869	0.0038	0.0001	0.0001	0.0044
Log likelihood	-4604.28	-4029.24	-3039.45	-2175.27	-1495.38

Panel B: Scope 2 emissions

	Dep. Var. =				
	D1LSC2	**D2LSC2**	**D3LSC2**	**D4LSC2**	**D5LSC2**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
REPHM	0.010	-0.017	-0.053*	-0.028	-0.091*
	(0.71)	(-0.79)	(-1.92)	(-0.78)	(-1.79)
REPHS	0.004	0.000	-0.025	-0.005	0.011
	(0.17)	(0.01)	(-0.59)	(-0.09)	(0.15)
ASU	0.042	-0.003	-0.102	-0.005	-0.037
	(0.96)	(-0.04)	(-1.29)	(-0.05)	(-0.25)
REPHMASU	-0.030*	-0.002	0.052	-0.028	0.051
	(-1.75)	(-0.07)	(1.59)	(-0.66)	(0.81)
REPHSASU	-0.026	-0.039	-0.020	-0.084	-0.135
	(-0.99)	(-1.02)	(-0.41)	(-1.38)	(-1.52)
SIZE	-0.001	-0.011	-0.031**	-0.067***	-0.099***
	(-0.20)	(-1.03)	(-2.14)	(-3.45)	(-3.44)
ROA	0.155	0.476**	0.435	1.444***	1.095*
	(1.17)	(2.32)	(1.48)	(3.70)	(1.83)
LEV	-0.100	-0.178*	-0.274*	-0.117	-0.583**
	(-1.43)	(-1.69)	(-1.96)	(-0.62)	(-2.05)
NEW	0.176***	0.309***	0.446***	0.885***	1.039***
	(2.90)	(3.27)	(3.55)	(5.39)	(4.42)
CAPIN	0.002	0.251***	0.213	0.036	-0.213
	(0.16)	(2.66)	(1.57)	(0.19)	(-0.68)
CSRC	-0.011	-0.022	0.014	0.101	0.148
	(-0.26)	(-0.34)	(0.14)	(0.73)	(0.73)
REDT	0.008	-0.007	0.017	-0.045	-0.071
	(0.35)	(-0.20)	(0.38)	(-0.73)	(-0.78)
REDP	-0.037	-0.047	-0.058	0.019	0.146
	(-1.22)	(-1.09)	(-1.02)	(0.25)	(1.28)
constant	-0.066	0.132	0.374	0.656*	1.112**
	(-0.51)	(0.69)	(1.42)	(1.86)	(2.18)
Year	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Observations	4,703	3,536	2,553	1,684	1,005
Chi-square	45.04	68.29	67.79	98.11	72.84
Prob (Chi-square)	0.0161	0.0001	0.0001	0.0001	0.0001
Log likelihood	-4208.73	-3843.76	-3029.47	-2124.98	-1404.908

Panel C: Scope 1 +2 emissions

	Dep. Var. =				
	D1LSC12	**D2LSC12**	**D3LSC12**	**D4LSC12**	**D5LSC12**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
REPHM	0.019*	-0.029	-0.075***	-0.057*	-0.095**
	(1.32)	(-1.40)	(-2.93)	(-1.67)	(-2.04)
REPHS	-0.005	-0.032	-0.046	-0.070	-0.069
	(-0.21)	(-0.99)	(-1.17)	(-1.38)	(-1.00)
ASU	0.008	-0.151***	-0.287***	-0.190*	-0.101
	(0.19)	(-2.61)	(-3.93)	(-1.94)	(-0.75)
REPHMASU	-0.020	0.042*	0.113***	0.044	0.073
	(-1.18)	(1.79)	(3.76)	(1.07)	(1.26)
REPHSASU	0.002	0.042	0.066	0.032	-0.011
	(0.06)	(1.16)	(1.47)	(0.55)	(-0.14)
SIZE	-0.006	-0.017*	-0.020	-0.042**	-0.090***
	(-0.88)	(-1.67)	(-1.52)	(-2.28)	(-3.46)
ROA	0.118	0.376*	0.808***	0.994***	0.667
	(0.90)	(1.95)	(3.00)	(2.67)	(1.21)
LEV	0.058	0.072	-0.079	-0.165	-0.393
	(0.85)	(0.74)	(-0.62)	(-0.93)	(-1.55)
NEW	0.140**	0.245***	0.330***	0.674***	0.819***
	(2.33)	(2.86)	(2.90)	(4.32)	(3.79)
CAPIN	0.053***	-0.033	0.112	-0.079	-0.470
	(6.54)	(-0.52)	(0.91)	(-0.43)	(-1.65)
CSRC	-0.056	-0.044	-0.020	0.157	0.353**
	(-1.44)	(-0.72)	(-0.22)	(1.18)	(1.99)
REDT	0.030	-0.004	-0.053	-0.115*	-0.112
	(1.32)	(-0.12)	(-1.28)	(-1.96)	(-1.33)
REDP	-0.050	-0.042	-0.032	0.043	0.113
	(-1.63)	(-1.03)	(-0.60)	(0.57)	(1.05)
constant	0.055	0.310*	0.424*	0.492	0.914**
	(0.44)	(1.75)	(1.77)	(1.47)	(1.97)
Year	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Observations	4,946	3,721	2,722	1,830	1,130
Chi-square	109.93	62.33	73.8	75.2	62.03
Prob (Chi-square)	0.0001	0.0001	0.0001	0.0001	0.0001
Log likelihood	-4524.95	-3887.15	-3083.92	-2298.50	-1539.47

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 5-5 presents regression results of Equation (1) using DLSC as the dependent variable. Panel A reports the regression results for the Scope 1 emissions. The dependent variables are the percentage change in SC1 over 1, 2, 3, 4, 5-year time horizon in Columns (1) – (5). Panel B reports the regression results for the Scope 2 emissions. The dependent variables are the percentage change in SC2 over 1, 2, 3, 4, 5-year time horizons in Columns (1) – (5). Panel C presents the regression results for the sum of Scope 1 and 2 emissions. The dependent variables are the percentage change in SC12 over 1, 2, 3, 4, 5-year time horizons in Columns (1) – (5).
All variables are defined in text and in Appendix B.

In summary, results from the main regression analyses suggest that hypotheses H1a, H1b and H2 are moderately supported. That is, a more stringent carbon reporting scheme in both the home and host countries are modestly effective in curbing Scope 1 emissions growth 2 years after a reporting scheme became effective. A company's carbon assurance engagement is significantly effective in reducing a company's Scope 1 emissions growth 2 years after and demonstrates an enduring effect. The positive coefficient on the interaction term over the 2- and 3- year time horizons suggests that the effect of carbon assurance is diminished when a client company is based in a home and/or host country with more stringent carbon- related reporting schemes. This also suggests that the effect of assurance engagements on curbing carbon emissions growth is most pronounced when carbon related reporting schemes are not so stringent. Thus, H3 is modestly and partially supported.

5.5 Sensitivity Analyses

To address some of the potential concerns arising from the main analyses, namely, the absence of country level variables and the mandatory nature of the EU ETS in prescribing mechanisms to enhance the credibility of reported carbon data. I conduct two sensitivity analyses in this section to test on the robustness of the results from the main analyses.

5.5.1 Inclusion of Country Level Characteristics

This sensitivity analysis specifies two country characteristics[141], the general audit environment and the enforceability of regulatory interventions, both of which might be relevant when considering the conclusions for two of the primary variables of interest, namely, the strength of the reporting scheme and assurance. Enforceability of a country's

[141] The two country level variables are included in the sensitivity test because the latest year when the two variables were constructed in Brown et al., (2014)'s study was 2008. The year 2008 falls outside the period of the sample in this study. Moreover, my study measures the changes in reporting schemes, correspondingly, the audit environment and enforcement variables would be more appropriate for inclusion if they were changing measures rather than static measures.

reporting schemes depends on the effectiveness of relevant government bodies, and the general audit environment might further contribute to the quality of assurance engagements conducted in the relevant national assurance market. My model is then modified as[142]:

$$D_nLSC(k)_{i,t} = \gamma_0 + \gamma_1\, REPHM_{j,t} + \gamma_2 REPHS_{j,t} + \gamma_3\, ASU_{i,t} + \gamma_4\, REPHMASU_{ij,t} + \gamma_5\, REPHSASU_{ij,t} + \gamma_6\, SIZE_{i,t} + \gamma_7\, ROA_{i,t} + \gamma_8\, LEV_{i,t} + \gamma_9\, NEW_{i,t} + \gamma_{10}\, CAPIN_{i,t} + \gamma_{11}\, CSRC_{i,t} + \gamma_{12}\, REDT_{i,t} + \gamma_{13}\, REDP_{i,t} + \gamma_{14}\, AUDT_{j,t} + \gamma_{15}\, ENFR_{j,t} + \mu_{0,i} + e_{i,j}, \tag{11}$$

AUDT is the summation of the audit environment and independent enforcement bodies developed by Brown et al. (2014) and applied in Preiato et al. (2015). While prior studies use market and governance devised variables to proxy for country characteristics (e.g., Dhaliwal et al., 2012; 2014), Brown et al. (2014) developed a series of variables that detach audit environment from other noisier institutional factors at the country level. It is expected that the better the audit environment, the better the quality of assurance practices. Credible disclosed emissions data lays the foundation for better management of emissions reduction. A negative sign is anticipated for the coefficient of this variable.

ENFR reflects "the level of resourcing of the regulators based on enforcement agencies' budget as a proportion of GDP or number of staffs per head of population". In response to Coffee's (2007) call for proxies that can directly measure the enforcement

[142] I ran an additional analysis, including the interaction term between the enforcement (ENFR) and audit environment (AUDT) variables. However, the coefficients of the interaction variable remain statistically insignificant across the models.

inputs and outputs to disentangle the element of enforcement from other institutional factors, Jackson and Roe (2009) constructed this measure to capture the public enforcement and supervisory activities in the securities markets. The better the enforcement by the regulatory bodies, the more likely it is that the implemented reporting schemes will be effective in achieving their purpose. I expect a negative sign for the coefficient of this variable.

Table 5-6 presents the results using the regression model (11). Panel A (Panel B) reports the results of the regression for Scope 1 (Scope 2) emissions. Inclusion of the two country level characteristics does not change the results of the main analyses[143]. Of interest is that the variable *AUDT* is significantly negative over the 1- (-0.002, $p< 0.01$) to 5- (-0.006, $p< 0.05$) year time horizons for Scope 2 emissions (Panel B), but only modestly significant for Scope 1 emissions (Panel A) over the 3- (-0.002, $p< 0.10$) to 5- (-0.005, $p< 0.10$) year time horizons. The results highlight that the general audit environment of the home country is consistently effective in curbing Scope 2 emissions growth rather than a company's engagement of carbon assurance, although the economic magnitude of the coefficient on *ASU* is greater.

Panel C (Panel D) reports the results of the regression for Scope 1 (Scope 2) emissions by splitting the observations into countries with low versus high audit environment. *AUDT* =1 for observations which reside in countries with greater than the mean of *AUDT*. Compared to the results of the high audit environment group, it seems that observations from low audit environment countries contribute to the statistical significance of the variables of interest. Specifically, the coefficients of *REPHM* (-0.134,

[143] Untabulated results of using DLSC12 as the dependent variables indicate that the results of the main analyses are robust.to the inclusion of the two country level variables.

p< 0.01; -0.119, *p*< 0.05; -0.118, *p*< 0.10), *REPHS* (-0.175, *p*< 0.01; -0.202, *p*< 0.05; -0.211, *p*< 0.10) and *ASU* (-0.521, *p*< 0.01; -0.577, *p*< 0.01; -0.587, *p*< 0.01; -0.498, *p*< 0.05) for the Scope 1 emissions model are significantly negative over the 2 to 4 (or 5) year horizons. The interactions between *ASU* and both *REPHM* and *REPHS* stay significantly positive over the 2 to 4 (or 5)_year horizons. More stringent reporting schemes and the undertaking of carbon assurance both demonstrate curbing effect on emissions for companies residing in low quality audit environment countries. However, similar with the results from the main analyses, the curbing effect of carbon assurance diminishes when companies reside in countries with more stringent reporting schemes. For Scope 2 emissions, the coefficient of *ASU* is significantly negative over the 2 to 4 year horizons, and the coefficients of *REPHM* and *REPHS* are statistically negative over the 4 year horizon for the low audit environment group. In the high audit environment group, the curbing effect of carbon assurance on Scope 2 emissions growth becomes more pronounced in host countries with stringent reporting schemes.

Panel E (Panel F) reports the results of the regression for Scope 1 (Scope 2) emissions by splitting the observations into countries with low versus high regulatory enforcement groups. *ENFR* =1 for observations residing in countries with greater than mean *ENFR* values. Results from the low regulatory enforcement group for Scope 1 emissions are consistent with those of the main analyses. The coefficients of *ASU* (-0.294, *p*< 0.01; -0.293, *p*< 0.01; -0.251, *p*< 0.05) are significantly negative over the 2 to 4 year horizons. For Scope 2 emissions, the coefficients of *REPHM* (-0.063, *p*< 0.05; -0.173, *p*< 0.01; -0.331, *p*< 0.01) are statistically significant in countries with high regulatory enforcement.

TABLE 5-6 The Impact of Carbon Reporting Schemes and Assurance on Carbon Emissions Growth including Country Level Audit Environment Characteristics

Panel A: Scope 1 emissions

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
REPHM	0.013	-0.042*	-0.025	-0.001	0.002
	(0.83)	(-1.87)	(-0.95)	(-0.03)	(0.04)
REPHS	-0.012	-0.058*	-0.050	-0.058	-0.044
	(-0.47)	(-1.68)	(-1.23)	(-1.15)	(-0.61)
ASU	0.002	-0.193***	-0.231***	-0.184*	-0.107
	(0.05)	(-3.04)	(-3.06)	(-1.92)	(-0.78)
REPHMASU	-0.002	0.072**	0.077**	0.053	0.013
	(-0.10)	(2.74)	(2.45)	(1.28)	(0.22)
REPHSASU	0.001	0.073*	0.072	0.069	0.007
	(0.04)	(1.86)	(1.54)	(1.19)	(0.09)
SIZE	-0.005	-0.009	0.000	-0.026	-0.043
	(-0.61)	(-0.88)	(0.03)	(-1.51)	(-1.65)
ROA	0.097	0.312**	0.607**	0.740**	0.884
	(0.68)	(1.53)	(2.27)	(2.08)	(1.63)
LEV	0.074	0.085	0.051	-0.028	-0.237
	(1.01)	(0.82)	(0.40)	(-0.16)	(-0.92)
NEW	0.023	0.022**	0.067	0.291*	0.357*
	(0.36)	(0.24)	(0.60)	(1.99)	(1.68)
CAPIN	-0.001	0.006***	0.010	-0.123	-0.346
	(-0.10)	(0.09)	(0.08)	(-0.68)	(-1.15)
CSRC	-0.027	0.035	0.060	0.081	0.250
	(-0.63)	(0.52)	(0.63)	(0.60)	(1.34)
REDT	-0.016	-0.089**	-0.154***	-0.217***	-0.225**
	(-0.67)	(-2.63)	(-3.65)	(-3.75)	(-2.61)
REDP	-0.100***	-0.103**	-0.071	-0.098	-0.095
	(-3.08)	(-2.33)	(-1.30)	(-1.31)	(-0.87)
AUDT	-0.001	-0.001	-0.002*	-0.003*	-0.005*
	(-0.70)	(-1.31)	(-1.72)	(-1.69)	(-1.84)
ENFR	0.001	0.000	0.002**	0.003**	0.003
	(1.04)	(0.62)	(2.26)	(2.54)	(1.29)
constant	0.142	0.423**	0.275	0.738**	0.913*
	(1.02)	(2.19)	(1.12)	(2.21)	(1.89)
Year	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Observations	4,795	3,609	2,638	1,761	1,089
Chi-square	34.75	49.7	65.85	82.14	49.92
Prob (Chi-square)	0.2130	0.0070	0.0001	0.0001	0.0022
Log likelihood	-4569.34	-4001.34	-3020.06	-2148.98	-1477.59

Panel B: Scope 2 emissions

	Dep. Var. =				
	D1LSC2	**D2LSC2**	**D3LSC2**	**D4LSC2**	**D5LSC2**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
REPHM	0.010	-0.027	-0.056**	-0.024	-0.084
	(0.69)	(-1.29)	(-2.09)	(-0.69)	(-1.66)
REPHS	-0.001	-0.014	-0.038	-0.008	0.012
	(-0.05)	(-0.42)	(-0.89)	(-0.14)	(0.16)
ASU	0.027	-0.032	-0.132*	-0.025	-0.034
	(0.62)	(-0.53)	(-1.67)	(-0.24)	(-0.23)
REPHMASU	-0.028	-0.002	0.045	-0.031	0.039
	(-1.68)	(-0.07)	(1.38)	(-0.71)	(0.61)
REPHSASU	-0.024	-0.033	-0.025	-0.095	-0.151*
	(-0.92)	(-0.87)	(-0.51)	(-1.53)	(-1.68)
SIZE	-0.001	-0.004	-0.010	-0.034*	-0.077**
	(-0.07)	(-0.37)	(-0.73)	(-1.84)	(-2.78)
ROA	0.206*	0.495**	0.529*	1.323***	1.068*
	(1.58)	(2.49)	(1.89)	(3.49)	(1.85)
LEV	-0.041	-0.075	-0.107	-0.027	-0.514*
	(-0.59)	(-0.73)	(-0.79)	(-0.14)	(-1.81)
NEW	0.162**	0.252**	0.360***	0.679***	0.852***
	(2.71)	(2.83)	(3.11)	(4.38)	(3.75)
CAPIN	0.002	0.280***	0.288**	0.155	-0.127
	(0.20)	(3.01)	(2.16)	(0.80)	(-0.40)
CSRC	0.002	-0.051	-0.040	0.027	0.087
	(0.04)	(-0.77)	(-0.41)	(0.19)	(0.42)
REDT	0.004	-0.021	0.005	-0.045	-0.075
	(0.15)	(-0.65)	(0.12)	(-0.72)	(-0.80)
REDP	-0.038	-0.033	-0.045	0.024	0.153
	(-1.27)	(-0.77)	(-0.81)	(0.30)	(1.33)
AUDT	-0.002**	-0.004***	-0.005***	-0.007***	-0.006**
	(-2.10)	(-3.43)	(-3.96)	(-3.67)	(-2.16)
ENFR	0.000	0.000	-0.001	0.001	0.002
	(0.91)	(-0.23)	(-0.69)	(0.61)	(0.85)
constant	-0.025	0.249	0.427	0.604*	1.129**
	(-0.19)	(1.32)	(1.67)	(1.69)	(2.16)
Year	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Observations	4,659	3,504	2,531	1,669	995
Chi-square	51.58	87.84	85.64	103.75	76.39
Prob (Chi-square)	0.0061	0.0001	0.0001	0.0001	0.0001
Log likelihood	-4080.17	-3773.89	-2978.23	-2119.00	-1393.05

Panel C: Scope 1 emissions when splitting the observations into countries with low (AUDT=0) versus high (AUDT=1) audit environment groups

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
AUDT== 0					
REPHM	0.025	-0.134***	-0.119**	-0.118*	-0.112
	(0.80)	(-2.97)	(-2.25)	(-1.84)	(-1.29)
REPHS	-0.066	-0.175**	-0.120	-0.202**	-0.211*
	(-1.33)	(-2.55)	(-1.47)	(-2.10)	(-1.73)
ASU	-0.064	-0.521***	-0.577***	-0.587***	-0.498**
	(-0.73)	(-4.46)	(-4.16)	(-3.47)	(-2.18)
REPHMASU	-0.004	0.192***	0.223***	0.189**	0.114
	(-0.11)	(3.72)	(3.69)	(2.53)	(1.09)
REPHSASU	0.058	0.229***	0.218**	0.280*	0.258*
	(1.05)	(3.03)	(2.46)	(2.66)	(1.89)
ENFR	0.001	0.000	0.002	0.001	-0.002
	(0.64)	(0.39)	(1.47)	(0.61)	(-0.66)
constant	0.150	0.617*	0.388	1.351**	1.326*
	(0.56)	(1.70)	(0.82)	(2.24)	(1.63)
Observations	1,928	1,447	1,061	709	449
Chi-square	18.04	31.89	43.72	41.02	28.02
Prob (Chi-square)	0.2049	0.0042	0.0001	0.0002	0.0142
Log likelihood	-2192.04	-1842.78	-1383.60	-939.00	-638.43
AUDT== 1					
REPHM	0.011	0.018	0.029	0.056	0.074
	(0.71)	(0.75)	(1.04)	(1.47)	(1.24)
REPHS	0.013	0.010	-0.002	0.012	0.043
	(0.51)	(0.27)	(-0.04)	(0.22)	(0.51)
ASU	0.042	0.037	0.004	0.068	0.189
	(0.85)	(0.52)	(0.04)	(0.60)	(1.11)
REPHMASU	-0.001	-0.003	-0.008	-0.029	-0.062
	(-0.03)	(-0.09)	(-0.25)	(-0.61)	(-0.85)
REPHSASU	-0.022	-0.029	-0.044	-0.096	-0.200
	(-0.74)	(-0.68)	(-0.85)	(-1.40)	(-1.92)
ENFR	0.001	0.000	0.002	0.003**	0.006**
	(1.11)	(0.33)	(1.51)	(1.97)	(2.27)
constant	0.166	0.340*	0.358	0.635	0.587
	(1.26)	(1.79)	(1.46)	(1.80)	(1.10)
Observations	2,867	2,162	1,577	1,052	640
Chi-square	34.66	50.72	45.8	60.36	46.2
Prob (Chi-square)	0.0017	0.0001	0.0001	0.0001	0.0001
Log likelihood	-2211.37	-2048.18	-1555.72	-1179.60	-823.48

Panel D: Scope 2 emissions when splitting the observations into countries with low (AUDT=0) versus high (AUDT=1) audit environment groups

	Dep. Var. =				
	D1LSC2	**D2LSC2**	**D3LSC2**	**D4LSC2**	**D5LSC2**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
AUDT== 0					
REPHM	0.037	0.015	-0.029	-0.127**	-0.028
	(1.49)	(0.43)	(-0.66)	(-2.35)	(-0.35)
REPHS	-0.046	-0.070	-0.106	-0.145*	-0.120
	(-1.13)	(-1.22)	(-1.54)	(-1.71)	(-1.01)
ASU	-0.067	-0.171*	-0.301***	-0.468***	-0.205
	(-0.95)	(-1.79)	(-2.60)	(-3.21)	(-0.99)
REPHMASU	-0.022	0.012	0.055	0.128**	-0.011
	(-0.77)	(0.28)	(1.10)	(2.03)	(-0.12)
REPHSASU	0.040	0.066	0.099	0.129	0.043
	(0.89)	(1.04)	(1.32)	(1.39)	(0.33)
ENFR	0.001	0.001	0.000	0.001	0.001
	(1.43)	(0.87)	(0.01)	(0.53)	(0.27)
constant	0.055	0.467	0.919**	1.324**	1.927***
	(0.25)	(1.50)	(2.28)	(2.49)	(2.62)
Observations	1,869	1,393	999	650	392
Chi-square	21.91	28.4	35.14	53.45	39.58
Prob (Chi-square)	0.0804	0.0126	0.0014	0.0001	0.0003
Log likelihood	-1740.45	-1497.32	-1124.69	-759.90	-500.07
AUDT== 1					
REPHM	-0.001	-0.032	-0.064*	0.035	-0.085
	(-0.05)	(-1.18)	(-1.82)	(0.75)	(-1.29)
REPHS	0.028	0.027	0.011	0.071	0.103
	(1.04)	(0.65)	(0.20)	(1.04)	(1.05)
ASU	0.111**	0.117	0.028	0.315**	0.186
	(2.05)	(1.46)	(0.26)	(2.23)	(0.91)
REPHMASU	-0.036*	-0.022	0.043	-0.127**	0.046
	(-1.77)	(-0.69)	(1.02)	(-2.18)	(0.55)
REPHSASU	-0.066**	-0.100**	-0.093	-0.234***	-0.300**
	(-2.03)	(-2.05)	(-1.44)	(-2.77)	(-2.41)
ENFR	0.000	0.000	0.003	0.004	0.004
	(0.58)	(0.40)	(1.20)	(1.36)	(1.19)
constant	0.020	0.155	0.411	0.650	1.050
	(0.14)	(0.70)	(1.29)	(1.44)	(1.61)
Observations	2,790	2,111	1,532	1,019	603
Chi-square	35.00	54.87	41.23	59.15	52.67
Prob (Chi-square)	0.0015	0.0001	0.0002	0.0001	0.0001
Log likelihood	-2325.91	-1497.32	-1835.61	-1335.59	-876.26

Panel E: Scope 1 emissions when splitting the observations into countries with low (ENFR=0) versus high (ENFR=1) regulatory enforcement groups

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
ENFR==0					
REPHM	-0.006	-0.085***	-0.055**	-0.027	0.001
	(-0.27)	(-2.74)	(-1.60)	(-0.63)	(0.02)
REPHS	-0.013	-0.110**	-0.029	-0.048	-0.060
	(-0.37)	(-2.39)	(-0.55)	(-0.76)	(-0.67)
ASU	-0.017	-0.294***	-0.293***	-0.251**	-0.075
	(-0.25)	(-3.30)	(-2.91)	(-1.99)	(-0.40)
REPHMASU	0.012	0.119***	0.120***	0.088	0.003
	(0.46)	(3.13)	(2.81)	(1.62)	(0.03)
REPHSASU	-0.026	0.117**	0.044	0.048	-0.031
	(-0.65)	(2.13)	(0.70)	(0.62)	(-0.26)
AUDT	-0.003	-0.004	-0.006	-0.003	-0.009
	(-1.41)	(-1.32)	(-0.79)	(-0.54)	(-1.09)
constant	0.218	0.607**	0.392	0.458	0.749
	(1.24)	(2.52)	(1.18)	(1.17)	(1.28)
Observations	3,346	2,524	1,847	1,225	760
Chi-square	20.25	32.99	45.86	56.32	27.75
Prob (Chi-square)	0.1225	0.0029	0.0001	0.0001	0.0154
Log likelihood	-3442.00	-2980.55	-2172.48	-1508.73	-1064.18
ENFR==1					
REPHM	0.037**	0.031	0.050	0.052	0.001
	(1.98)	(1.04)	(1.18)	(0.92)	(0.01)
REPHS	-0.019	0.032	-0.056	-0.031	0.039
	(-0.63)	(0.70)	(-0.87)	(-0.38)	(0.35)
ASU	0.035	-0.033	-0.189	-0.128	-0.113
	(0.61)	(-0.40)	(-1.63)	(-0.85)	(-0.54)
REPHMASU	-0.026	-0.002	0.023	0.014	0.056
	(-1.23)	(-0.06)	(0.49)	(0.21)	(0.62)
REPHSASU	0.038	-0.001	0.103	0.036	-0.059
	(1.12)	(-0.03)	(1.47)	(0.40)	(-0.48)
AUDT	0.002	0.000	-0.005	-0.013*	-0.010
	(1.18)	(0.05)	(-0.96)	(-1.93)	(-1.24)
constant	0.224	0.376	0.999**	2.447***	2.332***
	(1.20)	(1.35)	(2.32)	(4.02)	(2.79)
Observations	1,449	1,085	791	536	329
Chi-square	25.19	22.22	26.51	35.92	23.94
Prob (Chi-square)	0.0327	0.0742	0.0223	0.0011	0.0466
Log likelihood	-1033.50	-956.90	-835.27	-630.99	-405.84

Panel F: Scope 2 emissions when splitting the observations into countries with low (ENFR=0) versus high (ENFR=1) regulatory enforcement groups

	Dep. Var. =				
	D1LSC2	**D2LSC2**	**D3LSC2**	**D4LSC2**	**D5LSC2**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
ENFR==0					
REPHM	0.011	-0.002	-0.010	-0.054	0.000
	(0.57)	(-0.05)	(-0.29)	(-1.22)	(-0.01)
REPHS	0.013	0.000	-0.007	-0.010	0.071
	(0.43)	(0.00)	(-0.13)	(-0.16)	(0.77)
ASU	0.019	0.035	0.047	-0.008	0.324*
	(0.33)	(0.41)	(0.45)	(-0.06)	(1.74)
REPHMASU	-0.017	-0.017	-0.035	-0.014	-0.157*
	(-0.70)	(-0.50)	(-0.80)	(-0.24)	(-1.92)
REPHSASU	-0.043	-0.065	-0.097	-0.131	-0.288**
	(-1.18)	(-1.25)	(-1.49)	(-1.59)	(-2.40)
AUDT	-0.006**	-0.011	-0.009	-0.007	-0.022*
	(-2.39)	(-1.65)	(-0.87)	(-0.57)	(-1.72)
constant	0.167	0.641**	0.854**	1.144**	1.772***
	(1.04)	(2.33)	(2.24)	(2.26)	(2.72)
Observations	3,258	2,457	1,777	1,167	695
Chi-square	17.65	26.63	29.78	58.07	55.11
Prob (Chi-square)	0.223	0.0215	0.0082	0.0001	0.0001
Log likelihood	-2935.14	-2744.56	-2122.86	-1465.74	-959.53
ENFR==1					
REPHM	0.001	-0.063**	-0.173***	-0.010	-0.331***
	(0.07)	(-2.05)	(-4.09)	(-0.17)	(-3.57)
REPHS	-0.021	-0.007	-0.052	0.010	-0.002
	(-0.62)	(-0.15)	(-0.77)	(0.11)	(-0.02)
ASU	0.052	-0.039	-0.204*	-0.005	-0.312
	(0.80)	(-0.44)	(-1.66)	(-0.03)	(-1.20)
REPHMASU	-0.041*	0.022	0.196***	-0.030	0.387***
	(-1.74)	(0.65)	(4.04)	(-0.42)	(3.65)
REPHSASU	0.010	0.000	0.054	-0.058	-0.077
	(0.28)	(-0.01)	(0.72)	(-0.59)	(-0.52)
AUDT	0.000	-0.002	-0.007*	-0.012*	-0.011
	(-0.21)	(-0.86)	(-1.74)	(-1.95)	(-1.29)
constant	0.141	0.300	0.892**	1.128*	2.203**
	(0.68)	(1.01)	(2.02)	(1.66)	(2.13)
Observations	1,401	1,047	754	502	300
Chi-square	28.15	53.41	54.1	37.18	39.23
Prob (Chi-square)	0.0136	0.0001	0.0001	0.0007	0.0003
Log likelihood	-1141.66	-2744.56	-2122.86	-645.25	-423.38

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5-6 presents the regression results of Equation (11) using DLSC as dependent variables. Panel A reports the regression results for the Scope 1 emissions. The dependent variables are the percentage change in SC1 over 1, 2, 3, 4, 5-year time horizons in Columns (1) – (5). Panel B reports the regression results for the Scope 2 emissions. The dependent variables are the percentage change in SC2 over 1, 2, 3, 4, 5-year time horizons in Columns (1) – (5), respectively. Panel C and D report the regression results for the Scope 1 and 2 emissions when splitting the observations into countries with low versus high audit environment groups. Panel E and F report the regression results for the Scope 1 and 2 emissions when splitting the observations into countries with low versus high regulatory enforcement groups. All variables are defined in text and Appendix B.

5.5.2 Control of the EU Countries where Reporting Facilities Faces Mandatory Credibility Enhancement Mechanisms

There are variations in the requirements for assurance of the disclosed emissions data prescribed by the reporting schemes. The EU ETS requires mandatory third-party 'verification' as the credibility enhancement mechanism for the emissions data submitted. This sensitivity test assesses whether mandatory carbon assurance demonstrates an effect, varied or otherwise, on companies' performance in terms of carbon emissions growth. The EU ETS intends to regulate the Scope 1 emissions that are directly produced by facilities owned or controlled by a company among the EU countries. An indicator variable, which equals 1 when a company's home country is a member of the EU, and 0 otherwise, is then included in my main regression model (9) for the test of the Scope 1 emissions only. Table 5-7 shows that the main analysis results are robust in terms of the inclusion of the *EU* indicator variable[144]. Nevertheless, the *EU* indicator variable is not statistically significant in the model.

[144] I also conducted additional tests which involved dropping observations for companies residing in EU countries in order to eliminate any EU effect. Regression results indicate that the coefficients of the variables of interest remain qualitatively similar.

TABLE 5-7 The Impact of Carbon Reporting Schemes and Assurance on Carbon Emissions Growth including the EU Countries Dummy

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
REPHM	0.011	-0.044**	-0.031	-0.010	-0.001*
	(0.69)	(-1.98)	(-1.18)	(-0.29)	(-0.03)
REPHS	-0.014	-0.060*	-0.051	-0.057	-0.039
	(-0.57)	(-1.76)	(-1.26)	(-1.14)	(-0.55)
ASU	0.001	-0.191***	-0.222***	-0.188*	-0.102
	(0.03)	(-3.05)	(-2.96)	(-1.95)	(-0.74)
REPHMASU	-0.001	0.072***	0.076**	0.056	0.013
	(-0.04)	(2.77)	(2.42)	(1.37)	(0.22)
REPHSASU	0.005	0.077**	0.078*	0.084	0.019
	(0.18)	(2.00)	(1.69)	(1.44)	(0.23)
EU	-0.005	-0.014	-0.010	-0.024	-0.031
	(-0.27)	(-0.52)	(-0.31)	(-0.54)	(-0.48)
SIZE	-0.006	-0.010	-0.003	-0.031*	-0.046*
	(-0.76)	(-0.94)	(-0.26)	(-1.79)	(-1.78)
ROA	0.102	0.299	0.553**	0.653*	0.748
	(0.73)	(1.49)	(2.09)	(1.85)	(1.41)
LEV	0.065	0.053	-0.008	-0.101	-0.320
	(0.91)	(0.52)	(-0.06)	(-0.59)	(-1.27)
NEW	0.030	0.026	0.123	0.388***	0.452**
	(0.47)	(0.29)	(1.12)	(2.67)	(2.15)
CAPIN	-0.001	0.007	-0.016	-0.179	-0.433
	(-0.09)	(0.10)	(-0.13)	(-0.99)	(-1.47)
CSRC	-0.014	0.035	0.075	0.108	0.256
	(-0.35)	(0.53)	(0.79)	(0.81)	(1.37)
REDT	-0.014	-0.082**	-0.147***	-0.197***	-0.202**
	(-0.58)	(-2.45)	(-3.51)	(-3.42)	(-2.37)
REDP	-0.098***	-0.103**	-0.062	-0.091	-0.092
	(-3.05)	(-2.35)	(-1.14)	(-1.22)	(-0.85)
constant	0.129	0.377**	0.222	0.654**	0.732
	(0.95)	(1.99)	(0.92)	(2.00)	(1.56)
Year	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Observations	4,840	3,641	2,659	1,777	1,100
Chi-square	33.38	49.6	57.13	70.44	44.43
Prob (Chi-square)	0.2219	0.0051	0.0004	0.0001	0.0068
Log likelihood	-4604.24	-4029.11	-3041.84	-2176.84	-1495.30

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
The dependent variables are the percentage change in Scope 1 emissions over the 1,2,3,4,5- year time horizons in Columns (1)-(5), respectively.
All variables are defined in text.

5.6 Additional Analyses

One of the primary variables of interest in this study is *ASU*, an indicator variable for the company's having a carbon assurance engagement undertaken. To further identify and investigate whether specific elements of the assurance services provided influence a company's performance in terms of carbon emissions growth, further analyses were conducted in this section to explore additional potentially relevant characteristics of carbon assurance in the context of outcome performance.

5.6.1 The Choice of Assurance Provider

Carbon emissions is one of the subject matters included under the broader category of nonfinancial reporting. The assurance market for nonfinancial reporting is almost equally shared by audit firms and non-audit firm providers[145], (KPMG 2013, 2015, 2017, 2020). While the non-audit firm providers are commonly recognised as subject matter experts, audit firms have accumulated and transferred experience and expertise relating to traditional financial audits towards providing assurances for nonfinancial information (Huggins, Green, and Simnett, 2011). It is an empirical question as to whether the type of assurance provider impacts upon an assurance engagement when carbon assurance services are performed by two distinctive types of assurance providers in the market.

I hand collected assurance reports issued by the reporting companies to CDP in the period 2014-2017, through the links of the reports provided in CDP as well as the companies' individual websites. A list of items (such elements contained in an assurance

[145] Non-audit firm providers include engineering and consulting firms, certification bodies and government agencies.

report as the scope, assurance level, signing office, issue date and opinion) including the provider of the assurance services[146] and the assurance standard adopted during the assurance engagement were identified through the diligent investigation of the content of each assurance report. Consequently, an indicator variable *ACCT* is included in the main analysis model to be tested on the assurance subgroup of observations. The model is therefore modified as,

$$D_nLSC(k)_{i,t} = \gamma_0 + \gamma_1 REPHM_{j,t} + \gamma_2 REPHS_{j,t} + \gamma_3 ACCT_{i,t} + \gamma_4 SIZE_{i,t} + \gamma_5 ROA_{i,t} + \gamma_6 LEV_{i,t} + \gamma_7 NEW_{i,t} + \gamma_8 CAPIN_{i,t} + \gamma_9 CSRC_{i,t} + \gamma_{10} REDT_{i,t} + \gamma_{11} REDP_{i,t} + \mu_{0,i} + e_{i,}, \tag{12}$$

ACCT equals 1 if the company's carbon assurance provider is an audit firm, and 0 for all other assurance providers (i.e., engineering and consulting firms, certification bodies, and government agencies). There is a view that audit firm providers are superior assurance providers because they have globally pooled resources and training mechanisms to understand the evolving assurance market, and because they have reputational capital transferred from financial auditing services and stringent ethical and quality control frameworks governed by professional bodies (Power, 1997; Huggins et al., 2011; Simnett, 2012; KPMG, 2013, 2015, 2017, 2020; Zhou et al., 2016). A negative coefficient is anticipated for this variable.

As shown in Table 5-8, the regression results inform us that *ACCT* is negatively related with the dependent variables. *ACCT* (-0.044, $p < 0.10$) is statistically significant

[146] From investigation, the percentage of assurance services engaged by audit firms was 72.20 percent in 2014, jumping up to 76.20 percent in 2015, then slightly falling to 74.11 percent in 2016 and back to 72.20 percent in 2017.

in the *DLSC1* model over the 1- year time horizon. This supplies modest evidence consistent with the expectation that audit firm assurance providers differentiate themselves from non-audit firm assurance providers in facilitating companies' progress towards slowing down Scope 1 emissions growth over the 1- year time horizon.

TABLE 5-8 The Effect of Engaging Professional Accountant as Assurance Provider on Carbon Emissions Growth

	Dep. Var. =		
	D1LSC1	**D2LSC1**	**D3LSC1**
	(1)	**(2)**	**(3)**
REPHM	0.006	0.024	0.043
	(0.47)	(1.12)	(1.23)
REPHS	0.006	0.043	0.056
	(0.39)	(1.62)	(1.26)
ACCT	-0.044*	-0.060	-0.069
	(-1.73)	(-1.29)	(-0.87)
SIZE	-0.007	-0.043**	-0.067**
	(-0.65)	(-2.29)	(-2.22)
ROA	0.274	0.600*	1.205*
	(1.50)	(1.88)	(1.91)
LEV	0.173*	0.284	0.596*
	(1.72)	(1.56)	(1.92)
NEW	0.019	0.223	0.422
	(0.20)	(1.34)	(1.54)
CAPIN	0.095	-0.132	-0.486
	(0.99)	(-0.73)	(-1.41)
CSRC	-0.031	-0.148	-0.159
	(-0.54)	(-1.19)	(-0.62)
REDT	-0.004	-0.077	-0.241**
	(-0.10)	(-1.25)	(-2.40)
REDP	-0.019	-0.033	0.039
	(-0.33)	(-0.33)	(0.23)
constant	0.116	0.784**	1.190**
	(0.61)	(2.32)	(2.11)
Year	Y	Y	Y
Industry	Y	Y	Y
Observations	1,520	954	461
Chi-square	20.63	34.51	39.74
Prob (Chi-square)	0.5437[147]	0.0319	0.0054
Log likelihood	-1018.19	-913.25	-503.30

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 5-8 presents regression results of Equation (12) including the indicator of professional accountant as an assurance provider. The dependent variables are the percentage change in Scope 1 emissions over 1,2,3- year time horizons in Columns (1)-(3), respectively.
All variables are defined in text.

[147] Results should be interpreted with caution given the insignificant Chi-square of the regression model.

5.6.2 The Impact of Various Assurance Standards

The second element of the assurance engagement that is investigated in Study Two is the impact of the various assurance standards used. Variations in the content of assurance reports produced and inconsistencies in the procedures followed during the assurance engagement give rise to a call for up-to-date and comprehensive assurance standards to provide guidance and to safeguard the quality of carbon assurance (Simnett, 2012). The primary assurance standards adopted by assurance providers are ISAE3000/ 3410[148], ISO 14064-3[149], and AA1000[150] (Ge, Simnett, and Zhou, 2020). Over the past decade, the International Auditing and Assurance Standards Board has endeavoured to develop the best standards that are applicable to all assurance providers and facilitate the users' understanding of the assurance reports produced. The ISAE standards have therefore been revised to incorporate the recent evolvement of developments in the assurance of nonfinancial information. In Study Two an indicator variable, *ISAE,* is included to examine whether the assurance standard adopted is relevant to promoting carbon reduction. *ISAE* is coded 1 if the ISAEs standards are quoted in the assurance reports alone or in conjunction with other assurance standards, and 0 otherwise.

From investigation, there is a significant increase (from 11.44 percent to 16.06 percent) in the adoption of the ISAEs standard following the more stringent requirements[151] relating to the ethical and quality control standards that became effective

[148] The International Standard on Assurance Engagements 3000 (ISAE 3000) and ISAE 3410, Assurance Engagements on Greenhouse Gas Statements.
[149] Issued by the International Standardization Organization (2006) to guide the verification on GHG statements.
[150] Developed by AccountAbility, which is a global consulting and standards company that engages with business, governments, and international organizations to facilitate company's sustainable operations and performance and enhance company's reporting practices.
[151] The revised ISAE 3000 (effective for reports covering periods ending on after 15 Dec 2015) requires all practitioners claiming to follow ISAE 3000 to state explicitly in their assurance reports that they have applied the relevant quality control and ethical requirements (ISAE 3000.3 (a-b)).

at the end of 2015. The significant increase is contributed mainly by non-audit firm providers which have switched from the adoption of other[152] assurance standards to the ISAEs standard. Nevertheless, audit firms remain the primary adopter of the ISAEs standard, with an average adoption rate of 93 percent.

The regression results shown in Table 5-9 indicate that the coefficient of *ISAE* (-0.044, $p < 0.10$) is negatively and significantly associated with the percentage change of Scope 1 emissions over the 1- year time horizon. This provides modest evidence as to the choice of standard as a factor contributing to companies' carbon emissions growth. This result is also consistent with the result in the Section 5.6.1. because 93 percent of audit firm providers adopt the ISAEs standard when providing assurance services.

[152] These other assurance standards exclude the ISO 14064-3 and AA1000AS standards.

TABLE 5-9 The Effect of Using ISAEs as an Assurance Standard on Carbon Emissions Growth

	Dep. Var. =		
	D1LSC1	**D2LSC1**	**D3LSC1**
	(1)	**(2)**	**(3)**
REPHM	0.005	0.023	0.043
	(0.43)	(1.09)	(1.24)
REPHS	0.006	0.042	0.058
	(0.37)	(1.58)	(1.29)
ISAE	-0.044*	-0.048	-0.096
	(-1.73)	(-1.00)	(-1.18)
SIZE	-0.007	-0.043**	-0.065**
	(-0.62)	(-2.29)	(-2.14)
ROA	0.269	0.603	1.213*
	(1.47)	(1.89)	(1.92)
LEV	0.172*	0.290*	0.610*
	(1.71)	(1.60)	(1.96)
NEW	0.015	0.218	0.411
	(0.16)	(1.31)	(1.50)
CAPIN	0.096	-0.132	-0.496
	(1.00)	(-0.73)	(-1.44)
CSRC	-0.030	-0.149	-0.144
	(-0.52)	(-1.20)	(-0.56)
REDT	-0.005	-0.079	-0.244*
	(-0.15)	(-1.28)	(-2.43)
REDP	-0.020	-0.036	0.038
	(-0.34)	(-0.37)	(0.23)
constant	0.113	0.786**	1.157**
	(0.59)	(2.32)	(2.05)
Year	Y	Y	Y
Industry	Y	Y	Y
Observations	1,520	954	461
Chi-square	20.62	33.86	40.37
Prob (Chi-square)	0.5442[153]	0.0375	0.0045
Log likelihood	-1018.19	-913.58	-502.98

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 5-9 presents regression results of Equation (12) including the indicator of ISAEs as the adopted assurance standard. The dependent variables are the percentage change in Scope 1 emissions over 1,2,3-year time horizons in Columns (1)-(3), respectively.
All variables are defined in text.

5.7 Conclusions

Countries around the globe have committed to reducing GHG emissions by setting specified reduction targets within limited time horizons according to TPA. Current carbon emissions and reporting schemes operating within countries vary in

[153] Results should be interpreted with caution given the insignificant Chi-square of the regression model.

strength as measured in terms of their reporting type, nature, scope, geographic and industry coverage, and location. A large number of the companies reporting to the CDP are multinational in nature, and therefore may face various scheme requirements in the different countries in which they operate. While the CDP has become an established database in the extant carbon literature (e.g., Matsumura et al., 2014; Zhou et al., 2016; Griffin et al., 2017), little research has explicitly addressed the nature of companies reporting to the CDP and MNCs aggregate emissions data reported via subunits in the home countries and across the host countries. Subunits report their emissions to their parent companies and in the meantime, they are bounded by reporting schemes prescribed in their host countries.

I collect 6,664 company observations from 45 countries reporting to CDP over 2011-2017. Results from this study partially support the hypothesis that carbon assurance is negatively related with companies' Scope 1 emissions growth, by finding a negative impact for the period of 2-4 years following the assurance engagement. The results show that an increase in the strength of a carbon-related reporting scheme, both in the home and host countries, exhibits a negative effect on companies' Scope 1 emissions growth two years afterwards and it reduces Scope 1+2 emissions growth three years afterwards. The reduction effect of carbon assurance on Scope 1 emissions growth two years after is found to diminish when a company is based in a country (irrespective of the home and host countries) with a more stringent carbon- related reporting scheme. This potentially suggests that the curbing effect of carbon assurance is more pronounced when there is a less stringent prescribed carbon reporting scheme and provides evidence as to the substitution effect between the strength of carbon reporting schemes and independent assurance. Regulatory bodies should be aware of a MNC's internally developed reporting standards that are applicable to its subunits in various countries and take into consideration the potential overlap between the rigorous mandates arising from carbon reporting schemes and companies' proactive strategies aimed at adding credibility to the carbon information that is reported.

Moreover, regression results from this study also show the benefit of an implemented operational policy in constructing a company's GHG reduction targets. Emissions reduction targets are effective in curbing Scope 1 emissions growth two years afterwards, showing the benefit of target setting to sustain emissions reduction in the long-term. At the same time the implementation of a reductions policy is found to be effective in monitoring and managing Scope 1 emissions reductions in the short-term only (i.e., 1- and 2- years afterwards). In turn this evidence suggests that company management should carefully and strategically devise policies and practices to facilitate carbon performance in terms of emissions reduction over different time horizons.

Overall, the results from this study show that both carbon assurance engagements and emissions reduction targets demonstrate an enduring curbing effect on carbon emissions growth. When more stringent reporting schemes are prescribed, the benefits of carbon assurance tend to subside. Regulatory bodies should be cautious of the trade-off effects between reporting schemes and carbon assurance in regulating Scope 1 emissions and in order to achieve stated national targets give consideration to an approach that entails aligning companies' reduction targets with the committed national targets.

CHAPTER 6 STUDY THREE

6.1 Introduction

In this study, I investigate the relations between a company's carbon policy risk, the costs of debt financing, and emissions growth. This study further assesses whether and to what extent such relations are modified by the strength of carbon reporting schemes and the undertaking of a carbon assurance engagement.

As outlined in Chapter One to this thesis, climate change is a long-term problem that encompasses extreme risks (The Economist, 2015; UNEP-FI, 2019b). Climate change continues to generate a negative impact on business and society and it causes a global risk[154] in terms of uncertain events and conditions that, if they occur, can cause a significant negative impact for several countries or industries over the next 10 years (World Economic Forum 2019). Apart from economic costs associated with physical assets directly damaged in extreme weather events such as floods, droughts, and bushfires[155], the expected losses from climate change to the global stock of assets were valued in 2015 at US$4.2trn[156] (Dietz et al., 2016; The Guardian, 2016). Mispricing and misallocation of capital can give rise to concerns over financial stability. Capital markets since then have become increasingly vulnerable to the impact of climate change (TCFD, 2017). In the 1.5 °C scenario, companies are exposed to a significant value loss of US$10.7trn from the required transition to a lower carbon economy (UNEP-FI, 2019b).

[154] Global risk is defined as "an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next 10 years" in the Global Risks Report (2019).
[155] For instance, the economic costs are estimated at A$4.4bn from Australia's bushfires in 2019 (BBC, 2019) and US$4.25bn from India's worst floods in 100 years in 2018 (Acclimatise, 2019).
[156] This is compatible with the total value of all the world's listed oil and gas companies or Japan's entire GDP, even if global warming is held to an increase of 2 degree Celsius by 2100.

Release of the TCFD framework has now been widely supported worldwide[157], including a group of central banks and supervisors, as the United Nations is determined to mobilise financial markets to deliver positive change by accelerating the alignment of financial systems with the TPA and climate change goals (TCFD, 2019, 2020; UNEP-FI, 2021). TCFD's framework recommends that financial institutions factor in companies' emissions metrics for their portfolio management. This is a significant recommendation given that the debt financing market is 1.5 times larger than the equity financing market (BIS, 2020; WFE, 2020). The research literature to date has been mainly concerned with the relation between equity financing and the sustainability or environmental performance of a company. Given the leading role of financial institutions anticipated in promoting transition to a lower carbon economy, it is important to understand whether and how they contribute to mitigating borrower companies' carbon risks and improving their carbon performance with regard to carbon emissions reduction.

The prior literature that assesses the association between carbon risks and the cost of debt has found statistically positive results (Chapple et al., 2013; Jung et al., 2018; Kumar and Firoz, 2018; Maaloul, 2018). This corresponds to the tenet that carbon risk is a key factor considered in the capital market during the tightening of carbon regulation (Busch and Hoffmann, 2007; Busch and Lewandowski, 2016; Berkman, Jona, and Soderstrom, 2019a; Herbohn et al., 2019). This study subsequently examines whether and to what extent the cost of debt financing serves as an effective tool for the monitoring of a company's emissions reduction.

[157] To date, there are in total of over 1700 supporters of the TCFD framework across 70 countries (TCFD, 2021).

Upon ratification, 189 countries have committed to achieving the global goal of limiting global warming to within 2 degree Celsius by reducing GHG emissions over a specified timeframe (UNFCCC, 2015). This signifies countries' commitment to transit to a lower carbon economy. In the business sector, companies face increased regulatory costs in relation with the level of government commitment to climate change mitigation (Berkman et al., 2019b). This corresponds to the policy risk defined in the TCFD disclosure framework developed to assess and fully understand the carbon related risks under an escalated demand from the report preparers, investors, and regulators (TCFD, 2017).

Recent carbon-related reporting schemes have been shifting rapidly into a mandatory regime and relatedly we have seen the adoption rate of nonfinancial disclosure assurance steadily increase (KPMG, 2017, 2020; GRI and USB, 2020). The benefits of assurance engagements include the alleviation of information asymmetry, improvement in the value relevance of nonfinancial disclosures, enhancement of the credibility and reliability of reported information, and facilitation of internal decision making (see detailed discussion in Section 3.3). In the context of achieving the desired global goal, the strength of carbon-related reporting schemes demonstrates a country's determination in addressing the issue of climate change and potentially modifies the relations between carbon policy risk, the cost of debt financing, and a company's emissions reduction.

This study provides evidence on whether and to what extent companies voluntarily respond to national target setting and whether national target setting has an impact at the company level. Extant carbon risk literature commonly uses a carbon intensity proxy which is calculated as Scope 1 GHG emissions levels divided by operating income (Chapple et al., 2013; Kim, An, and Kim, 2015; Jung et al., 2018). In this study I disaggregate a country's emissions targets to the company level to quantify and monetarise carbon policy risk and assess its impact on the determination of a company's emissions changes. Few regulatory interventions have direct requirements for the alignment of a company's emission reduction targets with specified national targets. However, companies have incentives to help meet and beat national emissions targets in the process of a global transition to a lower carbon economy. As well as helping a country achieve its targets, it is beneficial for companies to reduce carbon costs through a mitigation of carbon risks while seeking opportunities to generate green revenue.

This study constructs a measure for the policy risk component that disaggregates a country's emissions reduction target to the company level (UNEP-FI, 2019b). I further collect the all-in-spread data for each of the current debt instruments issued by a company, in order to determine its cost of debt financing on a yearly basis. I find that both the carbon policy risk and the cost of debt financing are negatively associated with carbon emissions growth in the models including the interaction terms. Results from this study therefore provide evidence of the role of financial institutions in motivating and monitoring their client companies to achieve carbon emissions reduction. In addition, this result suggests that companies are also voluntarily aligning their carbon emissions reductions with national targets.

This study presents evidence to the regulators and thus it is policy relevant. Traditionally, countries have been setting reduction targets and enforcing mandatory reporting regimes. Companies have been initiating the development of climate resistant strategies during the transition period while they have been facing increasing regulation (Gasbarro, Rizzi, and Frey, 2016; TCFD, 2017; Bui, Chapple, and Truong, 2020). The interplay of the forces exerted at different levels could generate suboptimal outcomes. It is therefore beneficial to understand which factors are more critical and effective. This informs regulators and supervisors on determining which strategies and programs are more cost and resource effective ways of achieving national targets.

Results from this study also inform both the academic literature and standard setters regarding the role of carbon assurance in enhancing the credibility of disclosed carbon information. The quality of an assurance engagement is difficult to measure given the diverse range of assurance standards, the distinctive types of assurance providers, and their issued assurance reports (e.g., Simnett et al., 2009a; Cohen and Simnett, 2015; Farooq and de Villiers, 2019). Results from the impact of carbon assurance on carbon emissions growth to a certain extent implies whether companies engage in the undertaking of carbon assurance to avoid public scrutiny, or to enhance the reliability of their internal reporting systems, that may demonstrate divergent effects on the performance outcomes from reducing emissions in time series. It helps to consider whether assurance of carbon disclosure information is beneficial when devising carbon reporting schemes.

The remainder of the study is organised as follows. Section 2 develops the main hypotheses. Section 3 constructs the research models. Section 4 presents the main regression results, reports sensitivity tests and additional analyses. Section 5 concludes the study.

6.2 Hypotheses Development

This section develops a series of hypotheses for this study. Initially, I construct the first set of hypotheses by considering the relation between carbon policy risk (H1) and carbon emissions growth. In addition, I speculate on the moderation effects of the strength of carbon reporting schemes (H2) and the undertaking of carbon assurance engagements (H3). The second set of hypotheses focus on the association between the cost of debt and carbon emissions growth (H4), as well as on the moderating effects of the strength of carbon reporting schemes (H5) and the undertaking of carbon assurance engagements (H6). Lastly, H7 conjectures a sign for the coefficient of the interaction term between carbon policy risk and the cost of debt in terms of carbon emissions growth.

6.2.1 The Relation Between Carbon Policy Risk and Carbon Emissions Growth

Carbon output is one of the determinants of a company's carbon risk exposure. Carbon risks arise from multiple sources, including regulatory and business risks (Thompson, 1998; Coulson and Monks, 1999; Thompson and Cowton, 2004; Scholtens, 2006). Although countries ratifying the TPA do not directly assign emission reduction targets to companies, regulatory reporting schemes, pollution policies, and renewable energy subsidies have been extensively devised by national and state governments to address and tackle the issue of climate change since ratification of global environmental protocols (IPCC, 2018). In addition, stock exchanges have been prescribing listing rules that require carbon reporting, and banks have been advised by TCFD to incorporate companies' carbon output into risk evaluation metrics (TCFD, 2017). Members signing the Principles of Responsible Banking are committed to align their own and borrower companies' emissions reduction targets with the global goals set under TPA (UNEP-FI, 2019a). Overall, companies are driven by forces transmitted through different channels to indirectly meet their assigned reduction targets which, in turn, are set according to the countries in which they are based.

Carbon pricing serves as a means of reducing emissions and drives investments in cleaner options and it can be formulated through emissions trading systems (ETS) and carbon taxes depending on national and economic circumstances (The World Bank, 2020). By creating supply and demand for emissions allowances, a market price for GHG emissions is established under an ETS. An ETS caps the total level of GHG emissions, and required emission reductions will be enforced to keep companies within their pre-allocated carbon budgets. A carbon tax on the other hand, directly sets a tax rate on GHG emissions such that the carbon price is predefined, but not the emission reduction outcome. Currently, there are over 40 countries using carbon pricing mechanisms, and these are found to cover about half their emissions[158] (The World Bank, 2020).

Carbon risk comprises the costs in relation to regulatory and business risks. Higher carbon policy risk is an indicator for the company that it needs to act to mitigate carbon costs. Therefore, the first hypothesis states that the higher the carbon policy risk, the lower the expected carbon emissions growth of a company.

H1: A company's carbon policy risk is negatively related with its carbon emissions growth.

6.2.2 Moderation of the Strength of Carbon Reporting Scheme on the Relation Between Carbon Policy Risk and Carbon Emissions Growth

Regulatory compliance is viewed by banks as the first and foremost dimension in credit risk assessment (Labatt and White, 2007; Cogan et al., 2008; Rainforest Action Network, 2011; TCFD, 2017). There are regulatory differences across countries (KPMG

[158] This translates to approximately 13 percent of annual global GHG emissions.

et al., 2016; TCFD, 2017). Required under the TPA, the UNFCCC will conduct the first global carbon stock take in 2023 (UNFCCC, 2016). Given the global goal that has been set under TPA to reduce carbon emissions, countries have been stipulating multiple mechanisms to achieve their targets (IPCC, 2018). A carbon related reporting scheme is one of the mechanisms which, in turn, suggests that countries have been placing emphasis on enhancing companies' carbon transparency.

Due to institutional differences, the reporting schemes prescribed across countries vary in strength and this sends a political signal as to the government's determination to reduce emissions. From the perspective of regulatory non-compliance, carbon cost is therefore increased in a country with more stringent carbon-related reporting schemes. Therefore, this study hypothesizes that,

H2: The negative relation between carbon policy risk and carbon emissions growth of a company is more pronounced in a country with more stringent carbon reporting schemes.

6.2.3 Moderation of the Undertaking of Carbon Assurance on the Relation Between Carbon Policy Risk and Carbon Emissions Growth

The quality and reliability of the carbon information disclosed should be enhanced through third-party assurance. The number of companies seeking independent carbon assurance has been steadily increasing each year (KPMG, 2015, 2017, 2020). As yet, the impacts of carbon assurance on a company's carbon performance are inconclusive. On the one hand, the undertaking of carbon assurance is associated with higher levels of carbon disclosures and improved information asymmetry (Braam et al., 2016; Fan, Tang, and Pan, 2020). However, on the other hand, the carbon assurance literature also suggests that a company's motivation to undertake carbon assurance may simply be cosmetic (Cho and Patten, 2007), resulting in no follow- up action to improve the operational efficiency of the carbon management system.

No prior study has investigated the undertaking of carbon assurance in the context of carbon risk assessment. Given both sides of the arguments, this study further constructs a non-directional hypothesis,

H3: The undertaking of carbon assurance moderates the negative relation between carbon policy risk and carbon emissions growth of a company.

6.2.4 The Relation Between the Cost of Debt and Carbon Emissions Growth

Academic research suggests that financial institutions have incentives to consider borrowers' carbon risks in their credit assessment to mitigate default and reputational risks (Chapple et al., 2013; Chava, 2014; Jung et al., 2018; Lemma et al., 2020). Carbon constrained companies bear the costs associated with regulatory compliance, environmental lawsuits, and failure to effectively reduce carbon emissions and respond to changes in consumer preferences on 'green' and more sustainable products (COSO, 2013; TCFD, 2017). Carbon constrained companies' carbon risk exposure is also determined by the industry in which the company operates and the extent to which a company's business model relies on carbon inputs (Labatt and White, 2007). Carbon risk results in uncertainty of a company's future cash flows and thus gives rise to increased default risk (Allen and Saunders, 2004; Weber, 2012). In addition, when dealing with higher carbon risk companies, financial institutions may directly suffer from reputational damage (Thompson, 1998; Clarkson et al., 2004; Labatt and White, 2007; Subramaniam et al., 2015). Financial institutions serve the function of not only being fund providers, but also as being facilitators for enhancing their borrowers' carbon management (Schmidheiny and Zorraquı´n, 1996). This is because financial institutions have the capacity to shape, design, monitor, and influence their borrowers' carbon risk management policies and processes. Through reduced carbon costs, financial institutions can directly benefit from an increase in the firm value of a borrower.

The leading role of financial institutions in the transition to a lower carbon economy has been reinforced by clients, regulators, stakeholders, and the public in general. Several global principles for carbon risk assessment have been initiated by leading banks across the world (UNEP-FI, 2019a). These principles establish a framework for guiding a signatory's investment policies and risk assessment strategies and procedures for carbon related project finance. Close attention has been focused on the funding flow of the major banks during the post-TPA period, during a time when rapid and decisive transitions are required to align with the TPA goals. The size of the debt market is much greater than the size of the equity capital market and without strong action by financial institutions through debt financing to mitigate carbon risk, and promote carbon risk transparency and monitor carbon risk management, the efforts committed by other parties under the TPA may be in vain. Again, debt financing has the potential to be an essential mechanism in facilitating carbon emissions reductions of borrowing companies.

Prior studies show a positive relation between carbon risk and the cost of debt financing (Chen and Gao, 2012; Jung et al., 2018). Financial institutions charge a higher cost of debt when the counterparty's associated carbon risk is higher. To effectively lower their cost of borrowing, borrowers have incentives to revise their carbon risk management strategies and to plan to reduce their emissions levels. In turn, this helps the borrowers to be able to attain a lower cost of debt in the future. The second hypothesis therefore states that, *H4: A company's cost of debt is negatively related with its carbon emissions growth.*

6.2.5 Moderation of the Strength of Carbon Reporting Scheme on the Relation Between the Cost of Debt and Carbon Emissions Growth

Several studies investigating the relation between carbon risk and the cost of debt have emphasized the importance of disclosure as part of financial institutions' credit assessment (e.g., Sharfman and Fernando, 2008; Goss and Roberts, 2011; Schneider, 2011). Jung et al. (2018) find that a company's willingness to disclose carbon information alleviates the relation between carbon risk and the cost of debt. To a certain extent, financial institutions with properly enforced reporting schemes save on the cost of information searches and can more easily benchmark a company's carbon performance in time series and with industry norms.

In a more stringent regulatory environment, carbon risks in relation to regulatory non-compliance and operational carbon efficiency increase. Financial institutions need to assess carbon risks more diligently under the legislative frameworks that exist within countries and ensure that borrowers comply with all relevant carbon-related regulations, and monitor borrowers' carbon management efficiency. Following this argument, the study hypothesizes that,

H5: The strength of the carbon reporting scheme strengthens the negative relation between the cost of debt and carbon emissions growth of a company.

6.2.6 Moderation of the Undertaking of Carbon Assurance on the Relation Between the Cost of Debt and Carbon Emissions Growth

The impact of carbon assurance on carbon performance depends on the extent to which a company is willing to address the issues raised and follow recommendations provided in the relevant assurance report. In terms of debt financing, financial institutions which are sophisticated investors can directly rely on the independent assurance report. This adds credibility to the carbon information disclosed by borrowers with which they can evaluate borrowers' carbon risk. In addition, financial institutions can also rely on the assurance report to identify weaknesses and areas for improvement in borrowers' carbon management systems.

Given the benefits for financial institutions to request assured carbon information, this study expects that the undertaking of carbon assurance by borrowers will enhance the efficiency of credit evaluation and the effectiveness of facilitating carbon management systems, which should then be reflected in the cost of debt. Therefore,

H6: The negative relation between the cost of debt and carbon emissions growth of a company is more pronounced when the company undertakes a carbon assurance engagement.

6.2.7 Moderation of the Cost of Debt on the Relation Between Carbon Policy Risk and Carbon Emissions Growth

Carbon emissions levels are one determinant of a company's carbon risk (Busch and Hoffman, 2007; Hoffman and Busch, 2008). Higher carbon risk companies are associated with higher default risk due to the greater uncertainty associated with current and future cash flows (Allen and Saunders, 2004; Weber, 2012). When charged with a higher cost of debt, a company has incentives to improve its carbon risk management systems to lower the cost of future borrowings. Also, improved carbon risk management will slow down a company's carbon emissions growth rate resulting in the company generating less carbon emissions. Hence, the cost of debt is potentially an effective mechanism for reducing carbon emissions.

For companies with higher carbon risks which are seeking debt finance from financial institutions, they could more effectively attain a reduction in carbon outputs due to the well-intended operations of financial institutions which seek a lower-carbon economy transition. Hence, the third hypothesis predicts that,

H7: The negative relation between carbon policy risk and carbon emissions growth of a company is more pronounced when the companies incur higher levels for the cost of debt.

In sum, Study Three hypothesises a negative effect of carbon policy risk and the cost of debt in terms of a company's carbon emissions growth. Further, the study predicts that the negative relation between carbon policy risk and carbon emissions growth is more pronounced in a country with more stringent carbon reporting schemes and this is moderated by a company's undertaking of carbon assurance. In addition, the study anticipates that the negative relation between the cost of debt and carbon emissions growth is more pronounced in a country with more stringent carbon reporting schemes and when the company undertakes carbon assurance engagements.

6.3 Research Methodology

6.3.1 Research Model

To test the hypotheses, this study employs two primary variables of interest and a series of interaction terms to proxy for the moderation effects to construct the following research model,

$$D_nLSC(k)_{i,t} = \gamma_0 + \gamma_1 RISK_{i,t} + \gamma_2\, COD_{i,t} + \gamma_3 RISK_{i,t} * COD_{i,t} + \gamma_4 RISK_{i,t} * REPI_{j,t} + \gamma_5\, RISK_{i,t} * ASU_{i,t} + \gamma_6\, COD_{i,t} * REPI_{j,t} + \gamma_7\, COD_{i,t} * ASU_{i,t} + \gamma_8\, SIZE_{i,t} + \gamma_9\, ROA_{i,t} + \gamma_{10}\, LEV_{i,t} + \gamma_{11}\, NEW_{i,t} + \gamma_{12}\, CAPIN_{i,t} + \gamma_{13}\, CSRC_{i,t} + \gamma_{14}\, REDT_{i,t} + \gamma_{15}\, REDP_{i,t} + \gamma_{16}\, REW_{i,t} + \textit{Country fixed effect} + \textit{Industry fixed effect} + \textit{Year fixed effect} + e_i, \quad (13)$$

where the variables are as defined in Appendix B[159] and described below.

6.3.1.1 Dependent Variable

$\boldsymbol{D_nLSC(k)_{i,t}}$

This variable is also the dependent variable for Study Two and measures the rate of change of all of the subsidiaries' disclosed emissions from Scope 1[160], Scope 2[161], and the sum of both Scope 1 and Scope 2 (i.e., *k* = 1, 2, and 1+2) generated and or purchased by a company *i* over 1- to 5-year time horizons, and is calculated as the difference between the logarithm of a company's sum of all subsidiaries' emissions in year *t* + n (n = 1,2,3,4 and 5) and that in year *t*.

6.3.1.2 Variables of Interest

159 Appendix B summarizes the variables used in both Study Two and Three as the models constructed in both studies use the company level variables.
160 As defined by the GHG protocol (2004), Scope 1 refers to direct GHG emissions occurring from sources that are owned or controlled by a company.
161 As defined by the GHG protocol (2004), Scope 2 accounts for GHG emissions resulting from the generation of purchased electricity consumed by a company.

$\boldsymbol{RISK_{i,t}}$

This variable is a measure of carbon policy risk, calculated in two stages. The first stage disaggregates country level GHG emissions reduction targets based on their submitted reports to the UNFCCC. Using percentage of emissions reported by a company across its home and host countries, a company's assigned reduction amount is determined by the percentage of emissions reported per country times the country's emissions reduction target decomposed in year t. The second stage calculates the carbon policy risk using the total carbon cost estimated as Total cost = required GHG reduction amount × price per tCO2, where carbon pricing information is sourced from the World Bank (2020) using the carbon pricing under emissions trading schemes. This variable is used to test H1. A negative sign is predicted for the coefficient of this variable.

$\boldsymbol{COD_{i,t}}$

This variable measures the cost of debt financing. Loan spread is measured as an all-in spread, drawn in the Dealscan database. It is defined as the amount the borrower pays in basis points over LIBOR, or LIBOR equivalent for each dollar drawn down. This measure adds the borrowing spread of the loan over LIBOR to any annual fee paid to the bank group (Valta, 2012). Based on H4, a negative sign is anticipated for the coefficient of this variable.

$\boldsymbol{REPI_{j,t}}$

This variable represents the strength of carbon- related reporting schemes for country j in year t. Please refer to Chapter Four (Study One, Section 4.3.1.2) for the construction of the reporting index at the country level. Following the first two studies, a negative sign is predicted for the coefficient of this variable.

$\boldsymbol{ASU_{i,t}}$

This is an indicator variable which equals 1 if the company *i* undertakes a carbon assurance engagement in year *t*, and 0 otherwise. Following the first two studies, a negative sign is predicted for the coefficient of this variable.

$\boldsymbol{RISK_{i,t} * COD_{i,t}}$

This is the interaction term between $\boldsymbol{RISK_{i,t}}$ and $\boldsymbol{COD_{i,t}}$, calculated to test H7. The cost of debt contributes to a strengthening of the negative relation between carbon policy risk and the carbon emissions growth of a company. A negative sign is predicted for its coefficient.

$\boldsymbol{RISK_{i,t} * REPI_{j,t}}$

This is the interaction term between $\boldsymbol{RISK_{i,t}}$ and $\boldsymbol{REPI_{j,t}}$, calculated to test H2. The strength of the carbon reporting scheme strengthens the negative relation between carbon policy risk and carbon emissions growth of a company. Thus, a negative sign is predicted for its coefficient.

$\boldsymbol{COD_{i,t} * REPI_{j,t}}$

This is the interaction term between $\boldsymbol{COD_{i,t}}$ and $\boldsymbol{REPI_{j,t}}$, calculated to test H5. The negative relation between the cost of debt and carbon emissions growth of a company is more pronounced in a country with more stringent carbon reporting schemes. Thus, a negative sign is predicted for its coefficient.

$\boldsymbol{RISK * ASU_{i,t}}$

This is the interaction term between $\boldsymbol{RISK_{i,t}}$ and $\boldsymbol{ASU_{i,t}}$, calculated to test H3. The undertaking of carbon assurance moderates the negative relation between carbon policy risk and the carbon emissions growth of a company. The hypothesis does not predict a direction for the sign of this coefficient.

$\boldsymbol{COD_{i,t} * ASU_{i,t}}$

This is the interaction term between $\boldsymbol{COD_{i,t}}$ and $\boldsymbol{ASU_{i,t}}$, calculated to test H6. The negative relation between the cost of debt and carbon emissions growth of a company when the company undertakes carbon assurance. Therefore, a negative sign is predicted for its coefficient.

6.3.1.3 Control Variables[162]

$\boldsymbol{SIZE_{i,t}}$

The natural logarithm of total sales of company *i* reported for the year *t* (e.g., Matsumura et al., 2014; Griffin et al., 2020) is the measure used for company size. Consistent with prior findings, larger companies are more likely to disclose carbon emissions and are associated with higher levels of carbon emissions and thus greater carbon emissions growth. This variable is expected to have a positive coefficient.

$\boldsymbol{ROA_{i,t}}$

Return on assets, a measure of financial performance, and specifically it measures the efficiency of assets in producing income (King and Lenox, 2001; Delmas et al., 2015). It is calculated as net income before extraordinary items of company *i* for the year *t* divided by the average of total assets at the beginning and the end of the year

[162] Control variables used in Study Three are similar to those in Study Two.

t (Christensen, 2016). A company's return on financial resources may affect its social and environmental performance. On the one hand, a sustained improvement in environmental performance may lead to improved future financial performance (Clarkson et al., 2011). On the other hand, more profitable companies are in a better position to expend on preparatory costs for carbon disclosures (Ott et al., 2017). In terms of carbon emissions levels, ROA is associated with higher carbon emissions (Delmas et al., 2015; Qian and Schaltegger, 2017; Busch et al., 2020). A positive sign is expected on the coefficient of the variable.

$\boldsymbol{LEV_{i,t}}$

This variable is the ratio of long-term debt of company i to the average of total assets at the beginning and the end of the year t, and it is a measure of financial indebtedness. Highly indebted companies are more likely to, or expected to, have an interest in keeping creditors informed (Freedman and Jaggi, 2005; Cotter and Najah, 2012). However, while trying to construct a company-based emissions estimation model, Griffin et al. (2017) presents evidence that highly leveraged companies are less inclined to disclose information to the CDP. Therefore, no sign is predicted for the coefficient of this variable.

$\boldsymbol{NEW_{i,t}}$

This variable is a measure for the age of the technology equipment a company uses. It is calculated as the ratio of company *i*'s net properties, plant and equipment divided by gross properties, plant, and equipment at the end of the year *t*. It is expected that companies with newer (possibly cleaner) equipment or facilities tend to have better environmental performance and are more likely to engage in making disclosures

(Clarkson et al., 2008; Peters and Romi, 2015). A negative sign is anticipated for the variable's coefficient.

$\boldsymbol{CAPIN_{i,t}}$

This is capital intensity which is measured as the ratio of company *i*'s total capital expenditures to total sales during the year *t*. Similar to the argument above, companies with greater capital expenditures are more likely to invest in carbon efficient technologies, thus slowing down emissions growth. A negative sign is anticipated for the variable coefficient.

$\boldsymbol{CSRC_{i,t}}$

This is an indicator variable that equals 1 when company *i* has in place a sustainability committee as a subset or appointed by the Board of Directors, 0 otherwise. While earlier research presents mixed findings on the relation between the presence of an environmental committee and environmental disclosure/ performance (Rankin et al., 2011; Rodrigue et al., 2013), Peters and Romi's (2015) study highlights the role of an environmental committee in enhancing a company's environmental transparency. The variable's coefficient is predicted to be negative.

$\boldsymbol{REDT_{i,t}}$

This is an indicator variable that equals 1 when company *i* sets an emissions reduction target in the year *t*, and 0 otherwise. Countries bound by such international protocols as the Kyoto protocol and TPA are required to establish a specified reduction target which hold them accountable for emissions reduction (UNFCCC, 2012, 2015). A voluntarily determined target implies the company's willingness to both signal and reduce emissions and it may facilitate a company's effort towards achieving its target. Thus, a negative sign is expected for the coefficient of this variable.

$\boldsymbol{REDP_{i,t}}$

This is an indicator variable that equals 1 when company i has an established emissions reduction policy that is internally implemented in the year t, and 0 otherwise. A set target would not be effective without a proper policy implementation. That is, only through operational practice can a company's resources be directed to work towards target accomplishment (Matsumura et al., 2014). A negative sign is expected for this variable's coefficient.

$\boldsymbol{REW_{i,t}}$

This is an indicator variable that equals 1 when company i has a renewable energy policy that is internally implemented in the year t, and 0 otherwise. Innovative companies are more likely to pursue proactive investment strategies (Clarkson et al., 2011). Using renewable energy, it is expected to contribute significantly to reduce a company's carbon emissions growth. A negative sign is expected for the coefficient of this variable.

6.4 Results

6.4.1 Sample Selection

In addition to the variables of interest adopted in the first two studies of the thesis, three new variables have been collected and constructed for Study Three. First, a country's emissions reduction target ($REDT_{j,t}$) is decomposed based on their submitted reports to the UNFCCC. Using percentage of emissions reported by a company across its home and host countries (refer to Study Two, in particular Section 5.3.2 for details), a company's assigned reduction amount is determined by the percentage of emissions reported per country times the country's emissions reduction target decomposed in year

t. The carbon pricing data is collected from the World Bank. There are two pricing mechanisms currently implemented, with the more commonly adopted carbon pricing under ETS used in the primary regression tests, and carbon tax tested in the sensitivity analyses.

Second, the data on interest expense and total debt for the variable interest expense divided by the average of the total of short- and long-term loan was collected from the Worldscope database. Lastly, the loan spread variable was constructed by hand matching a company with each of the debt facilities[163] issued under its name within the sample period. The all-in spread data was sourced from the Dealscan database. At the end of the additional data collection process, the final sample used for testing includes 3,211 company year observations.

TABLE 6-1 Sample Selection

	Obs.
Companies reporting to CDP 2011- 2017	10,843
Less observations without emissions information	(516)
Less observations without information on control variables	(3,663)
Less observations without the loan spread information	(3,453)
Final sample	3,211

All variables are defined in text and in Appendix B.

6.4.2 Descriptive Statistics

Table 6-2 displays summary statistics of all the variables used in the regression model. Scope 1 emissions have a mean value of 12.567 (that is, 6,527,161 metric tonnes) and ranges from 0.432 (0 metric tonnes[164]) to 20.301 (656m metric tonnes). Scope 2

[163] Debt information in the Dealscan database is collected on a facility basis. Hence, each of the debt facilities needs to be hand matched with the borrowing company.
[164] Observations with 0.000 value for *Scope1* and *Scope2* variables are dropped when calculating the log of the Scope 1 (*LSC1*) and Scope 2 (*LSC2*) emissions. Table 6-2 presents the reduction of the no. of observations for the Scope 1 emissions: from 3,181 (*Scope1*) to 3,165 (*LSC1*), and for the Scope 2 emissions: from 3,158 (*Scope2*) to 3,084 (*LSC2*).

emissions have a mean value of 12.460 (that is, 1,054,872 metric tonnes) and ranges from 1.609 (0 metric tonnes) to 18.975 (174m metric tonnes). On average, the mean value of carbon policy risk (*RISK*) is 6.138, with a large variation that ranges from 0 to 20.141[165]. The mean value of the cost of debt issued (*COD*) is 1.408 (i.e., 140.8 basis points above the LIBOR rate), with the lowest being 0.012 and the highest 8.750[166].

Among the sample observations, the mean of the carbon related reporting index (*REPI*) for the country in which the companies are based is 3.141 and 70.3 percent of these companies have undertaken carbon assurance engagements (*ASU*). The size of the companies (*SIZE*) has a mean of 16.047 (that is, net sales of US$21,600,000), with return on assets (ROA) being 0.048 and leverage (*LEV*) being 0.246. Moreover, 51.8 percent of the cost of the property, plant and equipment (*NEW*) remains on balance (48.2 percent of the cost has been charged to depreciation). In addition, 92.6 percent of the companies in the sample have a sustainability committee (*CSRC*), 76.1 percent of the companies have set up reduction targets (*REDT*), 88.1 percent have a reduction policy in place (*REDP*), and 69.4 percent of the companies have an internal renewable policy (*REW*).

[165] A large variation in the range is due to the inherent limitations of the construction of this variable. For the lowest value, companies based in such home countries as Australia, Canada, and the U.S. generate 0 carbon costs. This is because Canada withdrew from the Kyoto protocol effective from 15 December 2012, the U.S. did not ratify the Kyoto Protocol, and Australia does not adopt an ETS system. For the highest value, the carbon cost borne by a company can be larger than expected. The number of companies reporting to CDP from each country is limited; and it is not representative of the industry/business composition of a country. Consequently, the reduction amount assigned by disaggregating a country's reduction target to each company may be potentially inflated.

[166] The cost of debt variable is winsorized at the 1st and 99th percentiles.

TABLE 6-2 Descriptive Statistics

	n	Mean	Std.	Min	Max
LSC1	3,165	12.567	2.858	0.432	20.301
Scope1	3,181	6527161	2.28×10^{7}	0.000	6.56×10^{8}
LSC2	3,084	12.460	1.890	1.609	18.975
Scope2	3,158	1054872	3712048	0.000	1.74×10^{8}
LSC12	3,211[167]	13.607	2.253	2.303	20.302
Scope12	3,211	7503639	2.36×10^{7}	10.000	6.56×10^{8}
RISK	3,211	6.138	8.447	0.000	20.141
COD	3,211	1.408	0.984	0.012	8.750
REPI	3,211	3.141	1.286	0.000	7.000
ASU	3,211	0.703	0.457	0.000	1.000
SIZE	3,211	16.047	1.343	4.605	20.002
ROA	3,211	0.048	0.076	-1.333	0.585
LEV	3,211	0.246	0.143	0.000	1.926
NEW	3,211	0.518	0.165	0.054	1.091
CAPIN	3,211	0.106	0.151	0.003	0.898
CSRC	3,211	0.926	0.262	0.000	1.000
REDT	3,211	0.761	0.427	0.000	1.000
REDP	3,211	0.881	0.324	0.000	1.000
REW	3,211	0.694	0.461	0.000	1.000

All variables are defined in text and in Appendix B.

6.4.3 Means Comparison

Panel A of Table 6-3 categorises the sample observations based on the mean value[168] of the carbon policy risk. The low carbon policy risk group includes the 2,085 observations that have a carbon policy risk lower than the mean value of 6.138 in the year *t*; and the high carbon policy risk group consists of the 1,126 observations that have a carbon policy risk higher than the mean value of 6.138 in the year *t*. In comparison, the high carbon policy risk group is associated with a higher level of Scope 1 (*LSC1*, t= -1.548, p< 0.10) but a significantly lower level of Scope 2 (*LSC2* t= 4.918, p< 0.01), and

[167] The no. of observations for the variable Scope12 (LSC12) is greater than the individual variables Scope1 and Scope2 because it is the sum of the Scope 1 and Scope 2 emissions. The variable *Scope12* drops only observations with 0.000 values for both the reported Scope 1 and Scope 2 emissions.
[168] When partitioning the sample using the median value of carbon policy risk, the means comparison results are qualitatively similar.

a lower sum of Scope 1 and 2 (*LSC12*, t= 1.633, p< 0.10) emissions than the low carbon policy risk group. The assurance adoption rate for the low carbon policy risk group is 65.4 percent, while the rate is at 79.2 percent for the high carbon policy risk group, showing that the high carbon policy risk companies more likely to have undertaken carbon assurance engagements (*ASU*, t= -8.643, p< 0.01). We also identify that high carbon policy risk companies are charged with a significantly lower cost of debt (*COD*, t= 1.957, p< 0.05).

In terms of company characteristics, high carbon policy risk companies also have a significantly lower return on assets (*ROA*, t= 6.139, p< 0.01), a lower level of leverage (*LEV*, t= 1.591, p< 0.10), and a lower capacity represented by new equipment in use (*NEW*, t= 3.047, p< 0.05). On the contrary, they are more likely to have a CSR committee (*CSRC*, t= -2.226, p< 0.05), have an emissions reduction target *(REDT*, t= -5.332, p< 0.01) and an emissions reduction policy in place *(REDP*, t= -8.233, p< 0.01), and have renewable energy sources in use in operations (*REW*, t= -5.958, p< 0.01).

Panel B of Table 6-3 subdivides the sample into the high (1,214 observations) and low cost (1,997 observations) of debt financing groups based on the mean value of 1.408. There is no difference between the two groups for the Scope 1 emissions (*LSC1*, t= -0.578, p> 0.10), but the high cost of debt financing group generates a significantly lower level of Scope 2 emissions (*LSC2*, t= 7.948, p< 0.01). Companies charged with a higher cost of debt are more likely to be based in countries with less stringent carbon reporting schemes (*REPI*, t= -2.307, p< 0.05). Corresponding with the results in Panel A, the high cost of debt group is associated with a significantly lower level of carbon policy risk (*RISK*, t= 1.922, p< 0.05). Moreover, the assurance adoption rate is significantly lower for companies charged with a higher cost of debt (*ASU*, $t= 5.790$, $p< 0.01$).

In terms of company characteristics, the higher cost of debt financing group are smaller (*SIZE*, $t= 14.124$, $p< 0.01$), has a lower return on assets (*ROA*, $t= 9.694$, $p< 0.01$), a lower capacity for new equipment in use (*NEW*, $t= 3.047$, $p< 0.05$), but a higher level of leverage (*LEV*, $t= -9.275$, $p< 0.01$) and a significantly higher level of capital expenditure (*CAPIN*, $t= -5.558$, $p< 0.01$). While the high cost of debt financing group is more likely to set up emissions reduction targets (*REDT*, t= -5.332, p< 0.01),, they are less likely to implement a reduction policy (*REDP*< $t= 3.220$, $p< 0.01$), have a renewable energy policy in operation (*REW*, $t= 8.019$, $p< 0.01$) and to have a sustainability committee as a feature of the company's board (*CSRC*, $t= 1.284$, $p< 0.10$).

6.4.4 Pearson Correlation

Table 6-4 presents the Pearson correlation matrix for the regression models. As expected, there is a high correlation between the three dependent variables: *LSC1* and *LSC2* (0.632), *LSC1* and *LSC12* (0.941), and *LSC2* and *LSC12* (0.792). Also, as expected, the larger the company size, the higher the emission levels for Scope 1 (0.500), Scope 2 (0.636) and the sum of Scope 1 and 2 (0.579). None of the other variables have correlations greater than 0.5 and therefore they do not raise concerns over multicollinearity issues for my variables of interest[169].

[169]High collinearity between variables may cause imprecise parameter estimates and larger standard errors. However, multicollinearity is not a concern if the collinearity is confined to control variables only, as the estimated parameters and standard errors on the variables of interest would not be affected. Furthermore, if a parameter estimate is found to be statistically significant it is not because, but rather despite multicollinearity issues (Wooldridge, 2016).

TABLE 6-3 Means Comparison

Panel A: Means Comparison Between the High and Low Carbon Policy Risk Groups

	Full sample		Low Risk		High Risk			
	n	Mean	n	Mean	n	Mean	t value	p value
LSC1	3,165	12.567	2,047	12.507	1,118	12.676	-1.548	0.061
LSC2	3,084	12.460	2,007	12.591	1,077	12.215	4.918	0.001
LSC12	3,211	13.607	2,085	13.657	1,126	13.513	1.633	0.051
COD	3,211	1.408	2,085	1.435	1,126	1.357	1.957	0.025
REPI	3,211	3.141	2,085	3.151	1,126	3.122	0.637	0.262
ASU	3,211	0.703	2,085	0.654	1,126	0.792	-8.643	0.001
SIZE	3,211	16.047	2,085	16.053	1,126	16.036	0.322	0.374
ROA	3,211	0.048	2,085	0.054	1,126	0.037	6.139	0.001
LEV	3,211	0.246	2,085	0.249	1,126	0.241	1.591	0.056
NEW	3,211	0.518	2,085	0.524	1,126	0.505	3.047	0.001
CAPIN	3,211	0.112	2,085	0.102	1,126	0.129	-3.165	0.001
CSRC	3,211	0.926	2,085	0.919	1,126	0.940	-2.226	0.013
REDT	3,211	0.761	2,085	0.733	1,126	0.814	-5.332	0.001
REDP	3,211	0.881	2,085	0.850	1,126	0.938	-8.233	0.001
REW	3,211	0.694	2,085	0.660	1,126	0.758	-5.958	0.001

Panel B: Means Comparison Between the High and Low Cost of Debt Groups

	Full sample		Low Cost of Debt		High Cost of Debt			
	n	Mean	n	Mean	n	Mean	t value	p value
LSC1	3,165	12.567	1,962	12.544	1,203	12.605	-0.578	0.282
LSC2	3,084	12.460	1,936	12.674	1,148	12.098	7.948	0.001
LSC12	3,211	13.607	1,997	13.634	1,214	13.562	0.863	0.194
RISK	3,211	6.138	1,997	6.361	1,214	5.772	1.922	0.027
REPI	3,211	3.141	1,997	3.100	1,214	3.208	-2.307	0.011
ASU	3,211	0.703	1,997	0.740	1,214	0.642	5.790	0.001
SIZE	3,211	16.047	1,997	16.310	1,214	15.615	14.124	0.001
ROA	3,211	0.048	1,997	0.059	1,214	0.030	9.694	0.001
LEV	3,211	0.246	1,997	0.227	1,214	0.278	-9.275	0.001
NEW	3,211	0.518	1,997	0.524	1,214	0.505	3.047	0.001
CAPIN	3,211	0.112	1,997	0.096	1,214	0.138	-5.558	0.001
CSRC	3,211	0.926	1,997	0.931	1,214	0.919	1.284	0.100
REDT	3,211	0.761	1,997	0.733	1,214	0.814	-5.332	0.001
REDP	3,211	0.881	1,997	0.896	1,214	0.857	3.220	0.001
REW	3,211	0.694	1,997	0.746	1,214	0.609	8.019	0.001

Panel A reports the results of the means comparison between the groups of high and low carbon policy risk. Panel B presents the results of the means comparison between the high and low cost of debt groups.
All variables are defined in text and in Appendix B.

TABLE 6-4 Correlations Between Carbon Emissions Growth, Carbon Policy Risk, Cost of Debt and Other Company Level Variables

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
A. LSC1	1.000															
B. LSC2	0.632	1.000														
C. LSC12	0.941	0.792	1.000													
D. RISK	-0.049	-0.159	-0.107	1.000												
E. COD	-0.039	-0.189	-0.067	-0.033	1.000											
F. REPI	0.016	0.013	0.011	-0.039	0.048	1.000										
G. ASU	0.251	0.272	0.290	0.090	-0.106	0.049	1.000									
H. SIZE	0.500	0.636	0.579	-0.087	-0.297	-0.029	0.290	1.000								
I. ROA	-0.140	0.001	-0.099	-0.043	-0.197	-0.023	0.000	0.044	1.000							
J. LEV	0.162	0.063	0.151	0.021	0.205	0.069	0.039	0.006	-0.156	1.000						
K. NEW	0.105	-0.080	0.076	-0.034	0.152	0.042	0.036	-0.195	0.004	0.200	1.000					
L. CAPIN	0.111	-0.094	0.079	0.007	0.119	0.014	-0.009	-0.292	-0.143	0.207	0.426	1.000				
M. CSRC	0.109	0.147	0.142	-0.026	-0.066	-0.050	0.122	0.139	-0.006	-0.020	0.010	0.019	1.000			
N. REDT	0.170	0.223	0.201	0.054	-0.137	-0.071	0.254	0.255	0.036	0.036	-0.100	-0.110	0.214	1.000		
O. REDP	0.236	0.208	0.242	0.073	-0.053	-0.023	0.222	0.238	-0.013	0.013	-0.085	-0.056	0.165	0.278	1.000	
P. REW	0.145	0.239	0.173	0.061	-0.116	0.027	0.224	0.244	0.020	0.081	-0.029	-0.045	0.098	0.237	0.276	1.000

All variables are defined in text and in Appendix B.

6.4.5 Regression Results

6.4.5.1 Scope 1 Emissions

Table 6-5 Panel A shows the main variables included in the regression model for Scope 1 emissions over the 1-5 year time horizons. *RISK* is significantly negatively related to *LSC1* in the 2 year (-0.008, $p < 0.05$) and 3 year (-0.009, $p < 0.10$) time horizons. A 1 percent increase in carbon policy risk leads to a 0.8 and 0.9 percentage decrease in Scope 1 emissions for the two- and three- year analyses. On the contrary, *COD* is positively related to *LSC1* for the 1 year (0.031, $p < 0.05$), 2- (0.045, $p < 0.05$) and 3 year (0.061, $p < 0.01$) time horizons. A 1 percentage point increase in the cost of debt financing corresponds with a 3.1, 4.5, and 6.1 percentage increase in Scope 1 emissions in the first, second and third years, respectively. In addition, *REPI* is significantly negative over the 3 year (-0.088, $p < 0.10$) time horizon, indicating an 8.8 percentage decrease in the emissions growth rate three years after a unit increase in carbon reporting strength. The sign on the coefficient of *ASU* is consistently negative over the 2-5 year time horizons, albeit they are statistically insignificant.

Among the control variables, the coefficient of *SIZE* is significantly negative over the 4 year (-0.062, $p < 0.05$) and 5 year (-0.104, $p < 0.05$) time horizons, indicating that larger companies are under more pressure to reduce emissions growth over the longer term. It has been argued that larger companies are subject to higher political and regulatory pressures, and therefore higher regulatory costs (Gamerschlag, Möller, and Verbeeten, 2011). To reduce the regulatory cost, larger companies may have a greater incentive to improve their environmental performance. This is consistent with Clarkson et al.'s (2011) finding that larger companies are well situated to invest in clean technology to enhance environmental performance, and they are more likely to invest in clean technology. The coefficient of *ROA* is significantly positive over the 1 year (0.427, $p < 0.05$) and 2 year (0.720, $p < 0.01$) time horizons, corresponding with an anticipation that companies with higher financial performance are associated with greater emissions growth (Qian and Schaltegger 2017).

While an emissions reduction policy is found to facilitate an emissions reduction in the first year following the implementation of the policy (REDP, -0.060, p< 0.10), the setting of emissions reduction targets helps to curb emissions growth consistently over the 2 year (-0.094, $p < 0.05$), 3 year (-0.188, $p < 0.01$), 4- (-0.287, $p < 0.01$) and 5 year (-0.421, $p < 0.01$) time horizons. This resonates with the findings in Study Two, that the introduction of an emissions reduction policy is effective in slowing down emissions growth in the short-term, but that the setting of a reduction target sustains emissions reduction over the longer term. In addition, the greater the capital expenditure, the greater the likelihood of slowing down emissions growth over the 5 year (-1.054, $p < 0.05$) time horizon.

TABLE 6-5 The Association Between Carbon Policy Risk, the Cost of Debt and Scope 1 Carbon Emissions Growth

Panel A: Inclusion of Main Variables

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISK	-0.003	-0.008**	-0.009*	-0.004	-0.006
	(-0.87)	(-1.99)	(-1.74)	(-0.64)	(-0.53)
COD	0.031**	0.045**	0.061***	0.015	-0.079
	(2.47)	(2.47)	(2.66)	(0.46)	(-1.62)
REPI	0.000	0.020	-0.079*	-0.111	0.210
	(-0.01)	(0.54)	(-1.51)	(-1.34)	(0.91)
ASU	0.015	-0.004	-0.031	-0.025	-0.056
	(0.59)	(-0.11)	(-0.67)	(-0.39)	(-0.56)
SIZE	0.006	0.006	-0.025	-0.062**	-0.104**
	(0.62)	(0.43)	(-1.37)	(-2.34)	(-2.52)
ROA	0.427**	0.720***	0.408	0.199	0.029
	(2.55)	(2.71)	(1.10)	(0.37)	(0.03)
LEV	-0.013	0.001	-0.124	-0.344	-0.414
	(-0.14)	(0.01)	(-0.74)	(-1.45)	(-1.11)
NEW	-0.029	-0.025	0.149	0.293	0.296
	(-0.35)	(-0.21)	(0.98)	(1.35)	(0.88)
CAPIN	0.063	0.046	-0.260	-0.425	-1.054**
	(0.63)	(0.31)	(-1.41)	(-1.57)	(-2.16)
CSRC	0.023	0.150*	0.062	0.008	-0.027
	(0.46)	(1.72)	(0.48)	(0.04)	(-0.10)
REDT	-0.013	-0.094**	-0.188***	-0.287***	-0.421***
	(-0.46)	(-2.19)	(-3.45)	(-3.70)	(-3.46)
REDP	-0.060*	-0.034	0.030	0.079	0.042
	(-1.68)	(-0.66)	(0.47)	(0.85)	(0.29)
REW	-0.022	-0.065*	-0.041	-0.074	-0.055
	(-0.85)	(-1.77)	(-0.90)	(-1.18)	(-0.58)
constant	-0.113	-0.288	0.795**	1.880***	1.188
	(-0.50)	(-0.85)	(1.75)	(2.69)	(0.77)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	2,376	1,796	1,313	871	530
R-sq	0.0399	0.0610	0.0987	0.1672	0.1878

Panel B of Table 6-5 shows the regression results after including the interaction terms. *RISK* remains significantly negative over the 2 year (-0.023, $p < 0.01$), 3 year (-0.027, $p < 0.01$), and 4 year (-0.022, $p < 0.10$) time horizons. A 1 percent increase in carbon policy risk is found to be associated with a consistent emissions reduction of approximately 2.5 percent Scope 1 emissions reduction for the two-, three- and four-year time horizons. However, *COD* became significantly negative over the 1 year (-0.075, $p < 0.05$), 2 year (-0.158, $p < 0.01$), and 3 year (-0.157, $p < 0.05$) time horizons, indicating that a 1 percentage point increase in the cost of debt financing is associated with a 7.5, 15.8 and 15.7 percent decrease in emissions growth over 1 year, 2 years, and 3 years, respectively. Both *REPI* and *ASU* become more statistically significant over the 2 year (*REPI*, -0.101, $p < 0.10$; *ASU*, -0.114, $p < 0.10$), 3 year (*REPI*, -0.205, $p < 0.01$; *ASU*, -0.174, $p < 0.05$), and 4 year (*REPI*, -0.179, $p < 0.10$; *ASU*, -0.245, $p < 0.05$) time horizons. This suggests that a 1-unit increase in the strength of the reporting index leads to 10.1 percent decrease in the emissions growth rate, and the decrease peaks at 20.5 percent in the third year, and it falls slightly in the fourth year. Meanwhile, the undertaking of assurance engagements corresponds with an 11.4 percent, 17.4 percent, and 24.5 percent decrease in emissions growth over 2-4 years respectively.

The interaction terms of *RISKASU* and *RISKREPI* are significantly positive over the 2 year (0.008, $p < 0.10$) and 3 year (0.006, $p < 0.10$) time horizons, respectively. Carbon policy risk is positively associated with carbon emissions growth when a company undertakes carbon assurance, or when a company is based in a country with more stringent carbon reporting schemes. Along a similar line, *CODREPI* is significantly positive[170] over the 1 year (0.025, $p < 0.05$), 2 year (0.048, $p < 0.01$), and 3 year (0.039, $p < 0.10$) time horizons, and *CODASU* is significantly positive over the 3 year (0.097, $p < 0.05$) and 4 year (0.146, $p < 0.05$) time horizons. The presence of a more stringent reporting scheme moderates the relation between *COD* and *LSC1* from being negative to becoming positive. When a carbon assurance

[170] It could be the case that financial institutions residing in a country with more stringent reporting schemes are more likely to charge higher cost of debt to companies with higher emission levels.

engagement is undertaken, the higher the cost of debt, the greater the growth rate of Scope 1 emissions.

Panel B: Inclusion of Interaction Terms

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISK	-0.007	-0.023***	-0.027***	-0.022*	-0.006
	(-1.26)	(-3.20)	(-2.95)	(-1.68)	(-0.23)
COD	-0.075**	-0.158***	-0.157**	-0.143	-0.137
	(-1.89)	(-2.82)	(-2.16)	(-1.29)	(-0.79)
REPI	-0.054	-0.101*	-0.205***	-0.179*	0.172
	(-1.38)	(-1.78)	(-2.87)	(-1.71)	(0.68)
ASU	-0.009	-0.114*	-0.174**	-0.245**	-0.173
	(-0.19)	(-1.70)	(-2.10)	(-2.13)	(-0.99)
RISKCOD	0.002	0.003	0.005*	0.005	-0.003
	(1.21)	(1.57)	(2.02)	(1.64)	(-0.65)
CODREPI	0.025**	0.048***	0.039*	0.009	0.012
	(2.42)	(3.25)	(1.97)	(0.30)	(0.22)
CODASU	0.016	0.049	0.097**	0.146**	0.081
	(0.61)	(1.34)	(2.12)	(2.34)	(0.86)
RISKREPI	0.001	0.004	0.006*	0.005	0.003
	(0.66)	(1.44)	(1.90)	(1.00)	(0.25)
RISKASU	0.000	0.008*	0.001	0.002	-0.001
	(-0.12)	(1.87)	(0.18)	(0.31)	(-0.10)
SIZE	0.006	0.005	-0.022	-0.054*	-0.104**
	(0.60)	(0.38)	(-1.21)	(-2.03)	(-2.49)
ROA	0.372**	0.596**	0.283	0.116	0.019
	(2.21)	(2.24)	(0.76)	(0.22)	(0.02)
LEV	-0.012	0.024	-0.131	-0.336	-0.396
	(-0.13)	(0.18)	(-0.78)	(-1.42)	(-1.05)
NEW	-0.021	-0.014	0.169	0.265	0.219
	(-0.25)	(-0.11)	(1.11)	(1.21)	(0.64)
CAPIN	0.058	0.052	-0.279	-0.420	-1.041**
	(0.58)	(0.35)	(-1.52)	(-1.55)	(-2.12)
CSRC	0.021	0.144*	0.052	0.032	0.035
	(0.43)	(1.65)	(0.41)	(0.17)	(0.13)
REDT	-0.011	-0.089**	-0.191***	-0.307***	-0.434***
	(-0.37)	(-2.08)	(-3.49)	(-3.94)	(-3.51)
REDP	-0.063*	-0.043	0.026	0.076	0.055
	(-1.77)	(-0.84)	(0.41)	(0.82)	(0.37)
REW	-0.021	-0.065*	-0.042	-0.078	-0.059
	(-0.81)	(-1.79)	(-0.93)	(-1.24)	(-0.61)
constant	0.123	0.303	1.434***	2.297***	1.316
	(0.44)	(0.75)	(2.78)	(2.98)	(0.80)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	2,376	1,796	1,313	871	530
R-sq	0.0437	0.0722	0.1094	0.1766	0.1904

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 6-5 presents regression results of Equation (1) using DLSC1 as dependent variables. Panel A reports the regression results with inclusion of the main variables only. The dependent variables are percentage change in Scope 1 emissions over 1,2,3,4,5- year time horizons in Columns (1)- (5) respectively. Panel B reports the regression results with inclusion of the interaction terms. The dependent variables are percentage change in Scope 1 emissions over 1,2,3,4,5- year time horizons in columns (1)- (5) respectively.
All variables are defined in text and in Appendix B.

6.4.5.2 Scope 2 Emissions

Table 6-6 presents the results for the Scope 2 emissions regression models. In Panel A, the coefficient for *RISK* is significantly negative over the 5 year (-0.018, $p < 0.05$) time horizon, and that of *ASU* and *COD* are significantly positive over the 2 year (*ASU*, 0.070, $p < 0.10$) and 3 year (*COD*, 0.052, $p < 0.05$) time horizons. When including the interaction terms in Panel B, only the coefficient for *REPI* is significant over the 3 year (-0.137, $p < 0.05$) time horizon. In general, the coefficients for the interaction terms are positive. For instance, when the reporting schemes are strengthened, the carbon policy risk becomes higher and the Scope 2 emissions growth rate increases by 0.8 percent 3 years afterwards. The coefficients for *CODASU* are significantly positive over the 2 year (0.091, $p < 0.05$), 3 year (0.134, $p < 0.01$) and 4 year (0.114, $p < 0.05$) time horizons. A 1 percentage point increase in the cost of debt financing is associated with a 9.1, 13.4, and 11.4 percent increase in Scope 2 emissions growth for 2, 3 and 4 years respectively, after a carbon assurance engagement is undertaken.

Consistent with the results for the Scope 1 emissions regressions, the larger a company's size, the lower the Scope 2 emissions growth rates over the 2 year (-0.023, $p < 0.10$), 3 year (-0.031, $p < 0.10$) and 5 year (-0.060, $p < 0.10$) time horizons. On the other hand, the higher the return on assets, the greater the Scope 2 emissions growth rate over the 2 year (0.482, $p < 0.10$) and 3 year (0.788, $p < 0.05$) time horizons. Also, the establishment of emissions reduction targets remains effective in curbing Scope 2 emissions growth by approximately 9.1 to 18.1 percent over the 3-5 year time horizons. In addition, the coefficient for NEW is consistently positive over the 2-5 year time horizons. The newer the equipment in use, the higher the Scope 2 emissions growth rate and the growth rate continues to increase from 26.3 to 58.8 percent.

TABLE 6-6 The Association Between Carbon Policy Risk, the Cost of Debt and Scope 2 Carbon Emissions Growth

Panel A: Inclusion of Main Variables

	Dep. Var. =				
	D1LSC2	**D2LSC2**	**D3LSC2**	**D4LSC2**	**D5LSC2**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISK	0.000	-0.003	-0.006	-0.006	-0.018**
	(0.05)	(-0.83)	(-1.07)	(-1.07)	(-1.63)
COD	0.016	0.025	0.052**	0.052	0.002
	(1.38)	(1.40)	(2.31)	(2.31)	(0.04)
REPI	0.016	0.007	-0.009	-0.009	-0.046
	(0.68)	(0.19)	(-0.18)	(-0.18)	(-0.24)
ASU	0.000	0.070*	0.071	0.071	-0.103
	(0.02)	(1.93)	(1.55)	(1.55)	(-1.24)
SIZE	-0.002	-0.024*	-0.033*	-0.033	-0.058*
	(-0.21)	(-1.77)	(-1.84)	(-1.84)	(-1.69)
ROA	0.195	0.506**	0.827**	0.827	1.157
	(1.23)	(1.96)	(2.18)	(2.18)	(1.57)
LEV	-0.065	-0.070	0.067	0.067	0.274
	(-0.77)	(-0.54)	(0.40)	(0.40)	(0.87)
NEW	0.129	0.272**	0.469***	0.469***	0.702***
	(1.61)	(2.30)	(3.11)	(3.11)	(2.54)
CAPIN	0.129	-0.047	-0.156	-0.156	-0.470
	(1.34)	(-0.33)	(-0.85)	(-0.85)	(-1.17)
CSRC	-0.008	-0.124	-0.079	-0.079	-0.059
	(-0.18)	(-1.47)	(-0.65)	(-0.65)	(-0.27)
REDT	-0.017	-0.063	-0.083	-0.083	-0.177
	(-0.60)	(-1.49)	(-1.51)	(-1.51)	(-1.70)
REDP	-0.002	-0.004	0.038	0.038	0.152
	(-0.06)	(-0.08)	(0.60)	(0.60)	(1.27)
REW	0.005	-0.015	-0.048	-0.048	0.057
	(0.19)	(-0.43)	(-1.08)	(-1.08)	(0.71)
constant	-0.163	0.248	0.284	0.284	1.255
	(-0.76)	(0.75)	(0.63)	(0.63)	(0.98)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	2,293	1,724	1,248	821	492
R-sq	0.0617	0.0894	0.1704	0.1051	0.1367

Panel B: Inclusion of Interaction Terms

	Dep. Var. =				
	D1LSC2	**D2LSC2**	**D3LSC2**	**D4LSC2**	**D5LSC2**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISK	0.001	-0.008	-0.013	-0.013	0.005
	(0.15)	(-1.09)	(-1.38)	(-1.04)	(0.20)
COD	-0.024	-0.058	-0.106	-0.130	-0.241
	(-0.65)	(-1.06)	(-1.49)	(-1.26)	(-1.69)
REPI	-0.006	-0.038	-0.137**	-0.133	-0.071
	(-0.16)	(-0.70)	(-1.96)	(-1.38)	(-0.34)
ASU	-0.013	-0.068	-0.096	-0.166	-0.194
	(-0.28)	(-1.03)	(-1.19)	(-1.60)	(-1.38)
RISKCOD	0.000	0.000	-0.002	-0.003	-0.003
	(-0.39)	(-0.15)	(-0.87)	(-0.89)	(-0.66)
CODREPI	0.012	0.006	0.027	0.032	0.082
	(1.22)	(0.45)	(1.38)	(1.12)	(1.86)
CODASU	0.009	0.091**	0.134***	0.114**	0.080
	(0.37)	(2.53)	(3.03)	(2.03)	(1.07)
RISKREPI	0.000	0.003	0.008**	0.006	-0.008
	(0.20)	(1.09)	(2.53)	(1.40)	(-0.68)
RISKASU	0.000	0.001	-0.007	-0.004	-0.007
	(-0.14)	(0.16)	(-1.29)	(-0.61)	(-0.77)
SIZE	-0.002	-0.023*	-0.031*	-0.035	-0.060*
	(-0.25)	(-1.68)	(-1.70)	(-1.43)	(-1.73)
ROA	0.184	0.482*	0.788**	0.752	1.133
	(1.15)	(1.85)	(2.08)	(1.49)	(1.52)
LEV	-0.068	-0.060	0.045	0.311	0.218
	(-0.80)	(-0.46)	(0.27)	(1.39	(0.69)
NEW	0.125	0.263**	0.446***	0.588***	0.585**
	(1.56)	(2.22)	(2.96)	(2.90)	(2.08)
CAPIN	0.132	-0.036	-0.164	-0.273	-0.432
	(1.37)	(-0.25)	(-0.89)	(-1.10)	(-1.08)
CSRC	-0.009	-0.112	-0.067	0.023	-0.005
	(-0.19)	(-1.32)	(-0.55)	(0.13)	(-0.02)
REDT	-0.016	-0.065	-0.091*	-0.099	-0.181*
	(-0.55)	(-1.55)	(-1.66)	(-1.32)	(-1.73)
REDP	-0.004	-0.008	0.026	0.045	0.167
	(-0.12)	(-0.17)	(0.41)	(0.53)	(1.40)
REW	0.006	-0.013	-0.040	-0.028	0.054
	(0.24)	(-0.38)	(-0.88)	(-0.47)	(0.67)
constant	-0.081	0.545	0.925*	1.097	0.885
	(-0.31)	(1.40)	(1.83)	(1.54)	(0.64)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	2,293	1,724	1,248	821	492
R-sq	0.0625	0.0937	0.1829	0.1151	0.1516

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 6-6 presents regression results of Equation (1) using DLSC2 as dependent variables. Panel A reports the regression results with inclusion of the main variables only. The dependent variables are the percentage change in Scope 2 emissions over 1,2,3,4,5- year time horizons in Columns (1)- (5) respectively. Panel B reports the regression results with inclusion of the interaction terms. The dependent variables are the percentage change in Scope 2 emissions over 1,2,3,4,5- year time horizons in Columns (1)- (5) respectively.
All variables are defined in text and in Appendix B.

6.4.5.3 Scope 1+2 Emissions

Panel A of the Table 6-7 presents the regression results for the sum of Scope 1 and 2 emissions when only the main variables of interest are included. The coefficient for *RISK* is significantly negative over the 4 year (-0.011, $p < 0.10$) time horizon, while that of the *COD* is significantly positive over the 1 year (0.025, $p < 0.05$), 2 year (0.035, $p < 0.05$) and 3 year (0.045, $p < 0.10$) time horizons. Panel B shows the results for the regression analysis after including the interaction terms. The coefficient for *COD* becomes significantly negative over the 1 year (-0.066, $p < 0.10$), 2 year (-0.146, $p < 0.01$), 3 year (-0.134, $p < 0.05$) and 4 year (-0.167, $p < 0.10$) time horizons. The coefficients for both *REPI* and *ASU* are significantly negative over the 3 year (*REPI*, -0.163, $p < 0.05$; *ASU*, -0.126, $p < 0.10$) and 4 year (*REPI*, -0.164, $p < 0.10$; *ASU*, -0.330, $p < 0.01$) time horizons.

Regarding the interaction terms, on the one hand, the coefficient for *CODREPI* is significantly positive over the 1 year (0.023, $p < 0.05$) and 2 year (0.041, $p < 0.01$) time horizons, while that for *CODASU* is significantly positive over the 2 year (0.064, $p < 0.05$), 3 year (0.133, $p < 0.01$), 4 year (0.217, $p < 0.01$) and 5 year (0.119, $p < 0.10$) time horizons. The relation between the cost of debt financing and the emissions growth rate becomes positive when a country in which a company is based strengthens its carbon related reporting schemes and when a carbon assurance engagement is undertaken. On the other hand, while the coefficient for *RISKREPI* (0.006, $p < 0.05$) is significantly positive, that of *RISKASU* (-0.009, $p < 0.10$) is significantly negative over the 3-year time horizon. The undertaking of an assurance engagement strengthens the relation between carbon policy risk and the emissions growth rate, while the strengthening of a carbon reporting scheme weakens the negative relation between carbon policy risk and the emissions growth rate.

Larger companies have demonstrated a degree of effort in slowing down the growth rate of combined Scope 1 and Scope 2 emissions. Moreover, emissions reduction targets are an effective mechanism for helping companies that endeavour to reduce emissions over the longer-term time horizon. It is observed that both the coefficients for *NEW* (over the 2 year (0.188, $p < 0.10$), 3 year (0.392, $p < 0.01$), and 4 year (0.335, $p < 0.10$) time horizons,) and *CSRC* (over the 4 year (0.315, $p < 0.05$) and 5 year (0.444, $p < 0.05$) time horizons) are significantly positive over longer time horizons. The use of newer equipment and the presence of a sustainability committee on boards have been associated with a company's emissions growth.

6.4.5.4 Summary of Hypothesis Testing

Based on the regression results reproduced above, the conclusions drawn from the tests of the hypotheses constructed in this study are summarised in the following section.

6.4.5.4.1 Test of H1

H1 states that a company's carbon policy risk is negatively related with its carbon emissions growth. The coefficients for *RISK* are negative and statistically significant for Scope 1 emissions over the 2-4 year time horizons, whether included alone or with the interaction terms. Its statistical significance is prominent for Scope 2 emissions over the 5- year time horizon and for the sum of Scope 1 and 2 emissions over the 4 year time horizon, but it then diminishes when the interaction terms are included. Overall, it appears that the higher the carbon policy risk, the greater the decrease in the growth rate of carbon emissions. H1 is therefore generally supported.

TABLE 6-7 The Association between Carbon Policy Risk, Cost of Debt and Scope 1+2 Carbon Emissions Growth

Panel A: Inclusion of Main Variables

	Dep. Var. =				
	D1LSC12	**D2LSC12**	**D3LSC12**	**D4LSC12**	**D5LSC12**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISK	-0.001	-0.004	-0.007	-0.011*	-0.012
	-0.41	-1.19	-1.50	-1.85	-1.32
COD	0.025**	0.035**	0.040*	-0.003	-0.050
	2.22	2.16	1.87	-0.11	-1.32
REPI	0.011	0.006	-0.058	-0.101	0.114
	0.49	0.18	-1.20	-1.40	0.63
ASU	0.009	0.026	0.028	-0.044	-0.077
	0.37	0.78	0.66	-0.79	-0.98
SIZE	-0.010	-0.014	-0.028*	-0.031	-0.086***
	-1.14	-1.12	-1.72	-1.37	-2.67
ROA	0.187	0.350	0.325	-0.317	-0.356
	1.25	1.49	0.94	-0.68	-0.51
LEV	-0.027	0.001	0.062	0.007	-0.138
	-0.33	0.01	0.40	0.03	-0.47
NEW	0.101	0.188*	0.398***	0.441**	0.505**
	1.33	1.74	2.82	2.33	1.91
CAPIN	0.024	-0.006	-0.183	-0.251	-0.485
	0.27	-0.05	-1.08	-1.09	-1.30
CSRC	0.016	0.065	-0.022	0.287*	0.373**
	0.37	0.85	-0.19	1.85	1.85
REDT	0.017	-0.032	-0.149***	-0.173**	-0.197**
	0.64	-0.85	-2.96	-2.56	-2.03
REDP	-0.013	0.008	0.055	0.137*	0.174
	-0.39	0.17	0.93	1.71	1.53
REW	0.005	-0.034	-0.006	0.004	0.084
	0.23	-1.04	-0.15	0.08	1.11
constant	-0.026	0.000	0.552	0.841	0.537
	-0.13	0.00	1.31	1.38	0.44
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	2,409	1,822	1,336	890	540
R-sq	0.0244	0.0568	0.1108	0.1461	0.1554

Panel B: Inclusion of Interaction Terms

	Dep. Var. =				
	D1LSC12	**D2LSC12**	**D3LSC12**	**D4LSC12**	**D5LSC12**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISK	-0.002	-0.008	-0.012	-0.013	-0.001
	(-0.33)	(-1.24)	(-1.47)	(-1.11)	(-0.04)
COD	-0.066*	-0.146***	-0.134**	-0.167*	-0.115
	(-1.84)	(-2.93)	(-1.99)	(-1.74)	(-0.84)
REPI	-0.016	-0.069	-0.163**	-0.164*	0.061
	(-0.45)	(-1.38)	(-2.47)	(-1.81)	(0.31)
ASU	-0.013	-0.068	-0.126*	-0.330***	-0.210
	(-0.30)	(-1.14)	(-1.66)	(-3.38)	(-1.57)
RISKCOD	0.001	0.001	0.000	-0.001	-0.009**
	(0.89)	(0.81)	(0.12)	(-0.33)	(-2.31)
CODREPI	0.023**	0.041***	0.026	0.013	0.022
	(2.44)	(3.13)	(1.42)	(0.49)	(0.52)
CODASU	0.012	0.064**	0.133***	0.217***	0.119*
	(0.53)	(1.97)	(3.20)	(4.12)	(1.67)
RISKREPI	0.000	0.001	0.006**	0.005	0.005
	(-0.29)	(0.61)	(2.03)	(1.12)	(0.49)
RISKASU	0.000	0.000	-0.009*	-0.006	-0.010
	(0.08)	(-0.11)	(-1.81)	(-1.04)	(-1.20)
SIZE	-0.011	-0.014	-0.026	-0.024	-0.086***
	(-1.21)	(-1.13)	(-1.55)	(-1.08)	(-2.69)
ROA	0.151	0.284	0.279	-0.287	-0.271
	(1.00)	(1.20)	(0.81)	(-0.62)	(-0.39)
LEV	-0.029	0.003	0.047	0.024	-0.107
	(-0.36)	(0.03)	(0.30)	(0.12)	(-0.36)
NEW	0.106	0.188*	0.392***	0.335*	0.339
	(1.39)	(1.74)	(2.79)	(1.76)	(1.26)
CAPIN	0.022	0.003	-0.193	-0.226	-0.381
	(0.25)	(0.02)	(-1.15)	(-0.99)	(-1.02)
CSRC	0.015	0.060	-0.017	0.315**	0.444**
	(0.35)	(0.79)	(-0.14)	(2.04)	(2.19)
REDT	0.020	-0.027	-0.155***	-0.200***	-0.216**
	(0.77)	(-0.73)	(-3.10)	(-2.96)	(-2.23)
REDP	-0.015	-0.001	0.046	0.122	0.183
	(-0.47)	(-0.03)	(0.78)	(1.54)	(1.61)
REW	0.006	-0.032	0.000	0.011	0.084
	(0.25)	(-0.99)	(0.00)	(0.21)	(1.10)
constant	0.057	0.306	1.079**	1.182*	0.638
	(0.23)	(0.85)	(2.27)	(1.77)	(0.50)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	2,409	1,822	1,336	890	540
R-sq	0.0287	0.0654	0.1234	0.1658	0.1788

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 6-7 presents regression results of Equation (1) using DLSC12 as dependent variables. Panel A reports the regression results with inclusion of the main variables only. The dependent variables are the percentage change in Scope 1 and 2 emissions over 1,2,3,4,5- year time horizons in Columns (1)- (5), respectively. Panel B reports the regression results with inclusion of the interaction terms. The dependent variables are the percentage change in Scope 1 and 2 emissions over 1,2,3,4,5- year horizons in columns (1)- (5), respectively.

All variables are defined in text and in Appendix B.

6.4.5.4.2 Test of H2

Based on H2, the negative relation between carbon policy risk and the carbon emissions growth in a company is more pronounced in a country with more stringent carbon reporting schemes. The coefficient for *RISKREPI* is significantly positive over the 3 year time horizon for Scope 1 (0.006, $p < 0.10$), Scope 2 (0.008, $p < 0.05$), and the sum of Scope 1 and 2 (0.006, $p < 0.05$) emissions. The negative relation between carbon policy risk and the emissions growth rate becomes positive when carbon reporting schemes are implemented or strengthened. Therefore, the strength of carbon reporting schemes seems to weaken the impact of carbon policy risk on the emissions growth rate, instead of facilitating it. H2 is not supported.

6.4.5.4.3 Test of H3

H3 states that the undertaking of carbon assurance moderates the negative relation between the carbon policy risk and the carbon emissions growth of a company. The coefficient for *RISKASU* is significantly positive for Scope 1 emissions over the 2 year time horizon, but negative for the sum of Scope 1 and 2 emissions over the 3 year time horizon. The undertaking of an assurance engagement could be effective in curbing the growth of a company's reported Scope 1 and 2 emissions, but this is not the case for Scope 1 emissions alone. The result modestly supports the hypothesis H3.

6.4.5.4.4 Test of H4

H4 states that a company's cost of debt is negatively related with its carbon emissions growth. The coefficient for *COD* is positive in the main variable regression and becomes negative in the regressions after including the interaction terms for Scope 1 and the sum of Scope 1 and 2 emissions. An increase in a company's cost of debt financing facilitates decreases its emissions' growth rate when there is no carbon reporting scheme prescribed and when the company does not undertake carbon assurance engagement. H4 is therefore partially supported.

6.4.5.4.5 Test of H5

H5 states that the strength of a carbon reporting scheme strengthens the negative relation between the cost of debt and the carbon emissions growth of a company. The coefficient of *CODREPI* is significantly positive over the 1-3 year time horizons for Scope 1 emissions and over the 1-2 year time horizons for the sum of Scope 1 and 2 emissions. This is the same as the result of H2 in that carbon reporting schemes weaken the negative relation between the cost of debt financing and the carbon emissions growth rate. H5 is not supported.

6.4.5.4.6 Test of H6

H6 states that the negative relation between the cost of debt and the carbon emissions growth of a company is more pronounced when the company undertakes a carbon assurance engagement. The coefficient for *CODASU* is consistently positive for Scope 1 emissions over the 3 year and 4 year time horizons, and for Scope 2 emissions over the 2-4 year time horizons, and for the sum of Scope 1 and 2 emissions over the 2-5 year time horizons. This outcome contradicts hypothesis H6. The higher the cost of debt financing, the greater the growth rate of carbon emissions when a company undertakes a carbon assurance engagement. Thus, H6 is not supported.

6.4.5.4.7 Test of H7

H7 specifies that the negative relation between carbon policy risk and carbon emissions growth of a company is more pronounced when a company incurs a higher level cost of debt. The economic magnitude of the coefficient for *RISKCOD* is minimal and only statistically significant for the sum of Scope 1 and 2 emissions over the 5 year (-0.009, $p < 0.05$) time horizon. The interaction between the two main variables of interest *RISK* and *COD* does not seem to have an economically meaningful impact on the emissions growth rate. H7 is not supported.

In summary, the results from hypotheses testing suggest that both carbon policy risk and cost of debt financing are associated with a slowing down of emissions growth. Nevertheless, strengthening of carbon reporting schemes and the undertaking of carbon assurance do not seem to contribute to the facilitating of emissions reductions. In terms of company characteristics, companies that generate higher financial returns and purchase greater amounts of new machinery and equipment as part of their operations have been experiencing increases in the growth rates of their carbon emissions. Meanwhile, larger companies could be under greater pressure to reduce their emissions and the setting of a reduction target is effective as a means of sustaining a company's efforts to achieve this, that is, reduce emissions.

6.5 Sensitivity Analyses

In this thesis, sensitivity analyses have been conducted to test for alternative measures that have been suggested in the prior literature for variables of interest. These include two alternative measures that are used as proxies for carbon policy risk and one alternative measure used to calculate the cost of debt financing.

6.5.1 Alternative Measure for Carbon Policy Risk Using Carbon Pricing Under Carbon Tax Regimes

There are two mechanisms prescribed under carbon pricing schemes, namely, ETS and carbon tax (The World Bank, 2020). In the main analysis, carbon pricing under ETS was employed. In the first sensitivity analysis, carbon tax is used as an alternative measure for calculating carbon policy risk.

According to the Carbon Pricing Dashboard (The World Bank, 2020), the number of nationally and sub-nationally imposed carbon tax systems increased from 13 in 2010 to 16 in 2016. A more significant growth is observed in the implementation of the ETS systems across countries: from 4 in 2010 to 17 in 2016.

Table 6-8 shows the regression results for Scope 1 emissions when an alternative carbon pricing mechanism (carbon tax[171]) *RISKTAX* is used to calculate carbon policy risk. The results indicate that the main analysis remains robust when using the alternative carbon policy risk measure. Consistent with the results observed from the main analysis, the coefficients for *RISKTAX*, *COD*, *REPI* and *ASU* are statistically negative, and the coefficients on the interaction terms are statistically positive.

Companies of larger sizes and which have a reduction target are associated with a sustained decrease in the growth rate of Scope 1 emissions. Companies with greater capacity to generate higher financial returns are associated with accelerating emissions growth.

[171] In the second stage of calculating the variable of interest *RISK* (refer to Section 6.3.1.1 for details), where Total cost = required GHG reduction amount × price per tCO2, the price per tCO2 uses the carbon tax data collected from the World Bank in this sensitivity test, instead of the carbon pricing under the ETS employed in the main analyses.

TABLE 6-8 The Association Between Carbon Policy Risk, the Cost of Debt and Scope 1 Carbon Emissions Growth Using Alternative Carbon Policy Risk Measures

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISKTAX	-0.015	-0.031***	-0.030**	-0.023	-0.013
	(-2.56)	(-3.68)	(-2.45)	(-1.19)	(-0.38)
COD	-0.057	-0.130**	-0.116	-0.067	-0.191
	(-1.47)	(-2.43)	(-1.66)	(-0.64)	(-1.25)
REPI	-0.061*	-0.083*	-0.133**	-0.126	0.185
	(-1.83)	(-1.75)	(-2.20)	(-1.39)	(0.77)
ASU	-0.023	-0.107	-0.183**	-0.225*	-0.186
	(-0.50)	(-1.62)	(-2.25)	(-1.99)	(-1.08)
RISKCOD	0.004**	0.007	0.004	-0.001	-0.001
	(2.62)	(3.05)	(1.31)	(-0.19)	(-0.21)
CODREPI	0.018*	0.038***	0.033	-0.002	0.025
	(1.77)	(2.58)	(1.69)	(-0.06)	(0.50)
CODASU	0.014	0.048	0.100**	0.140**	0.082
	(0.53)	(1.31)	(2.19)	(2.24)	(0.88)
RISKREPI	0.002	0.005*	0.006	0.011	-0.001
	(1.47)	(1.97)	(1.56)	(1.32)	(-0.04)
RISKASU	0.006*	0.013***	0.004	-0.002	0.006
	(1.73)	(2.57)	(0.54)	(-0.17)	(0.42)
SIZE	0.006	0.006	-0.023	-0.057**	-0.103**
	(0.63)	(0.44)	(-1.27)	(-2.16)	(-2.45)
ROA	0.351**	0.591**	0.332	0.190	0.027
	(2.09)	(2.23)	(0.89)	(0.35)	(0.03)
LEV	0.005	0.036	-0.123	-0.330	-0.401
	(0.06)	(0.27)	(-0.73)	(-1.39)	(-1.06)
NEW	-0.011	0.005	0.158	0.233	0.230
	(-0.13)	(0.04)	(1.04)	(1.06)	(0.67)
CAPIN	0.035	0.017	-0.292	-0.414	-1.075**
	(0.35)	(0.11)	(-1.59)	(-1.52)	(-2.18)
CSRC	0.018	0.133	0.066	0.020	0.022
	(0.36)	(1.53)	(0.51)	(0.11)	(0.08)
REDT	-0.011	-0.093**	-0.198***	-0.320	-0.436***
	(-0.37)	(-2.19)	(-3.62)	(-4.08)	(-3.54)
REDP	-0.061*	-0.044	0.028	0.079	0.056
	(-1.73)	(-0.86)	(0.43)	(0.85)	(0.38)
REW	-0.020	-0.065*	-0.040	-0.071	-0.065
	(-0.80)	(-1.80)	(-0.89)	(-1.12)	(-0.67)
constant	0.205	0.222	1.005**	2.033***	1.197
	(0.82)	(0.61)	(2.12)	(2.86)	(0.76)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	2,376	1,796	1,313	871	530
R-sq	0.0476	0.0766	0.1066	0.1746	0.1906

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 6-8 presents the regression results for Equation (1) using alternative carbon policy risk measures. The dependent variables are the percentage change in Scope 1 emissions over 1,2,3,4,5- year time horizons in Columns (1)- (5), respectively. All variables are defined in text.

6.5.2 Alternative Measure for Carbon Policy Risk Using the Difference Between Assigned and Reported Emissions

For some of the countries which have set emissions reduction targets, but which have not implemented carbon pricing mechanisms throughout the sample period, such as Australia which implemented an ETS in 2012 but repealed the scheme in 2014, their carbon policy risk may not be fully captured in the main analysis. An alternative carbon policy risk measure *RISKDIFF* has been constructed which does not use carbon pricing schemes, but rather it captures the difference[172] between a company's assigned and disclosed emissions.

Results from Table 6-9 indicate that the results of the main analysis remain robust when using the alternative carbon policy risk measure. The coefficient for *RISKDIFF* is consistently and significantly negative and its magnitude increases across the 1-5 year time horizons. The coefficients for *COD*, *REPI* and *ASU* are also significantly negative across multiple periods. The coefficients for the interaction terms are statistically positive, indicating the moderating effects of the strength of carbon reporting schemes and assurance engagements that are undertaken. However, these effects are opposite to the expectations under hypotheses H7, H2, H5 and H6. Companies with a greater return on assets demonstrate a greater rate of Scope 1 emissions growth. Different from the result in the main analysis, larger companies are associated with a statistically significant increase in emission growth rates over the short-term, i.e., 1- 2 year time horizons. Nevertheless, emission reduction targets are still strongly effective in curbing emissions growth over longer-term periods

[172] In the second stage of calculating the variable of interest *RISK* (refer to Section 6.3.1.1 for details), instead of calculating the Total cost = required GHG reduction amount × price per tCO2, *RISK* is proxied by the difference between a company's disaggregated share of emissions reduction assigned to individual companies and its reported emissions change from year t-1 to year t.

(statistically significant across the 3-5 year time horizons, with increasing economic magnitude).

6.5.3 Alternative Measure for the Cost of Debt Financing

Several prior related studies use the ratio of interest expense divided by total debt (*INTEXP*) to derive the cost of debt financing (e.g., Pittman and Forin, 2004; Chapple et al., 2013; Jung et al., 2018), while this study in its main analysis employs the variable of all-in spread. In this sensitivity analysis, this commonly adopted measure for the cost of debt financing is used to test for the robustness of the results derived from the main regression analysis.

Table 6-10 displays the results for the alternative cost of debt financing measure for Scope 1 emissions. The result obtained from the main analysis loses statistical significance when using the alternative cost of debt measure. Contrary to expectations, the coefficient of *INTEXP* is positive with no statistical significance. While the coefficients for *RISK* and *REPI* are significantly negative over the 1-2 year time horizons and 1-4 year time horizons, the negative coefficient on *ASU* is not statistically significant. Among the interaction terms, the coefficients for *RISKREPI* and *RISKCOD* are significantly positive over the 1-2 year time horizons. Both the cost of debt and the strengthening of carbon reporting schemes weaken the negative relation between carbon policy risk and Scope 1 emissions growth by 10.7 and 0.4 percent, respectively. Companies earning greater financial returns are associated with greater Scope 1 emissions growth. But larger companies have been motivated to reduce emissions and the establishment of reduction targets and the introduction of reduction policies is effective in facilitating companies to achieve emissions reductions.

TABLE 6-9 The Association Between Carbon Policy Risk, the Cost of Debt and Scope 1 Carbon Emissions Growth Using Alternative Carbon Policy Risk Measures

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISKDIFF	-0.035**	-0.078***	-0.119***	-0.145***	-0.180***
	(-2.48)	(-3.98)	(-4.97)	(-4.20)	(-2.96)
COD	-0.132*	-0.235**	-0.232*	-0.254	-0.412
	(-1.88)	(-2.39)	(-1.98)	(-1.53)	(-1.71)
REPI	-0.027	-0.045	-0.303**	-0.297*	-0.020
	(-0.41)	(-0.46)	(-2.52)	(-1.63)	(-0.05)
ASU	0.009	-0.465***	-0.362*	-0.513*	-0.432
	(0.08)	(-2.87)	(-1.79)	(-1.87)	(-1.05)
RISKCOD	0.006	0.008	0.011	0.016*	0.020
	(1.32)	(1.33)	(1.55)	(1.67)	(1.49)
CODREPI	0.024**	0.047***	0.031	-0.005	0.021
	(2.39)	(3.23)	(1.62)	(-0.16)	(0.43)
CODASU	0.012	0.043	0.078*	0.098	-0.001
	(0.48)	(1.16)	(1.70)	(1.55)	(-0.01)
RISKREPI	0.000	0.000	0.013*	0.014	0.013
	(-0.05)	(0.08)	(1.92)	(1.37)	(0.60)
RISKASU	-0.001	0.030***	0.017	0.026	0.028
	(-0.12)	(2.60)	(1.15)	(1.31)	(0.96)
SIZE	0.021**	0.027*	0.008	-0.016	-0.033
	(2.02)	(1.82)	(0.40)	(-0.57)	(-0.73)
ROA	0.340**	0.576**	0.241	0.062	-0.193
	(2.03)	(2.19)	(0.66)	(0.12)	(-0.22)
LEV	-0.006	0.058	-0.033	-0.168	-0.161
	(-0.07)	(0.44)	(-0.20)	(-0.72)	(-0.43)
NEW	0.026	0.052	0.232	0.341	0.435
	(0.31)	(0.42)	(1.53)	(1.57)	(1.28)
CAPIN	0.115	0.155	-0.134	-0.219	-0.685
	(1.15)	(1.06)	(-0.73)	(-0.81)	(-1.41)
CSRC	0.020	0.117	0.043	0.035	-0.012
	(0.41)	(1.35)	(0.34)	(0.19)	(-0.04)
REDT	0.003	-0.064	-0.159***	-0.244***	-0.340***
	(0.12)	(-1.49)	(-2.93)	(-3.15)	(-2.80)
REDP	-0.048	-0.009	0.059	0.103	0.093
	(-1.34)	(-0.17)	(0.93)	(1.13)	(0.64)
REW	-0.022	-0.064*	-0.034	-0.078	-0.050
	(-0.88)	(-1.77)	(-0.77)	(-1.25)	(-0.54)
constant	0.144	0.511	1.930***	3.001***	2.437
	(0.46)	(1.10)	(3.27)	(3.39)	(1.37)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	2,376	1,796	1,313	871	530
R-sq	0.0528	0.0897	0.1321	0.2028	0.2286

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 6-9 presents the regression results for Equation (1) using alternative carbon policy risk measures. The dependent variables are the percentage change in Scope 1 emissions over 1,2,3,4,5- year time horizons in Columns (1)- (5), respectively.

All variables are defined in text.

TABLE 6-10 The Association Between Carbon Policy Risk, the Cost of Debt and Scope 1 Carbon Emissions Growth Using an Alternative Cost of Debt Measure

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	1	**2**	**3**	**4**	**5**
RISK	-0.010***	-0.020***	-0.013	-0.009	0.007
	(-2.04)	(-2.86)	(-1.55)	(-0.75)	(0.33)
INTEXP	0.314	0.182	0.280	0.367	3.708
	(0.26)	(0.11)	(0.14)	(0.15)	(1.01)
REPI	-0.059*	-0.052	-0.090	-0.148*	-0.126
	(-1.81)	(-1.12)	(-1.56)	(-1.87)	(-0.64)
ASU	0.002	-0.067	-0.112	-0.149	-0.020
	(0.04)	(-1.12)	(-1.54)	(-1.59)	(-0.14)
RISKCOD	0.036	0.107*	0.120	0.059	-0.004
	(0.80)	(1.76)	(1.62)	(0.59)	(-0.03)
CODREPI	-0.067	-0.283	-0.435	-0.565	-1.165
	(-0.22)	(-0.66)	(-0.78)	(-0.77)	(-1.02)
CODASU	0.065	0.637	1.463	1.972	-0.174
	(0.09)	(0.65)	(1.22)	(1.28)	(-0.08)
RISKREPI	0.004**	0.003	0.002	0.003	-0.002
	(2.53)	(1.62)	(0.80)	(0.87)	(-0.22)
RISKASU	0.002	0.004	-0.002	-0.001	-0.005
	(0.84)	(1.05)	(-0.47)	(-0.13)	(-0.66)
SIZE	-0.005	-0.019	-0.023	-0.062***	-0.070**
	(-0.50)	(-1.54)	(-1.53)	(-3.09)	(-2.30)
ROA	0.131	0.318	0.588*	0.633	0.864
	(0.83)	(1.37)	(1.96)	(1.58)	(1.37)
LEV	0.039	0.026	-0.068	-0.239	-0.398
	(0.48)	(0.23)	(-0.48)	(-1.27)	(-1.40)
NEW	-0.045	-0.031	0.021	0.164	0.196
	(-0.59)	(-0.30)	(0.17)	(0.97)	(0.78)
CAPIN	0.114	0.041	-0.098	-0.190	-0.384
	(1.27)	(0.32)	(-0.63)	(-0.90)	(-1.10)
CSRC	-0.035	0.015	0.063	0.002	0.085
	(-0.79)	(0.20)	(0.63)	(0.01)	(0.42)
REDT	-0.020	-0.092**	-0.178***	-0.284***	-0.287***
	(-0.74)	(-2.51)	(-3.87)	(-4.57)	(-3.07)
REDP	-0.112***	-0.111**	-0.093	-0.144*	-0.186
	(-3.22)	(-2.31)	(-1.59)	(-1.83)	(-1.60)
REW	-0.029	-0.043	-0.018	-0.035	-0.058
	(-1.26)	(-1.38)	(-0.49)	(-0.71)	(-0.81)
constant	0.615***	0.890***	1.178***	2.612***	2.485**
	(2.60)	(2.70)	(2.86)	(4.47)	(1.98)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	4,576	3,446	2,529	1,690	1,046
R-sq	0.0174	0.0303	0.0537	0.0954	0.0978

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 6-10 presents the regression results for Equation (1) using an alternative cost of debt measure INTEXP. The dependent variables are the percentage change in Scope 1 emissions over 1,2,3,4, and 5- year time horizons in columns (1)- (5), respectively.

All variables are defined in text.

6.6 Additional Analyses

6.6.1 U.S. versus non- U.S. Sample Comparison

During the data collection process for the ALL-IN-SPREAD variable, it was observed that 43.35 percent of the sample is comprised of companies whose home country is the U.S. In prior studies the U.S. has found to be an outlier for various variables of interest for this study, in particular assurance of non-financial information (Simnett et al., 2009a; Casey and Grenier, 2015). An additional test is therefore conducted to compare the results of the U.S. and non-U.S. samples.

Table 6-11 shows the regression results using the non-U.S. sample for Scope 1 emissions. The coefficients for *RISK*, *COD*, and *REPI* are significantly negative over the 2-4 year time horizons. A 1 percent increase in carbon policy risk (-0.029, $p< 0.10$; -0.025, $p< 0.10$) and 1 percentage point increase in the cost of debt financing (-0.071, $p< 0.10$; -0.106, $p< 0.10$) are associated with an approximate 2.9 and 7.1 percent decrease in Scope 1 emissions growth over the 2 year time horizon, and 2.5 and 10.6 percent decrease over the 3 year time horizon, respectively. However, a unit increase in the strength of carbon reporting schemes leads to an 18.5 percent decrease in Scope 1 emissions growth three years afterwards. Nevertheless, the undertaking of carbon assurance engagements is associated with a 25.5 percent increase in emissions growth, but it strengthens the negative relation between carbon policy risk and emissions growth over the 1 year time horizon in non-U.S. countries. While higher financial return is accompanied by a greater increase in Scope 1 emissions growth, large companies remain under pressure to reduce their disclosed emissions. This subsample analysis further implies that emissions reduction targets and policies may not serve their purpose among non-U.S. countries.

Table 6-12 presents the regression results using the U.S. sample only for Scope 1 emissions. Except for the coefficient of *COD*, which is only significantly negative over the 5 year (-0.556, $p < 0.05$) time horizon, the coefficients for *RISK*, *REPI*, *ASU* are consistently and significantly negative across multiple periods and the magnitude of the coefficients are much greater than those for the non- U.S. sample. A 1 percent increase in carbon policy risk consistently leads to a 21.4 to 42.9 percent decrease in Scope 1 emissions reductions. A unit increase in the strength of carbon reporting schemes corresponds with a 60.9 to 129.4 percent decrease in emission growth and undertaking a carbon assurance engagement is associated with a 29.6 to 146.5 percent decrease in Scope 1 emissions growth. In addition, the strength of reporting scheme weakens the negative relation between carbon policy risk and emissions growth. Meanwhile, undertaking a carbon assurance engagement weakens the negative association between carbon policy risk and emissions growth across the 1-5 year time horizons but strengthens the negative relation between the cost of debt financing and emissions growth over the 3 year time horizon.

Contrary to what has been found from prior analyses, large companies, and companies with greater capital investment in the U.S. sample, are associated with an accelerating growth rate of Scope 1 emissions. However, setting up emissions reduction targets helps a company to reduce emissions growth by 16.4 percent in 3 years and 45.1 percent in 5 years.

TABLE 6-11 The Association Between Carbon Policy Risk, the Cost of Debt and Scope 1 Carbon Emissions Growth

Panel A: Non-U.S. Sample

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISK	0.003	-0.029*	-0.025*	-0.014	-0.005
	(0.23)	(-1.34)	(-0.91)	(-0.33)	(-0.08)
COD	-0.008	-0.071*	-0.106*	-0.090	-0.535
	(-0.08)	(-0.53)	(-0.60)	(-0.31)	(-1.16)
REPI	-0.050	-0.064	-0.185***	-0.142**	0.056
	(-0.91)	(-0.80)	(-1.68)	(-0.82)	(0.18)
ASU	0.255*	-0.330	-0.060	-0.009	0.186
	(1.29)	(-1.18)	(-0.17)	(-0.02)	(0.24)
RISKCOD	-0.002	-0.002	-0.001	-0.003	0.022
	(-0.32)	(-0.22)	(-0.13)	(-0.19)	(0.83)
CODREPI	0.022**	0.036***	0.027**	0.012	-0.005
	(2.37)	(2.72)	(1.47)	(0.46)	(-0.12)
CODASU	0.010	0.057*	0.177***	0.225**	0.172
	(0.30)	(1.20)	(2.74)	(2.60)	(1.29)
RISKREPI	0.001	0.001	0.009*	0.007*	-0.003
	(0.31)	(0.22)	(1.24)	(0.56)	(-0.14)
RISKASU	-0.020**	0.016	-0.016	-0.025	-0.037
	(-1.50)	(0.87)	(-0.69)	(-0.73)	(-0.73)
SIZE	0.008	0.008	-0.017*	-0.031**	-0.126***
	(0.64)	(0.47)	(-0.72)	(-0.86)	(-2.23)
ROA	0.402*	0.749**	0.308	-1.015	0.719
	(1.80)	(2.25)	(0.60)	(-1.33)	(0.62)
LEV	-0.059	0.115	-0.174	-0.516	-0.238
	(-0.47)	(0.63)	(-0.73)	(-1.57)	(-0.48)
NEW	0.035	0.037	0.196	0.503	0.757
	(0.35)	(0.25)	(1.02)	(1.86)	(1.78)
CAPIN	0.079	0.168	-0.040	-0.508	-1.353
	(0.65)	(0.96)	(-0.17)	(-1.44)	(-2.24)
CSRC	0.058	0.217	-0.038	0.005	-0.239
	(0.78)	(1.66)	(-0.18)	(0.02)	(-0.50)
REDT	0.044	0.005	-0.024	-0.015	-0.027
	(1.15)	(0.09)	(-0.33)	(-0.14)	(-0.16)
REDP	-0.048	-0.035	0.000	0.057	0.123
	(-0.81)	(-0.41)	(0.00)	(0.34)	(0.48)
REW	0.015	0.001	0.057	0.006	0.112
	(0.44)	(0.03)	(0.90)	(0.06)	(0.85)
constant	-0.212	0.195	0.956***	1.056***	2.511
	(-0.68)	(0.43)	(1.54)	(1.15)	(1.80)
Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	1,352	1,029	760	510	308
R-sq	0.0246	0.0442	0.0823	0.0935	0.1125

Panel B: U.S. Sample

	Dep. Var. =				
	D1LSC1	**D2LSC1**	**D3LSC1**	**D4LSC1**	**D5LSC1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
RISK	-0.214***	-0.347***	-0.429***	-0.376***	-0.326***
	(-4.22)	(-5.12)	(-5.91)	(-3.58)	(-6.58)
COD	-0.100	-0.126	-0.231	0.077	-0.556**
	(-0.56)	(-0.50)	(-0.87)	(0.21)	(-2.45)
REPI	-0.623***	-1.087***	-1.294***	-0.609	
	(-3.04)	(-3.88)	(-4.28)	(-1.34)	
ASU	-0.296*	-0.613***	-0.547**	-1.277***	-1.465***
	(-1.87)	(-2.69)	(-2.17)	(-3.59)	(-2.94)
RISKCOD	0.000	0.000	0.000**	0.000**	0.001**
	(0.56)	(1.23)	(2.41)	(2.11)	(2.39)
CODREPI	0.000	0.000	-0.000	-0.002	
	(0.33)	(-0.03)	(-0.09)	(-1.36)	
CODASU	0.000	-0.000	-0.001**	-0.001	-0.001
	(0.21)	(-0.67)	(-2.13)	(-0.89)	(-1.18)
RISKREPI	0.043***	0.068***	0.082***	0.043	
	(2.93)	(3.33)	(3.67)	(1.25)	
RISKASU	0.026**	0.054***	0.056***	0.110***	0.133***
	(2.22)	(3.18)	(2.97)	(4.00)	(3.41)
SIZE	0.065***	0.090***	0.093***	0.131***	0.190***
	(3.47)	(3.41)	(3.24)	(3.15)	(3.07)
ROA	0.345	0.327	0.126	0.717	-0.686
	(1.39)	(0.76)	(0.26)	(1.07)	(-0.61)
LEV	0.163	0.062	0.003	0.209	-0.022
	(1.33)	(0.33)	(0.01)	(0.69)	(-0.05)
NEW	-0.003	0.088	0.487**	0.352	0.290
	(-0.02)	(0.46)	(2.35)	(1.17)	(0.64)
CAPIN	0.475**	0.630**	0.380	0.930**	1.361**
	(2.41)	(2.20)	(1.23)	(2.12)	(1.98)
CSRC	-0.019	0.012	-0.055	-0.002	0.199
	(-0.30)	(0.11)	(-0.38)	(-0.01)	(0.68)
REDT	-0.007	-0.072	-0.164**	-0.315***	-0.451***
	(-0.15)	(-1.17)	(-2.44)	(-3.16)	(-2.98)
REDP	-0.051	0.008	0.090	0.089	0.069
	(-1.16)	(0.13)	(1.34)	(0.91)	(0.46)
REW	-0.054	-0.099**	-0.056	-0.112	-0.084
	(-1.55)	(-2.00)	(-1.05)	(-1.44)	(-0.73)
constant	1.817**	3.528***	4.522***	2.845*	1.007
	(2.42)	(3.51)	(4.22)	(1.86)	(0.93)
Country	N	N	N	N	N
Industry	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Observations	1,024	767	553	361	222
R-sq	0.0867	0.1526	0.2558	0.3353	0.4072

*, **, *** Denote significance at the 0.10, 0.05, and 0.01 levels, respectively.
Table 6-11 presents regression results of Equation (1) between the non-U.S. and the U.S. samples. Panel A reports the results using the non-U.S. sample. The dependent variables are the percentage change in Scope 1 emissions over 1,2, 3, 4,,and 5- year time horizons in Columns (1)- (5), respectively. Panel B reports the results using the U.S. sample. The dependent variables are the percentage change in Scope 1 emissions over 1 ,2 ,3 ,4,,and 5- year horizons in columns (1)- (5), respectively.
All variables are defined in text.

6.7 Conclusions

This study examines the impact of carbon policy risk and the cost of debt financing, and the moderating effects of the strength of the carbon reporting schemes and the undertaking of an assurance engagement, on a company's carbon emissions growth. Countries have been setting up emissions reduction targets under the TPA, while companies accounted for 70 percent of the global emissions (CDP, 2017). In the carbon context of a company, carbon policy risk arises when a gap exists between a company's carbon performance and its host country's emissions reduction target. Whether companies identify and manage such risks is, as yet, unknown. In addition, financial institutions are an important fund provider for companies and they play a key role in assessing and monitoring the borrowing companies' carbon management practices (e.g., Busch and Hoffmann, 2007; Cogan et al., 2008; Herbohn et al., 2019). Little is known as to whether and how financial institutions' assessment of a borrowing company's carbon profile impacts on the company's carbon emissions growth.

Two variables of interest have been identified. First, a carbon policy risk variable is constructed using data collected at both the country and company level as in the prior two studies of the thesis. Second, there is a cost of debt variable which has been hand collected from the Dealscan database. The results from the main analyses demonstrate that companies have been able to identify carbon policy risk and work towards mitigation of such risk by reducing emissions growth, especially for large companies. In addition, the evidence that the cost of debt financing serves as a mechanism to motivate companies to slow down emissions growth suggests that financial institutions have been building capacity to influence and monitor companies' carbon management systems. Nevertheless, attention should also be focused on the moderating effects of the strengthening of carbon reporting schemes at the country level and the undertaking of carbon assurance engagements at the company level, which could potentially weaken the desired negative association between carbon policy risk, the cost of debt financing and a company's carbon emissions growth. Results from this study suggest that the alignment of reduction targets between a company and its host country could potentially be an effective mechanism to facilitate the attainment of a country's commitments in terms of carbon emissions reduction.

CHAPTER 7 CONCLUSIONS

7.1 Introduction

Climate change mitigation is a global issue that transcends an individual country or company domains. A coordinated effort at the global level needs to be summoned and sustained to slow down the rate of environmental degradation. This thesis provides empirical evidence with regard to the role of accounting, credibility enhancement mechanisms (including assurance), and financial institutions, in climate change mitigation at both the country and the company levels. Public interest theory and GAL at the country level advocate the relevance of accounting and assurance in establishing reporting metrics and accountability for countries to reduce carbon emissions. Institutional theory enables the highlighting of the internal regulatory differences across countries in terms of the reporting metrics and accountability in carbon emissions reduction.

There is an extensive literature covering the nexus between economic growth, energy consumption and carbon emissions growth at the country level. There is also an abundance of research that investigates the association between carbon emissions, regulatory schemes and carbon disclosure at the company level. Little empirical research however has been undertaken examining the contribution of accounting and credibility enhancement mechanisms to climate change mitigation. The practical significance and regulatory momentum in relation to climate change mitigation have led to the need to learn about the impact of regulatory reporting schemes and credibility enhancement mechanisms to articulate countries' accountability and understand companies' operations during the transition to a lower carbon economy.

To identify and examine the role of accounting and credibility enhancement mechanisms at the country and company level, a theoretical framework was first constructed that depicts the significance of accounting and credibility enhancement mechanisms (including assurance) in providing metrics and measurement, promotes regulatory efficiency, and establishes accountability in the setting of a global goal for carbon emissions reduction. Second, I factor in the variations of the carbon related reporting schemes across countries and measure the strength of the regulatory environment to proxy for the institutional differences emphasized in the theoretical framework. Third, I utilize the UNFCCC GHG database that consolidates countries' reported carbon information in time series and the CDP database that collates companies' reported carbon information across countries. These form an appropriate setting to empirically test the issues addressed in this thesis. In addition, by proxying for carbon policy risk by using the unique data set employed in the thesis and manually collecting the actual pricing of the cost of debt based on companies' debt financing portfolio, I further investigate the association between carbon policy risk, the cost of debt financing and carbon emissions growth, in order to better understand the role of financial institutions in monitoring and motivating companies to reduce carbon emissions growth.

This thesis is comprised of three studies. Study One examines the impact of carbon reporting schemes and associated credibility enhancement mechanisms on carbon emissions growth at the country level. Study Two examines the impact of carbon reporting schemes and carbon assurance engagements on carbon emissions growth at the company level. Moreover, by considering the reporting schemes at the home and host countries of MNCs operations, Study Two assesses the effects arising from varied institutional environments on MNCs' aggregated carbon emissions growth. Study Three investigates whether and to what extent carbon policy risk and the cost of debt financing are associated with companies' carbon emissions growth, and the interaction effects between the primary variables of interest, carbon policy risk and the cost of debt, and carbon reporting schemes and carbon assurance engagements. As a package these studies provide empirical evidence which identifies the potential benefits and costs associated with carbon accounting and credibility enhancement mechanisms in a global regulatory setting.

The three studies in this thesis have connected theories and methodologies. First, although carbon emissions research at the country and company level occupy distinctive domains, the theoretical framework in this thesis depicts the relations underlying the role of accounting and related credibility enhancement mechanisms across the country and company level and synthesizes the benefits of a simultaneous assessment. Second, the three studies share a common dependent variable, that is, the carbon emissions growth. It measures the rate of change of carbon emissions levels, which indicates the growth pattern of carbon emissions. It tests how sensitive the rate of change of emissions is to placing an emphasis on the reliability of reported carbon emissions. As such, the three studies inform and complement each other to assist in the depiction of a picture in understanding how accounting and credibility enhancement mechanisms play a role in the issue of climate change mitigation.

7.2 Key Findings

This section provides a summary of the key findings from two perspectives. First, the potential benefits associated with accounting and credibility enhancement mechanisms in climate change mitigation are summarized in Section 7.2.1. Second, Section 7.2.2 discusses the findings of carbon policy risk and the cost of debt financing in relation to climate change mitigation. Section 7.2.3 concludes the key findings.

7.2.1 Key Findings on the Potential Benefits of Accounting and Credibility Enhancement Mechanisms in Climate Change Mitigation

Study One and Study Two share two common variables of interest, namely, the strength of carbon reporting schemes and related credibility enhancement mechanisms. These credibility enhancement mechanisms are represented by the presence of in-country expert review at the country level, and the undertaking of independent assurance engagements at the company level, respectively.

7.2.1.1 Thesis Study One

Study One examines whether and to what extent the strength of carbon reporting schemes and in-country expert review impact upon carbon emissions growth at the country level. Using a sample consisting of panel data from a total of 123 countries (1,600 country-year observations) reported to the UNFCCC for the period of 1990-2016, my results show that an increase in the strength of a reporting scheme contributes to reduce per capita carbon emissions growth by approximately 1 percentage point 10 years (exactly from the 7^{th} till 12^{th} year when additional year horizons are tested, refer to Section 4.5.1) after the reporting scheme came into force. In-country expert team reviews start to curb per capita emissions growth by approximately 2 percentage points five years afterwards (exactly from the 3^{rd} till 15^{th} when additional year horizons are tested, refer to Section 4.5.1) and the mitigating effect continues until the 15th year.

The curbing effect of the strength of carbon reporting schemes and in-country expert review on carbon emissions growth is found to be robust to alternative measures of environmental regulation and of carbon emissions growth. Inclusion of the difference between countries' self-reported and scientific estimated carbon emissions as the dependent variable presents inconsistent evidence as to the effect of the strength of reporting schemes, but provides robust evidence of the efficacy of the presence of in-country expert reviews as a credibility enhancement mechanism. The results suggest that merely reporting, and an increase in the credibility of reported information, might be among the first few critical steps in the implementation of carbon emissions reduction policies. While carbon reporting schemes are relevant in climate change mitigation (Lorente and Álvarez-Herranz, 2016), the presence of a credibility enhancement mechanism could be playing a more significant role in slowing down the reported growth in carbon emissions.

7.2.1.2 Thesis Study Two

Study Two separately identifies the strength of reporting schemes at the home and host countries of the MNCs and examines whether and to what extent the strength of carbon reporting schemes and carbon assurance engagements impacts upon carbon emissions growth at the company level. Multilevel regression results show that more stringent carbon reporting schemes in both home and host countries are modestly effective in curbing Scope 1 emissions growth 2 years after becoming effective. A carbon assurance engagement is significantly effective in reducing a company's Scope 1 emissions growth 2 years after the engagement and demonstrates an enduring effect.

The curbing effect of the strength of reporting schemes in the host country is slightly more pronounced than that in the home country, while the curbing effect of a carbon assurance engagement is found to be three times the strength of the reporting schemes. The positive interaction term over the 2 year and 3 year time horizons implies that there might be a trade-off between the strength of a reporting scheme and the undertaking of a carbon assurance engagement. The results from additional analyses do not present evidence of an effect from engaging different types of assurance practitioners or of adopting different assurance standards contributing to slow down carbon emissions growth.

The regression results also suggest that the setting of reduction targets by companies is effective in curbing Scope 1 emissions growth, consistent with the findings of Matsumura et al. (2014). The time horizon analyses enable the study to identify that the curbing effect starts to take place two years after a target is set. Moreover, this study finds that the implementation of a company emissions reduction policy is effective in monitoring and managing Scope 1 emissions reductions within the 1- and 2-year time horizons.

7.2.2 Key findings of Carbon Policy Risk and the Cost of Debt Financing on Climate Change Mitigation

7.2.2.1 Thesis Study Three

Study Three investigates the association between carbon policy risk, the cost of debt financing and carbon emissions growth. Means comparison descriptive results indicate that companies in the high carbon policy risk group are associated with a higher level of Scope 1 emissions but a lower level of Scope 2 emissions and a lower sum of Scope 1 and 2 emissions, and are more likely to have carbon assurance engagements undertaken, but are charged with a lower cost of debt. Companies charged with a higher cost of debt financing are based in countries with less stringent carbon reporting schemes and are associated with lower Scope 2 emissions, lower carbon policy risks and are less likely to undertake carbon assurance engagements.

Regression results suggest that both carbon policy risk and the cost of debt financing are associated with a slowing down of carbon emissions growth. Inclusion of the two variables of interest do not diminish the curbing effect of the strength of carbon reporting schemes, nor does it curb the effect of undertaking a carbon assurance engagement. However, the moderating effect of the strength of carbon reporting schemes at the country level and undertaking a carbon assurance engagement at the company level could potentially weaken the desired negative association between carbon policy risk, the cost of debt financing and a company's emissions growth. In comparison to the results using the non-U.S. sample, that of the U.S. sample demonstrates a significant and persistent effect from the undertaking of carbon assurance engagements in slowing down carbon emissions growth.

7.2.3 Summary of Key Findings

Overall, the results of the three thesis studies demonstrate the benefits of carbon accounting and credibility enhancement mechanisms at both the country and company level in safeguarding the credibility of reported carbon information and how they could be critical in effectively addressing the issue of climate change mitigation. First, in-country expert reviews as a credibility enhancement mechanism display significant and persistent curbing effects on carbon emissions growth and mitigating effects on the difference between reported and estimated carbon emissions at the country level. Second, the undertaking of carbon assurance engagements is significant, consistent, and enduring in curbing carbon emissions growth at the company level. Third, there is a negative and significant association between the strength of carbon reporting schemes and carbon emissions growth at both the country and company level.

Additionally, this thesis shows that carbon policy risk and the cost of debt financing are negatively related to carbon emissions growth at the company level, thus highlighting companies' voluntary alignment with carbon emissions reduction targets set at the country level. This role could be undertaken by financial institutions in facilitating the attainment of carbon emissions reductions.

7.3 Key Contributions

This thesis makes the following contributions:

7.3.1 Contributions to the Literature

First, this thesis extends public interest theory and GAL to the climate change mitigation setting and constructs a theoretical framework that emphasizes carbon accounting and credibility enhancement mechanisms at the country level. The thesis answers the call for macroeconomic evidence of the benefits of regulatory disclosures (Leuz and Wysocki, 2016). Second, this thesis contributes to country level carbon emissions research and substantiates the evidence that reliance on economic development to mitigate environmental degradation is questionable and consumes significant time. Accounting and credibility enhancement mechanisms (including independent assurance engagements) can be considered as integral parts of and environmental policy and a regulatory framework that can facilitate carbon reduction within a reasonable time period.

Moreover, this thesis adds to the international business literature regarding the varied regulatory effects arising from MNC's operations in the home versus host countries on companies' aggregate environmental performance outcomes from carbon emissions growth. In addition, this thesis fills a gap in the company level carbon emissions research through addressing the issues covering regulatory disclosure effects and the undertaking of carbon assurance engagements relating to carbon emissions growth. A newly constructed carbon policy risk measure that disaggregates countries' emissions reduction targets set at the company level is applied to test the efficacy of the risk measure in terms of carbon emissions growth (UNEP-FI, 2019b). The empirical results support its relevance in the measurement of companies' carbon risk portfolios.

7.3.2 Practical Contributions

First, this thesis takes advantage of the UNFCCC data and provides evidence relating to the functions of formulating the accounting and credibility enhancement mechanisms at the country level. It highlights the practical relevance for such a global governing body as the UNFCCC tackling the global risks associated with the difficulties of climate change mitigation. Based on the normative approach, there is a fundamental support in the academic literature that accounting, and credibility enhancement mechanisms such as independent assurance engagements maintain discipline over metrics and measurement, and build up accountability. This thesis presents empirical findings for the efficacy of carbon accounting and related credibility enhancement mechanisms at the country level.

Second, the empirical analyses in this thesis provides reporting entities with the benefits arising from the undertaking of credibility enhancement mechanisms such as independent expert reviews and carbon assurance engagements. Specifically, the curbing effects of these credibility enhancement mechanisms at the country and company level are significant and persistent: their effect is found to be double that of the strength of the reporting schemes at the country level with time horizons spanning from 3-15 years; and triple that of the strength of the reporting schemes at the company level with time horizons spanning from 2-4 years. There is scope for assurance practitioners to use this evidence to promote the benefits of credibility enhancement mechanisms (including assurance engagements), not only through their increasing the credibility of reported information, but also through their enhancing internal carbon management systems in view of an anticipated decline in carbon emissions growth.

Third, the results from this study should be of interest to MNCs. The diverse carbon regulatory landscape across their operations in multiple countries presents challenges for MNCs to accurately identify and evaluate policy implications, and to formulate relevant strategies. The curbing effects of reporting schemes at the home and host countries on MNCs' carbon emissions growth is similar, with a negative effect slightly more pronounced in the host countries. This finding needs to be considered in the light of the limitations outlined later in this chapter, but it could be relevant to MNCs' plans to proactively address regulatory differences in the interests of attaining better carbon performance in terms of emissions reductions.

Fourth, the results from this thesis provide important information as to the benefits of setting carbon emissions targets in general. Specifically, Study Three finds evidence that companies have been considering and incorporating emissions reduction targets set at the country level into their internal carbon management systems. Study Two identifies that the effects of setting up reduction targets and policy carry-over to different time horizons. While a carbon emissions reduction policy can be more immediate in slowing down carbon emissions growth, an emissions reduction target has a prolonged effect on sustaining carbon emissions reduction.

7.3.3 Regulatory Contributions

First, the TPA ratified under the governance of the UNFCCC has specified the first stock take of a global GHG inventory will be in 2023 and every five years afterwards. This thesis provides timely empirical evidence as to the functions of the UNFCCC in formulating accounting and credibility enhancing mechanisms targeted at reporting entities at the country level. Specifically, the time horizon analyses provide for the thesis to identify the sustaining (from the 3rd to 15th year horizons), and to identify the more significant (double the economic magnitude) negative effects of credibility enhancement than the carbon reporting schemes relating to carbon emissions growth. The results inform the UNFCCC regarding the effects of the global momentum underlying a transition to a mandatory carbon reporting regime for carbon emissions reduction.

Second, national regulators could place a greater emphasis on the requirement for carbon assurance for company level reporting entities to ensure that country level reduction targets could be more efficiently attained. In addition, the enduring effects of assurance engagements could call for an extended time interval in between a company's undertaking of carbon assurance engagements. Meanwhile, national regulatory bodies should focus attention on the tradeoff effects between the strength of reporting schemes and a company's undertaking of carbon assurance engagements in attaining emissions reduction targets.

Third, in 2019, 33 leading central banks created the Principles for Responsible Banking which promotes the banking industry as playing a leading role in attaining the goals expressed in the Sustainable Development and the TPA. The central banks need to achieve climate neutrality within a year of joining and they are publicly accountable for their impact and for the progress made towards meeting their commitments. The findings in this thesis regarding the negative relation between the cost of debt financing and carbon emissions growth inform financial institutions as to their capacity to contribute to curbing carbon emissions growth and thereby to the transition to a lower carbon economy.

7.4 Limitations

The results from this thesis should be interpreted in the light of the following limitations. Where appropriate, I have addressed the limitations through research design, sensitivity analyses to address the impact of research design choices, and additional analyses to explore further issues. Nevertheless, there remain the following limitations.

7.4.1 Sample Selection

The sample selected is constrained for the following reasons. First, disparate requirements prescribed under the UNFCCC for, and the incommensurate reporting capacity of, the Annex I and non-Annex I countries results in an unbalanced sample being collected at the country level. Although there are 123 countries included in the analysis, the Annex I country group represents a significantly more comprehensive dataset than the non-Annex I country group. Also, as outlined in Chapter Four, the absence of an in-country expert review for the non-Annex I countries restricts the empirical results covering credibility enhancement mechanisms to only the Annex I country group.

Second, although CDP is a well-recognized research database in the academic literature, the sample is restricted to larger companies. Therefore, the companies reporting to CDP may not be representative of a country's industry and/or business portfolio. Moreover, the CDP sample is comprised primarily of U.S. and UK.

companies, while there is a lack of data from developing countries that are, in turn, the biggest emitters worldwide (e.g., China and India).

Third, devising a cost of debt financing variable for Study Three has resulted in a loss of approximately half the observations in the sample collected for Study Two. More than half of the sample remaining is thus comprised of U.S. companies. Therefore, my result should be read in the context of this limitation, and the reader will need to exercise caution if extrapolating and generalizing the results to a population of countries/companies not represented in my sample.

7.4.2 Endogeneity

A common challenge faced by archival studies is the concern of endogeneity[173].. The studies in my thesis are not an exception. Two key issues when assessing the effect of the strength of carbon reporting schemes and credibility enhancement mechanisms on both countries' and companies' carbon emissions growth are: 1) simultaneity/omitted variable bias: namely, that these issues are jointly determined by an underlying factor, and 2) assessing the construct of reporting scheme strength without any statistical measurement error is difficult. I have attempted to find an instrumental variable to potentially address these endogeneity concern. However, identification of a proper instrumental variable at either the country or company level presents significant challenges. It has proven difficult to find suitable variables that cause strong enough variation in reporting scheme strength and credibility enhancement mechanisms, but also do not have a direct effect on carbon emissions growth at the country and company level.

[173] Larcker and Rusticus (2010) contend that instrumental variable estimation is considered a promising econometric approach next to the ideal instrument that is the result of a "natural experiment". However, this is conditional on having a valid instrument that is predicted to affect the independent variable, and is not correlated with the second-stage error term.

Instead, this thesis adopts the following approaches to mitigate endogeneity concerns. The three studies use the rate of change of carbon emissions as the dependent variable; Study One uses a first differencing change model that could be considered as controlling for all observable and unobservable time invariant differences between countries (Larcker and Rusticus, 2010); Study Two adopts a multilevel methodology in an attempt to rule out the concern over potential correlation between the strength of reporting scheme and the omitted variable at the country level and between the undertaking of a carbon assurance engagement and the omitted variable at the company level. Two variables of interest employed in Study Three to a certain extent alleviate the concern over potential correlation between the carbon policy risk, cost of debt financing and the omitted variable at the company level. Specifically, *RISK* which measures the carbon policy risk is constructed in the first stage where a company's share of emissions reduction is disaggregated from country level GHG emissions reduction targets (rather than a self-reported emissions reduction); and *COD* which measures the cost of debt financing does not adopt a company's reported interest expenses as a proxy, but uses the market pricing on a company's individual debt facilities.

While I believe that these research design features do help mitigate concern regarding the endogeneity issues of the studies in this thesis, I cannot rule out these concerns completely.

7.5 Future Research Opportunities

There are potentially fruitful opportunities for future research. First, there are exciting opportunities regarding the availability of assessed national inventory reports from Annex I countries and the availability of more consistently reported carbon information from the non-Annex I countries. The UNFCCC conducts technical reviews to assess the transparency and completeness of the biennial reports submitted from the Annex I countries since 2014 (UNFCCC, 2012). Future studies could explore and provide empirical evidence regarding the quality of a country's carbon disclosures and its determinants. Given the unbalanced data set collected in this thesis between the Annex I and non-Annex I countries groups, future research could yield benefits from examining the impact of carbon reporting schemes in the non-Annex I countries on carbon emissions growth.

Second, there are types of credibility enhancing mechanisms (for instance, internal audit, third-party comments, and combined assurance) that can be further examined in addition to independent assurance engagements at the company level. For instance, combined assurance which coordinates the assurance of management, internal assurance providers, and external assurance providers serves the purpose of carbon disclosures as to ensure the quality of information used for internal management and external reporting (Decaux and Sarens, 2015; Zhou et al., 2019). Future studies could investigate the impact of combined assurance on carbon emissions growth. Moreover, as observed in the sample of this thesis, while the two types of assurance providers (audit firm versus other assurance provider) seem to equally account for the assurance market on a global scale, their market shares differ within each country. Financial audit research suggests that the higher quality auditors' market share is positively associated with clients' earnings quality (Francis, Michas, and Seavey, 2013). It would be interesting to understand the relation between the market share of each type of assurance provider across countries and the assurance quality in curbing carbon emissions growth.

Third, while Study Three examines the association between carbon policy risk, the cost of debt financing, and carbon emissions growth to be consistent with the themes of this thesis, it would also be beneficial to examine the impact of carbon policy risk and carbon emissions growth on the cost of debt financing to present comprehensive evidence of how financial institutions are incorporating carbon emissions reduction and carbon policy risk in their assessment of clients' carbon profiles.

Fourth, the International Federation of Accountants has recently released a climate- related financial disclosure standard that aligns with the conceptual framework of the International Financial Reporting Standard (IFAC, 2020). The development of the standard has been facilitated by the Impact Management Project, World Economic Forum and Deloitte with the effort of drawing together leading nonfinancial reporting organizations CDP, CDSB, GRI, IIRC and SASB to largely promote a comprehensive corporate reporting system and drive a greater consistency in reporting frameworks internationally. The standard extends on the TCFD framework and heightens the importance of carbon related disclosures in reporting on enterprise value. Future research could further explore the market reaction of companies' voluntary adoption of the TCFD framework or the alignment of their emissions reduction targets with the national commitments submitted under TPA. In addition, given that a large number of the world's leading companies has signed to support the TCFD framework (TCFD, 2021), the analysis of the content of their issued reports prepared in accordance with this reporting framework, and any decision-making consequences arising from these revised disclosures present exciting opportunities with the potential in generating fruitful future research.

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APPENDIX A DEFINITION OF VARIABLES FOR STUDY ONE

Variable	Definition
Dependent variable	
$\%\Delta_i GHGPC_{j,t}$	measured in the form of $\frac{GHGPC_{j,t+i} - GHGPC_{j,t}}{GHGPC_{j,t}}$, which is the growth rate of the GHG emissions per capita for country *j* in year *t*+i (i=5,10,15) from year *t*. $GHGPC_{j,t}$ is calculated as the GHG total without LULUCF (in metric tonnes CO_2 equivalent) divided by the total population for country *j* in year *t.* (Source: the UNFCCC GHG database).
$\%\Delta_i CO2_{j,t}$	measured in the form of $\frac{CO2_{j,t+i} - CO2_{j,t}}{CO2_{j,t}}$, which is the growth rate of the CO_2 emissions per capita for country *j* in year *t*+i (i=5,10,15) from year t. (Source: The World Bank, 2017).
$\%\Delta_i GHGSPC_{j,t}$	measured in the form of $\frac{GHGSPC_{j,t+i} - GHGSPC_{j,t}}{GHGSPC_{j,t}}$, which is the growth rate of the GHG emissions per capita for country *j* in year *t*+i (i=5,10,15) from year *t*. $GHGSPC_{j,t}$ is calculated as the GHG total with LULUCF (in metric tonnes CO_2 equivalent) divided by the total population for country *j* in year *t.* (Source: the UNFCCC GHG database).
TargetComp	the percentage of a given target that is completed at the end of the five-year horizon (2008-2012). (Source: the UNFCCC GHG database).
$\%\Delta_i EDG_{j,t}$	the difference between GHG emissions in year *t*+5, t+10, and t+15 and the GHG emissions in year *t* divided by the emissions in year *t* for country *j*. It is calculated as the percentage change in the emissions estimated using the EDGAR database for country *j* over the 5-, 10-, and 15- year time horizons. (Source: the EDGAR database, 2019).
$\%\Delta_i GHGEDG_{j,t}$	the difference between GHG emissions calculated by the EDGAR database and that reported to the UNFCCC over the 5-, 10-, and 15- year time horizons divided by the emissions reported to the UNFCCC for country *j* in year *t*. This measures the percentage deviation of reported emissions from uniform scientific estimates for country *j*. (Source: the EDGAR database, 2019).
Variables of interest	
$\Delta_i REP\_IND_{j,t}$	calculated as the difference between the reporting index for country *j* in year *t*+i (i=5,10,15) and that for country *j* in year *t*. The index constructed in this study specifically accounts for systematic variations of and measures the strength of the carbon-related reporting instrument formulated across countries. To provide a comprehensive picture of the jurisdictional arrangements that regulate the carbon reporting, following the Carrots and Sticks report (KPMG et al., 2016), this index integrates not only the schemes that directly requests the GHG emissions reporting but also the legislation or listing requirements that demands reporting of the Corporate Social Responsibility/non-financial information encompassing the environmental aspect. Based on the TCFD's (2017) final report on recommendations, the index accounts for the six factors of: 1) the regulatory type (equals 3 for legislation, 2 for code of conduct/guidelines, and 1 for initiatives); 2) reporting scope (equals 2 for environmental information and, 1 for sustainability information); 3) reporting nature (equals 2 for mandatory and 1 for voluntary); 4) geographical scope (equals 2 for national and 1 for sub-national); 5) industry sectors (equals 2 for all and 1 for specific); and 6) location (equals 2 for report to regulator and 1 for annual report) covered by the reporting instrument. For each of the reporting instrument extracted from the Sustainability reporting instrument worldwide database, a score is assigned to each of the six factors listed above. The index of each reporting instrument is computed as the addition of 6 scores obtained and then divided by the total score of 13. The index per reporting instrument is summed to specify all the reporting instruments in force in year *t*. This index is expressed using the equation $REP\_IND = \sum_{i=1}^{n} \frac{1}{13}(Type, Scope, Nature, Geographic, Industry, Location)$. (Source: The Carrots and Sticks Sustainability reporting instrument worldwide database and relevant government websites).
$\sum_{i=0}^{n} TEC\_REV_{j,t}$	measured as the total number of in-country expert reviews conducted for country *j* during the time period between year *t* and year *t*+i (i=5,10,15). An indicator that equals to 1 for the year when the country's submission is subject to an in-country review and issuance of an associated review report and 0 otherwise (Simnett et al. 2009; Moroney et al., 2012; Braam et al., 2016; Zhou et al., 2016). (Source: the UNFCCC GHG database.)

$\Delta_i CCLaw_{j,t}$	the difference between the number of climate change laws in country *j* in year *t*+i (i=5,10,15) and that in year *t*. (Source: The Climate Change Laws of the World database, 2017).
$\Delta_i CCPolicy_{j,t}$	the difference between the number of climate change policies in country *j* in year *t*+i (i=5,10,15) and that in year *t*. (Source: The Climate Change Laws of the World database, 2017).
$\Delta_i Litigation_{j,t}$	the difference between the number of climate change litigation cases initiated in country *j* in year *t*+i (i=5,10,15) and that in year *t*. (Source: The Climate Change Laws of the World database, 2017; Sabin Center / Arnold & Porter Kaye Scholer database, 2017).
Control variables	
TargetDiff	the targeted percentage reduction in carbon emissions from the base year level in 2008. (Source: the UNFCCC GHG database).
$\%\Delta_i GDPPCj,t$	the growth rate of the Gross Domestic Product per capita (GDPPC) in constant 2010 U.S. dollars in a country in year *t*+i (i=5,10,15) from year *t* and is measured in the form of $\frac{GDPPC_{j,t+i} - GDPPC_{j,t}}{GDPPC_{j,t}}$. (Source: The World Bank, 2017).
$\%\Delta_i EGUj,t$	growth rate of the energy use (in kg of oil equivalent per capita) (EGU) in a country *j* in year *t*+i (i=5,10,15) from year *t* and is measured in the form of $\frac{EGU_{j,t+i} - EGU_{j,t}}{EGU_{j,t}}$. (Source: The World Bank, 2017).
$\%\Delta_i EPCj,t$	the growth rate of the electric power consumption (in kWh per capita) in year *t*+i (i=5,10,15) from year *t* and is measured in the form of $\frac{EPC_{j,t+i} - EPC_{j,t}}{EPC_{j,t}}$. (Source: The World Bank, 2017).
$\Delta_i TRDj,t$	the difference between the trade (as a percentage of GDP) of country *j* in year *t*+i (i=5,10,15) from year *t*. (Source: The World Bank, 2017).
$\Delta_i URBj,t$	the difference between country *j*'s urban population as a percentage of its total population in year *t*+i (i=5,10,15) and that in year *t*. (Source: The World Bank, 2017).
$\Delta_i ROLj,t$	the difference between the rule of law index for country *j* in year *t*+i (i=5,10,15) and that in the year *t*. This index originates from Kaufmann, Kraay, and Mastruzzi (2009) and captures ''the perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.'' This variable ranges from a theoretical minimum of -2.50 to a maximum of 2.50. The median value over all countries in Kaufmann et al. (2009) is 0.0 (Andersen et al., 2006; Lamoreaux et al., 2015). (Source: World Governance Indicators, the World Bank, 2017).

APPENDIX B DEFINITION OF VARIABLES FOR STUDIES TWO AND THREE

Variable	Definition
Dependent variable	
$D_nLSC(k)_{i,t}$	This variable measures the rate of change of all the subsidiaries' disclosed emissions in Scope 1[174], Scope 2[175], and the sum of both Scope 1 and Scope 2 (i.e., k = 1, 2, and 1+2) generated and/or purchased by a company i over 1- to 5-year horizons, and is calculated as the difference between the logarithm of a company's sum of all subsidiaries' emissions in year t+ n (n = 1,2,3,4 and 5) and that in year t.
Variables of interest	
$REPI_{j,t}$	The reporting instrument index follows the KPMG et al.'s (2016) Carrots and Sticks and the TCFD's (2017) reports and integrates not only the schemes that directly request for the GHG emissions reporting but also the legislation or listing requirements that demands reporting of the Corporate Social Responsibility/non-financial information encompassing the environmental aspect. The index is coded as follows: 1) the regulatory type (equals 3 for legislation; 2 for code of conduct/guidelines; 1 for initiatives; and 0 otherwise); 2) reporting scope (equals 2 for environmental information; 1 for sustainability information; and 0 otherwise); 3) reporting nature (equals 2 for mandatory; 1 for voluntary; and 0 otherwise); 4) geographical scope (equals 2 for national; 1 for sub-national; and 0 otherwise); 5) industry sectors (equals 2 for all;1 for specific; and 0 otherwise); and 6) location (equals 2 for report to regulator; 1 for annual report; and 0 otherwise) covered by the reporting instrument. If there is no carbon-related reporting scheme entry into force in year t, a 0 score is assigned across the six factors. And the index for all the reporting instruments in force in country j in year t is the sum[176] of the index calculated for each reporting scheme: $\mathrm{REPI}_{j,t}$ = Σ13 ($Type$, $Scope$, $Nature$, $Geographic$, $Industry$, $Location$), n_i=1
$REPHM_{j,t}$	This variable measures the strength of the carbon reporting scheme in company i's home country in year t, thus adopting the base reporting scheme index $\mathrm{REPI}_{j,t}$ in company i's home country in year t weighted by the percentage of emissions disclosed in the home country j over the total of emissions reported by the company i in year t. Based on H1a, a negative sign is expected on the variable.
$REPHS_{j,t}$	This variable measures the strength of the carbon reporting scheme in company i's host countries in year t. It is calculated as the sum of the base reporting scheme index $\mathrm{REPI}_{j,t}$ in each of the host countries weighted by the percentage of emissions disclosed in the host country j over the total of emissions reported by the company i in year t. Based on H1b, a negative sign is expected on the variable.
$ASU_{i,t}$	An indicator variable that equals 1 when company i engages with assurance in the year t, and 0 otherwise. Based on H2, a negative sign is expected on the coefficient of the variable.
$REPHMASU_{ij,t}$	To test hypothesis H3b, an interaction term is calculated between two of the primary variables of interest $REPHS_{j,t}$ and $ASS_{i,t}$. It measures the weighted strength of the host country j's carbon reporting schemes when company i engages with assurance in the year t. Based on H3b, no sign is predicted on the coefficient of this variable.
$REPHSASU_{ij,t}$	To test hypothesis H3b, an interaction term is calculated between two of the primary variables of interest $REPHS_{j,t}$ and $ASS_{i,t}$. It measures the weighted strength of the host country j's carbon reporting schemes when the company i engages with assurance in the year t. Based on H3b, no sign is predicted on the coefficient of this variable.
$ACCT$	equals 1 if the company's carbon assurance provider is an audit firm, and 0 for all other assurance providers (i.e., engineering and consulting firms, certification bodies, and government agencies). There is a view that audit firm providers are superior assurance

[174] As defined by the GHG protocol (2004), Scope 1 refers to direct GHG emissions which arise from sources that are owned or controlled by the company.

[175] As defined by the GHG protocol (2004), Scope 2 GHG emissions are indirect emissions from sources that are owned or controlled by the company. Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by a company.

[176] It is due to the nature of the regulatory schemes. Once a regulatory reporting instrument becomes effective, it remains in force unless a specific amendment is passed to announce its termination.

	providers because they have globally pooled resources and training mechanisms to understand the evolving assurance market, and because they have reputational capital transferred from financial auditing services and stringent ethical and quality control frameworks governed by professional bodies (Power, 1997; Huggins et al., 2011; Simnett, 2012; KPMG, 2013, 2015, 2017, 2020; Zhou et al., 2016). A negative coefficient is anticipated for this variable.
$ISAE$	coded 1 if the ISAEs standards are quoted in the assurance reports alone or in conjunction with other assurance standards, and 0 otherwise. Over the past decade, the International Auditing and Assurance Standards Board has endeavoured to develop the best standards that are applicable to all assurance providers and facilitate the users' understanding of the assurance reports produced. The ISAE standards have therefore been revised to incorporate the recent evolvement of developments in the assurance of nonfinancial information. a negative coefficient is predicted for this variable.
$RISK_{i,t}$	This variable is a measure of carbon policy risk, calculated in two stages. The first stage disaggregates country level GHG emissions reduction targets to calculate a company's share of emissions reduction assigned to individual companies (UNFCCC, CDP). The second stage calculates the carbon policy risk using the total carbon cost estimated as Total cost = required GHG reduction amount × price per tCO2, where carbon pricing information is collected from the World Bank (2019), This variable is used to test H1. A negative sign is predicted for the coefficient of this variable.
$RISKTAX_{i,t}$	In the second stage of calculating the variable of interest *RISK* (refer to Section 6.3.1.1 for details), where Total cost = required GHG reduction amount × price per tCO2, the price per tCO2 uses the carbon tax data collected from the World Bank in this sensitivity test, instead of the carbon pricing under the ETS employed in the main analyses. This variable is used to test H1. A negative sign is predicted for the coefficient of this variable.
$RISKDIFF_{i,t}$	In the second stage of calculating the variable of interest *RISK* (refer to Section 6.3.1.1 for details), instead of calculating the Total cost = required GHG reduction amount × price per tCO2, *RISK* is proxied by the difference between a company's disaggregated share of emissions reduction assigned to individual companies and its reported emissions change from year t-1 to year t. This variable is used to test H1. A negative sign is predicted for the coefficient of this variable.
$COD_{i,t}$	This variable measures the cost of debt financing. Loan spread is measured as an all-in spread, drawn in the Dealscan database. It is defined as the amount the borrower pays in basis points over LIBOR, or LIBOR equivalent for each dollar drawn down. This measure adds the borrowing spread of the loan over LIBOR to any annual fee paid to the bank group (Valta 2012). Based on H4, a negative sign is anticipated for the coefficient of this variable.
$INTEXP_{i,t}$	The ratio of interest expense divided by total debt. Based on H4, a negative sign is anticipated for the coefficient of this variable.
$RISK_{i,t} * COD_{i,t}$	This is the interaction term between $CLIMRISK_{i,t}$ and $COD_{i,t}$, calculated to test H7. The cost of debt contributes to a strengthening of the negative relation between carbon policy risk and the carbon emissions growth of a company. A negative sign is predicted for its coefficient.
$RISK_{i,t} * REPI_{j,t}$	This is the interaction term between $CLIMRISK_{i,t}$ and $REPI_{j,t}$, calculated to test H2. The strength of the carbon reporting scheme strengthens the negative relation between carbon policy risk and carbon emissions growth of a company. Thus, a negative sign is predicted for its coefficient.
$COD_{i,t} * REPI_{j,t}$	This is the interaction term between $COD_{i,t}$ and $REPI_{j,t}$, calculated to test H5. The negative relation between the cost of debt and carbon emissions growth of a company is more pronounced in a country with more stringent carbon reporting schemes. Thus, a negative sign is predicted for its coefficient.
$RISK * ASU_{i,t}$	This is the interaction term between $CLIMRISK_{i,t}$ and $ASU_{i,t}$, calculated to test H3. The undertaking of carbon assurance moderates the negative relation between carbon policy risk and the carbon emissions growth of a company. The hypothesis does not predict a direction for the sign of this coefficient.
$COD_{i,t} * ASU_{i,t}$	This is the interaction term between $COD_{i,t}$ and $ASU_{i,t}$, calculated to test H6. The negative relation between the cost of debt and carbon emissions growth of a company when the company undertakes carbon assurance. Therefore, a negative sign is predicted for its coefficient.

Control variables	
$AUDT$	the summation of the audit environment and independent enforcement bodies developed by Brown et al. (2014) and applied in Preiato, Brown, and Tarca (2015). While prior studies use market and governance devised variables to proxy for country characteristics (e.g., Dhaliwal et al., 2012; 2014), Brown et al. (2014) developed a series of variables that detach audit environment from other noisier institutional factors at the country level. It is expected that the better the audit environment, the better the quality of assurance practices. Credible disclosed emissions data lays the foundation for better management of emissions reduction. A negative sign is anticipated for the coefficient of this variable.
$ENFR$	reflects "the level of resourcing of the regulators based on enforcement agencies' budget as a proportion of GDP or number of staffs per head of population". In response to Coffee's (2007) call for proxies that can directly measure the enforcement inputs and outputs to disentangle the element of enforcement from other institutional factors, Jackson and Roe (2009) constructed this measure to capture the public enforcement and supervisory activities in the securities markets. The better the enforcement by the regulatory bodies, the more likely it is that the implemented reporting schemes will be effective in achieving their purpose. I expect a negative sign for the coefficient of this variable.
EU	an indicator variable, which equals 1 when a company's base country is a member of the EU, and 0 otherwise. No sign is predicted on the coefficient.
$SIZE_{i,t}$	Proxy for company size. The natural logarithm of total sales of company i reported for the year t (e.g., Matsumura et al., 2014; Griffin et al., 2020). Consistent with prior findings, larger companies are more likely to disclose carbon emissions and are associated with higher levels of carbon emissions and thus greater carbon emissions growth. This variable is expected to have a positive coefficient.
$ROA_{i,t}$	Return on assets, a measure of financial performance, and specifically it measures the efficiency of assets in producing income (King and Lenox, 2001; Delmas et al., 2015). It is calculated as net income before extraordinary items of company i for the year t divided by the average of total assets at the beginning and the end of the year t (Christensen, 2016). A company's return on financial resources may affect its social and environmental performance. On the one hand, a sustained improvement in environmental performance may lead to improved future financial performance (Clarkson et al., 2011). On the other hand, more profitable companies are in a better position to expend on preparatory costs for carbon disclosures (Ott et al., 2017). In terms of carbon emissions levels, ROA is associated with higher carbon emissions (Delmas, Nairn-Brich, and Lim, 2015; Qian and Schaltegger, 2017; Busch et al., 2020). A positive sign is expected on the coefficient of the variable.
$LEV_{i,t}$	Measured as the ratio of long-term debts of company i to the average of total assets at the beginning and the end of the year t. Highly indebted companies are more likely or expected to have an interest of keeping creditors informed (Freedman and Jaggi, 2005; de Villiers et al., 2011; Cotter and Najah, 2012). However, while trying to construct companies' emissions estimation models, Griffin et al. (2017) presents evidence that highly leveraged companies are less inclined to disclose to the CDP. Thus, no sign is predicted on the coefficient.
$NEW_{i,t}$	An indicator for the age of the technology equipment a company uses. Calculated as the ratio of company i's net property, plant and equipment by gross property, plant, and equipment at the end of the year t. It is expected that companies with newer (possibly cleaner) equipment or facilities tend to have better environmental performance, and engage in greater disclosures (Clarkson et al., 2008; Peters and Romi, 2015). A negative sign is anticipated for this variable's coefficient.
$CAPIN_{i,t}$	Capital intensity, measured as the ratio of company i's total capital expenditures to total sales during the year t. Similar to the argument above, companies with greater capital expenditures are more likely to invest in carbon efficient technologies, thus slowing down emissions growth. A negative sign is anticipated for the variable coefficient.
$CSRC_{i,t}$	An indicator variable that equals 1 when company i has in place a sustainability committee as a subset or is appointed by the Board of Directors, 0 otherwise. While earlier research presents mixed findings on the relation between the presence of an environmental committee and environmental disclosure/ performance (Rankin et al., 2011; Rodrigue, Magnan, and Cho, 2013), Peters and Romi's (2015) highlights the role of an environmental

	committee in enhancing a company's environmental transparency. The variable is predicted to have a negative sign for the coefficient.
$REDT_{i,t}$	An indicator variable that equals 1 when company i sets an emissions reduction target in the year t, and 0 otherwise. Countries bound by such international protocols as the Kyoto protocol and TPA are required to establish a specified reduction target which hold them accountable for emissions reduction (UNFCCC, 2012, 2015). A voluntarily determined target implies the company's willingness to both signal and reduce emissions and it may facilitate a company's effort towards achieving its target. Thus, a negative sign is expected for the coefficient of this variable.
$REDP_{i,t}$	An indicator variable that equals 1 when company i has an established emissions reduction policy that is internally implemented in the year t, and 0 otherwise. A set target would not be effective without a proper policy implementation. That is, only through operational practice could a company's resources be directed to working towards target accomplishment (Matsumura et al., 2014). A negative sign is expected for the coefficient.
$REW_{i,t}$	This is an indicator variable that equals 1 when company i has a renewable energy policy that is internally implemented in the year t, and 0 otherwise. Innovative companies are more likely to pursue proactive investment strategies (Clarkson et al., 2011). Using renewable energy, it is expected to contribute significantly to reduce a company's carbon emissions growth. A negative sign is expected for the coefficient of this variable.

APPENDIX C CARBON RELATED REPORTING SCHEMES

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
Australia	1998	National Pollutant Inventory, 1998	The National Pollutant Inventory (NPI) requires industrial companies to report emissions and inventories for specific substances and fuel to regulatory authorities for inclusion in a public database.	Environment	Guidelines	Mandatory	National	Specific	Industrial companies- except those in the public sector	Report to regulator
	2001	Renewable Energy (Electricity) Act 2000	The objects of this Act are: (a) to encourage the additional generation of electricity from renewable sources; and (b) to reduce emissions of greenhouse gases in the electricity sector; and (c) to ensure that renewable energy sources are ecologically sustainable. This is done through the issuing of certificates for the generation of electricity using eligible renewable energy sources and requiring certain purchasers (called liable entities) to surrender a specified number of certificates for the electricity that they acquire during a year.	Environment	Legislation	Mandatory	National	All	All except those in the public sector	Report to regulator
	2001	Corporations Act – Sect 299, 2001	This act requires companies that prepare an Annual Directors' Report to specify whether the entity's operations are subject to any significant environmental regulations under state or national law. The report must also provide details of the entity's performance in relation to these environmental regulations.	Environment	Legislation	Mandatory	National	All	All except those in the public sector	Annual report
	2003	Listing Rule 4.10.3, Australian Stock Exchange (ASX); The Australian Securities and Investments Commission (ASIC) Section 1013DA Disclosure Guidelines, 2003.	ASX Listing Rule 4.10.3 applies to all companies listed on the ASX and requires companies to annually disclose the extent to which they have followed the recommendations set by the ASX Corporate Governance Council which include the establishment of a code of conduct on issues related to the community, pollution and environmental controls and how sustainability considerations have been integrated into the company's risk management process.	ESG	Legislation	Mandatory	National	All	All listed companies	Annual report
	2008	National Greenhouse and Energy Reporting Regulations 2008	The National Greenhouse and Energy Reporting (NGER) Scheme was introduced in 2007 to provide data and accounting in relation to	Environment	Legislation	Mandatory	National	All	All organizations except those in the public sector	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			greenhouse gas emissions and energy consumption and production. The Scheme's legislated objectives are to: •inform policymaking and the Australian public •meet Australia's international reporting obligations •provide a single national reporting framework for energy and emissions reporting. The Department of the Environment has formal oversight of the NGER Scheme and responsibility for tracking progress against Australia's target under the Kyoto Protocol. The Department will fulfill this role by ensuring that NGER Scheme legislation continues to support emissions reduction policies and by conducting research to inform policy makers and the public.							
	2010	Requirements under the Financial Services Reform Act (FSRA), 2010	In 2010 Australia introduced its new ethical disclosure requirements under the Financial Services Reform Act (FSRA). Issuers of financial products are obliged to disclose the extent to which "labor standards or environmental, social or ethical considerations are taken into account in the selection, retention or realization of an investment". Product issuers are required to make two separate Product Disclosure Statements (PDS): the first on labor standard considerations, the other concerning environmental, social and ethical deliberations.	ESG	Legislation	Mandatory	National	Specific	Large, listed companies- issuers of financial products	Annual report
	2011	Carbon Credits (Carbon Farming Initiative) Act, 2011; integrated into the Emission Reduction Fund	The first objective of the Act is to remove greenhouse gases (GHGs) from the atmosphere and avoid emissions of GHGs, in order to meet Australia's obligations under any or all of the following: (a) the Climate Change Convention / UNFCCC; (b) the Kyoto Protocol; (c) an international agreement that is the successor (whether immediate or otherwise) to the Kyoto Protocol (i.e., the 2015 Paris Agreement). The second objective of the Act is to create incentives for GHG offsetting projects. Its third objective is to increase carbon abatement in a manner that: (a) is consistent with the protection of Australia's natural environment; and (b) improves resilience to the effects of climate	Environment	Legislation	Voluntary	National	All	All reporting entities	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			change. Its fourth objective is to authorize the purchase by government of carbon abatement units.							
	2014	Corporate Governance Principles and Recommendations, 3rd Edition, ASX Corporate Governance Council, 2014.	The 2014 edition of the Guidelines include a new recommendation under Principle 7: Recognize the manage risk. Recommendation 7.4: A listed entity should disclose whether it has any material exposure to economic, environmental and social sustainability risks and, if it does, how it manages those risks.	ESG	Guidelines	Voluntary	National	All	Large, listed companies	Annual report
Austria	2003	Guidelines: Reporting about Sustainability, 2003	The voluntary guidelines are the result of a program initiated, developed and commissioned by Bundesministerium für Verkehr, Innovation und Technologies (BMVIT). The intention of the guidelines, which are addressed to all enterprises in Austria, is to standardize and facilitate reporting on sustainable management issues	ESG	Guidelines	Voluntary	National	All	All except those in the public sector	Annual report
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
Belgium	1995	Article 4.1.8 of VLAREM II, 1995.	It stipulates that certain companies have to issue an annual environmental report (only applicable for the region of Flanders).	Environment	Legislation	Mandatory	Sub-national	All	All organizations except those in the public sector	Annual report
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			and ratified for the European Union by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.							
Canada	2000	Canadian Environmental Protection Act (The National Pollutant Release Inventory (NPRI)); Canadian Environmental Protection Act (GHG reporting) North America Current 1999	As a part of the Canadian Environmental Protection Act, the National Pollutant Release Inventory (NPRI) is Canada's legislated, publicly accessible inventory of pollutant releases and transfers. NPRI data helps the Government of Canada to track progress in pollution prevention, evaluate releases and transfers of substances of concern, identify and take action on environmental priorities, conduct air quality modelling, and implement policy initiatives and risk management measures. Under section 46 of the Canadian Environmental Protection Act, the GHG Reporting Program applies to the largest industrial greenhouse gas emitters in Canada. All facilities that emit the equivalent of 50 kilotons or more of greenhouse gases in carbon dioxide equivalent units per year are required to submit a report.	Environment	Legislation	Mandatory	National	Specific	Largest industrial greenhouse gas emitters	Report to regulator
	2009	Building the Canadian Advantage: A Corporate Social Responsibility (NONFINANCIAL) Strategy for the Canadian International Extractive Sector, 2009.	As part of the Government of Canada's approach to encourage voluntary compliance with internationally recognized NONFINANCIAL tools and guidelines, the Government of Canada promotes GRI, which can help Canadian companies measure and manage their economic, environmental, social and governance performance. In turn, enhanced accountability and transparency through the reporting process can lead to good NONFINANCIAL performance and encourage market-based rewards for Canadian companies.	ESG	Guidelines	Voluntary	National	Specific	Companies in the Canadian International Extractive Sector	Annual report
	2010	Environmental Reporting Guidance, 2010. [CSA Staff Notice 51-333]	Canada's Securities Commission requires that public companies report on current and future financial and operational effects of environmental and social issues in their financial reporting. In 2010, the Canadian Securities Administrators issued Staff Notice 51-333	ESG	Guidelines	Voluntary	National	All	All listed companies	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			Environmental Reporting Guidance to provide guidance to reporting issuers about existing continuous disclosure requirements for environmental matters.							
	2014	NONFINANCIAL Implementation Guide for Canadian Business	This guide is a primer on corporate social responsibility. As such, it contains information on how to assess the effects of business activities on others, develop and implement a corporate social responsibility strategy and commitments, and measure, evaluate and report on performance and engage with stakeholders.	ESG	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report
Croatia (EU)	2013	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
Cyprus	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
	2013	National Action Plan for Corporate Social Responsibility	The Government has decided to proceed with the development of the National Action Plan (NAP) for 2013 – 2015 to promote, in a coordinated manner, the concept of Corporate Social Responsibility (NONFINANCIAL) in Cyprus, to encourage responsible	ESG	Plan	Voluntary	National	All	All organizations except those in the public sector	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			entrepreneurship and to motivate companies to take into account the impact of their activities on society.							
Czech Republic	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
Denmark	2001	The Danish Financial Statements Act, 2001	This Act required reporting on intellectual capital resources and environmental aspects in the management report, if it is material to providing a true and fair view of the company's financial position.	ESG	Legislation	Mandatory	National	All	All organizations except those in the public sector	Annual report
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
	2009	Financial Statements Act 2008-2012	2008: Amendment: Under this amendment, large businesses must account for their work on NONFINANCIAL in their annual reports (from the financial year 2009 and onwards). The aim is to inspire businesses to take an active position on social responsibility and communicate this.	ESG	Legislation	Mandatory	National	All	Large companies in accounting class C, listed companies and state-owned companies in accounting class D (according to the	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
									Financial Statements Act)	
	2013	Financial Statements Act 2008-2012	2013: This amendment has two key points: firstly, introducing mandatory reporting on climate change and human rights impacts and secondly, companies are required to set a target of the underrepresented gender in the Board of Directors and implement a diversity policy to increase the share of the underrepresented gender at other management levels	ESG	Legislation	Mandatory	National	All	Large companies in accounting class C, listed companies and state-owned companies in accounting class D (according to the Financial Statements Act)	Annual report
Estonia	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
Finland	1997	The Finnish Accounting Act, 1997	The Act requires certain companies to include material non-financial issues in the director's report of the annual/financial report and refers to the guidelines for good practice. The report shall include an assessment defining the key ratios necessary to understand operations and financial position, as well as the results of operations of the reporting entity. In addition, ratios and other information on personnel and environmental factors, and other potentially significant matters impacting on the operations of the reporting entity, need to be disclosed.	ESG	Legislation	Mandatory	National	All	Large companies (listed & unlisted)	Annual report
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.							
	2006	General guidelines for recording, accounting and disclosing of environmental issues, 2006.	The Finnish Accounting Board issued general guidelines for the recording, accounting and disclosing of environmental issues as part of the legally required financial statements. The guidelines are broadly based on the EU commission's recommendation 2001/453/EU and are to be interpreted to be a part of binding good accounting practice.	ESG	Legislation	Mandatory	National	All	All reporting entities	Annual report
	2011	Government Resolution on State Ownership Policy, 2011	The Finnish resolution asks non-listed state-owned companies and state majority-owned companies to report their sustainability performance in an accurate and comparable manner. The resolution provides information about the main practices of the state as an owner, and the guidelines for ownership within ministries.	ESG	Legislation	Mandatory	National	All	Non-listed state-owned companies	Annual report
	2014	National Action Plan for the implementation of the UN Guiding Principles on Business and Human Rights	Key aims for the action plan are the legislative support, definition of the due diligence obligation, and the application of social criteria in public procurement. Encourage companies to publish the non-financial data on the social and environmental impact of their activities. The Finnish corporate responsibility network FIBS act as a partner of GRI to register responsibility reports.	ESG	Plan	Voluntary	National	All	Companies who participate in public procurement	Annual report
France	2002	New Economic Regulations Act (NRE), 15 May 2001	In Article 116 of the New Economic Regulations (NRE) Act of 15 May 2001, it is stipulated that companies whose securities can be traded on a regulated market are required to publish information on the manner in which they address the social and environmental impacts of their activities. This information is to be included in their annual reports.	ESG	Legislation	Mandatory	National	All	Companies whose securities can be traded on a regulated market	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
	2010	Art 224, Grenelle Act II, 2010	Art 224 states that mutual funds have to mention in their annual report and their documentation how environmental, social and governance quality objectives have been taken into account in their investment policy. The report should explain which criteria have been assessed and how they are embedded in the decision-making process. It should also disclose how voting rights have been exercised. The decree established a presentation framework for all due information, such as: tools and methodology in place to take into account ESG objectives, ESG criteria used (including sector-specific), percentage of value of the mutual funds which take into account ESG criteria, and impact of the assessment on the investment and divestment process.	ESG	Legislation	Mandatory	National	Specific	Mutual Funds	Annual report
	2012	Art 225 Grenelle Act II, 2010	Article 225 of the Act makes corporate sustainability reporting mandatory for companies exceeding size thresholds. The legislation, passed in 2012, requires companies to include information on their environmental and social performance, including all of the company's subsidiaries, in their annual report—effectively turning it into the foundation for a full integrated report.	ESG	Legislation	Mandatory	National	All	All listed companies with an annual balance or turnover of 100 million Euros and an average of 500 permanent employees	Annual report
	2012	Code de l'Enivronnement, Livre II, Titre II, Article L229-25	Companies with more than 500 employees have to publish their scope 1 and 2 greenhouse gas emissions by 31 December 2012 at the latest, with an update at least every three years.	Environment	Legislation	Mandatory	National	All	Large companies (listed & unlisted) with above 500 employees	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
Germany	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
	2011	German Sustainability Code, 2011	The German Council for Sustainable Development passed the German Sustainability Code (GSC), which was sent to the German Federal Government with a recommendation for implementation. The code addresses companies of every size and legal form and is recommended to be used as a voluntary instrument. It features 20 indicators of sustainability performance that are aligned with the GRI Guidelines, the UNGC principles, the OECD Guidelines for Multinational Companies and the ISO 26000 Guidelines. The disclosures regard strategic analysis and measures, process management, environment, and society.	ESG	Guidelines	Voluntary	National	All	All organisations	Annual report
	2012	Bilanzrechtsreformgesetz (BilReG – Reform Act on Accounting Regulations), 2005.	The EU Modernization Directive (2003/51/EG) was transposed in Germany through the Bilanzrechtsre formgesetz (BilReG) and has led to amendments to §§ 289 and 315 HGB (Germany's commercial code). Beyond this Directive, the BilReG also demands reporting about chances for future developments, in addition to risk reporting to enhance the quality of the management report and to allow for target/performance comparisons. Effective for financial years beginning after December 31, 2012, the German Accounting Standard No. 20 'Group Management Report' (GAS 20) amends GAS 15 'Management Reporting'. If non-financial performance indicators are used for	ESG	Legislation	Mandatory	National	All	All organizations except those in the public sector	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			internal management, quantitative information on these indicators should be provided.							
	2013	Deutsche Börse AG Best Practice Guide on Sustainability Reporting, 2013	In 2013 the Deutsche Börse Group (stock exchange organization) published a Best Practice Guide with recommendations on a comprehensive approach to capital market communications regarding sustainability.	ESG	Guidelines	Voluntary	National	All	All listed companies	Annual report
Greece	2006	Law 3487, 2006	This law transposed the EU Modernization Directive 2003/51/EC into Greek national legislation. The Directive states that for companies which meet certain financial criteria, to the extent necessary for understanding the company's overall position/performance, the Annual Report (and Financial Statements) shall include financial and non-financial indicators (if deemed applicable/required) related to the company's business activity.	ESG	Legislation	Mandatory	National	All	Companies who: Exceed a Balance Sheet value of EUR 2.5 million; Exceed net sales of EUR 5 million ; Exceed average personnel number of 50 throughout the financial year	Annual report
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
Hungary	2004	Accounting Act, Act C, Section 95, 2000	The EU Modernization Directive (2003/51EC directive) was implemented in Hungary by Act XCIX, approved by the Hungarian Parliament in October 2004. The requirements of the directive were incorporated into the Accounting Act, Act C of 2000. There is no specific detailed guidance for reporting and assurance on these disclosures.	ESG	Legislation	Mandatory	National	All	All organizations except those in the public sector	Annual report
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.							
Iceland	2004	National Regulation on Green Accounting, 2002	The National Regulation on Green Accounting (Reg. 851/2002) amended Act No. 7/1998 on Hygiene and Pollution Control, to require companies operating in environmentally sensitive sectors to disclose environmental sustainability information related to their operations. The Act had already been amended in 2001 to make it mandatory for businesses in specific polluting industries to keep green accounting: material accounting with quantitative information on the status of environmental affairs.	Environment	Legislation	Mandatory	National	Specific	Companies operating in environmentally sensitive sectors	Annual report
	2013	Report of the Parliamentary Committee on the Strengthening of the Green Economy (Action 14), 2011	To address the Icelandic Parliament decision to actively work towards achieving a Green Economy, a Parliamentary Committee was set up with the objective of producing recommendations for a vision and policy. The Committee launched a report that includes 48 actions that will need to be implemented between 2013 and 2014. One of the actions is that all institutions of the respective ministries and all state-owned companies should publish annual reports using GRI's Framework.	ESG	Guidelines	Mandatory	National	All	Public sector and state-owned organizations	Annual report
Ireland	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			undertaking activities specified in Annex 1 to report on emissions and specific substances.							
	2012	Bord Bia Origin Green Quality Assurance Scheme	Launched in 2012, Origin Green is the national sustainability programme for the Irish food and drink industry. The programme operates on a national scale, uniting government, the private sector and food producers, through Bord Bia, the Irish Food Board. Independently verified at every stage, Origin Green enables Ireland's farmers and food producers to set and achieve measurable sustainability targets, reduce environmental impact and serve local communities more effectively.	ESG	Guidelines	Voluntary	National	Specific	Large companies and SMEs - farmers & food manufacturers	Report to regulator
	2014	Energy Efficiency Obligation Scheme, Statutory Instrument No. 131, 2014	This 2014 regulation transposes the relevant provisions of the 2012 EU Energy Efficiency Directive into Irish Law. The Scheme aims to assist in the delivery of Ireland's legal obligation to achieve new savings each year from 1 January 2014 to 31 December 2020 of 1.5% of the annual energy sales to final customers of all energy distributors and retails energy sales companies by volume.	Environment	Legislation	Mandatory	National	All	Large companies and state-owned entities - any energy distributor or retail energy sales company that has a market sales volume in Ireland of greater than 600 GWh per annum	Report to regulator
Italy	2002	The NONFINANCIAL-SC project, 2002	This initiative enables organizations to voluntarily participate and adopt a social report in accordance with pre-defined guidelines and indicators. Many chambers of commerce have help desks available to assist companies in implementing their reporting in accordance with the NONFINANCIAL-SC.	ESG	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report
	2005	Social Reporting in the Public Sector, 2005; Guidelines on reporting for the Public Administration, 2006	The Gruppo di Studio per il Bilancio Sociale (GBS) or Study Group for Social Reporting (GBS) was established in 1998 and developed Principles for Social Reporting which was published by 2001. It has also developed guidelines for the preparation of sustainability reports by the public sector, published in 2005.	ESG	Guidelines	Voluntary	National	Specific	Public sector organizations	Annual report
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.							
	2007	Legislative decree no. 32/2007; Directors' report on financial statements, 2009	The decree 32/2007 follows up the EU modernization directive (2003/51EC). It modifies Italian legislation, stating that companies shall provide a description of employee relations and environmental performance in the directors' report of financial statements.	ESG	Legislation	Mandatory	National	All	All organizations except those in the public sector	Annual report
	2010	The Guidelines for the Social Reporting for Non-Profit Organizations, 2010	Issued by the former National Authority for non-profit registered organizations (Agenzia per le Onlus), these guidelines recommend GRI's Framework regarding the adopted methodology.	ESG	Guidelines	Voluntary	National	All	Non-profit organizations	Annual report
	2011	Guidance by Ministry of Economic Development and National Contact Point for OECD Guidelines, 2011	The Italian Ministry of Economic Development and the National Contact Point (NCP) for the OECD Guidelines for Multinational Enterprises has developed a number of initiatives for the promotion of sustainability among Italian SMEs related to social responsibility (NONFINANCIAL) Key Performance Indicators (KPIs) and the OECD Guidelines. These include Due Diligence Guidelines for the Supply Chain, Promotion of the OECD Guidelines in the Textile Industry, and initiatives for enhancing the use of proposed NONFINANCIAL KPIs.	ESG	Guidelines	Voluntary	National	All	Large companies (listed/unlisted) and SMEs in particular	Annual report
	2014	The Social Reporting Standards, 2013	In 2014 the Gruppo di Studio per il Bilancio Sociale (GBS) published BGS 2013, updated Principles and Standards for Social (Sustainability) Reporting. Inspired by the history of preparing Social Balance Sheets, it addresses Corporate Governance, Value Added methodologies, social and environmental dimensions, as well as stakeholder engagement.	ESG	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2014	Operational Guidelines for adoption of GRI-based KPIs in the banking sector, 2014	The Italian Banking Association (ABI) has published guidelines in order to help Italian banks adopt the GRI Indicators in their social reporting. Specific to the financial sector, the guidelines contribute to standardized social reporting by the banking sector. In 2014 guidelines concerning the environmental indicators were published. Following that, the guidelines were updated in 2016 with reference to specific coefficients and key performance indicators (KPIs). The document should therefore be considered as a compendium of the ABI Lab guidelines on the application in the banking sector of the G4 indicators of the GRI Guidelines.	ESG	Guidelines	Voluntary	National	Specific	Companies in the banking sector	Annual report
Japan	1998	Law concerning the Rational Use of Energy (1979) and Act on Promotion of Global Warming Countermeasures, 1998	The energy conservation law was introduced in Japan in 1979 following the oil crises in the 1970s. Its law has served as the foundation of energy demand policy and has been revised many times. It among others addresses energy-related reporting by companies. It was followed by the Act on Promotion of Global Warming Countermeasures in 1998 (post-Kyoto climate conference) as the first climate-dedicated law in Japan. Under this legislation companies that consume a certain amount of energy are obligated to report the amount of energy consumption and greenhouse gas (GHG) emissions to government. The reported information is made public. Government has also issued the GHG Monitoring and Reporting Manual, which gives detailed guidance on how to calculate emissions. Many companies refer to this manual. The legislation has therefore indirectly helped increase the comparability of GHG data in sustainability reporting.	Environment	Legislation	Mandatory	National	All	All organizations that consume a certain amount of energy (more than 1,500kl (crude oil equivalent) of energy per year)	Report to regulator
	2005	Mandatory GHG Accounting System, 2005	Japan's Mandatory GHG Accounting System requires specified entities to calculate their GHG emissions and report the results to Government.	Environment	Legislation	Mandatory	National	All	All organisations meeting the requirement	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2011	Principles for financial action towards a sustainable society, 2011	The principles apply to all Japanese financial institutions. They provide a standard for financial institutions to follow with regard to various issues that imply human rights. These include matters such as the disclosure of corporate information, environmental and social risks, and supporting small and medium enterprises, as well as steps taken to maintain Japan's environmental performance and disaster readiness. Specifically, there are seven guidelines that provide general goals towards which Japanese financial institutions should strive.	ESG	Guidelines	Voluntary	National	Specific	Financial institutions	Annual report
	2012	Environmental Reporting Guidelines, 2012	Issued by the Ministry of the Environment, the Environmental Reporting Guidelines sets out definitions and calculation methods for reporting environmental performance indicators. Major revisions as of 2012 include the following: (1) If companies wish to report in accordance with the guidelines, they are required, among other things, to include summary lists and tables for major indicators; to report on the status of environmentally conscious investment or financing; and to report on the status of biodiversity conservation and sustainable use of biological resources. (2) Companies are recommended to take measures for improving the reliability of environmental reporting and prepare an environmental report with a greater focus on stakeholders' views.	Environment	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report
Kazakhstan	2007	Code on Corporate Governance, 2007	A chapter 9 on Environmental Protection also requires a corporate policy on this and applying due care. Application of the principles of the Code should therefore include the Environmental Protection.	ESG	Guidelines	Voluntary	National	All	All listed companies	Annual report
	2009	Stock exchange listing requirements, 2009	The annual report of a listed company must provide a balanced picture and include information about Social and Environmental Liabilities, Human Resource Management System, and Corporate Governance	ESG	Legislation	Mandatory	National	All	All listed companies	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2014	National welfare fund Samruk-Kazyna – Corporate governance code, 2014	Samruk-Kazyna is a sovereign wealth fund and joint stock company in Kazakhstan which owns, either in whole or in part, many important companies in the country. Holding companies are responsible for implementing the principles of sustainable development in the whole group. They need to publish sustainability reports annually.	ESG	Guidelines	Mandatory	National	All	All companies of the sovereign wealth fund	Annual report
Latvia	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
Liechtenstein	2013	Carbon Dioxide Act 2013	Companies are required to submit annually monitoring report to the regulator regarding their GHG emission activities.	Environment	Legislation	Mandatory	National	All	All organizations except those in the public sector	Report to regulator
Lithuania	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
Luxembourg	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention,	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.							
Malta	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
Netherlands	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
	2009	Recommendations for Dutch State Holdings, 2009	expects the largest Dutch State Holdings to use GRI Guidelines in their annual reporting	ESG	Guidelines	Mandatory	National	All	State owned entities	Annual report
	2009	Netherlands Council for Annual Reporting – Statement 2009-7, 2009	implementing provisions of the EU Accounts Modernization Directive	ESG	Guidelines	Voluntary	National	All	All organizations except those in the public sector - medium and large enterprises	Annual report
	2012	Dutch Civil Code, 1838	Article 2:391 subsection 1 of the Dutch Civil Code effects the direct implementation of the	ESG	Legislation	Mandatory	National	All	All listed companies	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
			EU Accounts Modernization Directive (2003/51/EC) into Dutch law							
New Zealand	2003	Climate Change Response Act 2002	established an institutional and legal framework for New Zealand to ratify and meet its obligations and the Kyoto Protocol and the United Nations Framework Convention on Climate Change	Environment	Legislation	Mandatory	National	All	All organizations except those in the public sector	Report to regulator
Norway	1999	The Norwegian Accounting Act, 1998	The Norwegian Accounting Act requires the inclusion of information on working environment, gender equality, ethnicity, religion and environment-related issues in the Director's Report of annual reporting. In addition, it requires information about the implementation of measures that can prevent or reduce negative impacts or trends.	ESG	Legislation	Mandatory	National	All	All organizations except those in the public sector	Annual report
	2014	Act amending the Norwegian Accounting Act, 2013	The Act introduces provisions requiring large companies to provide information about what they do to integrate considerations for human rights, labor rights and social issues, the environment and anti-corruption in their business strategies, in their daily operations, and in their relations with their stakeholders.	ESG	Legislation	Mandatory	National	All	Large companies (listed & unlisted)	Annual report
Portugal	2006	Public Transport & Communications Enterprises Sustainability Report, 2006	compulsory for enterprises (public entities) that are under its guardianship to publish an annual sustainability report.	ESG	Legislation	Mandatory	National	Specific	All organizations except those in the public sector - transport & communication sectors	Annual report
	2006	Law 19/2006 on access to environmental information, 2006	transposes Directive 2003/4/EC on public access to environmental information and is part of Portugal's effort to further implement the policies agreed upon in the Aarhus Convention.	Environment	Legislation	Mandatory	National	All	All organizations, notably public authorities	Report to regulator
	2007	Council of Ministers Resolution, No 49/2007	encourages all public companies to develop a sustainability strategy and to adopt sustainability practices	ESG	Guidelines	Voluntary	National	All	Large, listed companies	Annual report
	2010	The Financial Reporting Accounting Standard no 26, 2010	adopts the European Commission recommendation of 30 May 2001 on the recognition, measurement and disclosure of environmental issues in the annual accounts and annual reports of companies.	Environment	Legislation	Mandatory	National	All	All companies	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
Romania	2006	Governmental Decision 878/2005 on public access to environmental information, 2005	public access to certain environmental information, including environmental impact assessment reports and environmental authorizations	Environment	Legislation	Mandatory	National	All	Certain companies depending on their environmental impact	Report to regulator
	2006	Government Decision no. 780/2006 for GHG emissions trading, 2006	Companies falling under EU-ETS Directive are required to annually publish GHG emission reports	Environment	Legislation	Mandatory	National	All	All organizations except SMEs - companies under EU-ETS requirements	Report to regulator
Russian Federation	2013	Russian Government Directive 1710-13, 2013	requires government representatives on the Board of Directors of the 22 largest Russian state-owned companies to consider at board meetings the regular publication of non-financial reports, including disclosure of information on sustainable development and environmental responsibility	ESG	Legislation	Mandatory	National	All	Large state-owned companies	Annual report
Slovakia	2015	Amendment to act No. 431/2002 Coll. on Accounting, 2015	Listed companies of public interest and companies with more than 500 employees and their subsidiaries should state in their annual report the position and impact of the company on environmental, social and labor areas, on human rights and the information on the fight against corruption and bribery	ESG	Legislation	Mandatory	National	All	Listed companies and companies over 500 employees.	Annual report
Spain	2006	ICAC Resolution of 8 February, 2006	lays out how organizations subject to the National Assignments Plan for GHG emissions should approach the measurement, disclosure and audit of GHG emissions.	Environment	Guidelines	Voluntary	National	Specific	Companies with GHG emissions potential	Report to regulator
	2010	NONFINANCIAL law of Extremadura, 2010	to promote NONFINANCIAL in Extremadura – a western Spanish region (bordering Portugal)	ESG	Legislation	Mandatory	sub-national	All	All organizations except SMEs	Annual report
	2011	Spanish Sustainable Economy Law, 2011	an amendment that encourages Spanish limited companies to disclose their NONFINANCIAL policies and achievements publicly, in a specific annual report.	ESG	Legislation	Voluntary	National	All	All listed companies	Annual report
	2014	GHG Emissions Registry, 2014	requiring the registration of carbon footprints, compensation and projects absorbing carbon dioxide.	Environment	Legislation	Voluntary	National	All	All organizations	report to regulator
	2014	Planes PIMA, 2014	represent a tool for promoting a set of concrete measures that contribute to improving environmental conditions	Environment	Plan	Voluntary	National	All	All organizations	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2014	Spanish Corporate Social Responsibility Strategy, 2014-2020	binds companies, public authorities and other organizations to take steps towards a more competitive, productive, sustainable and integrated society and economy.	ESG	Plan	Voluntary	National	All	All organizations	Annual report
Sweden	2005	Annual Accounts Act, 1999 amended 2005	certain companies have an obligation to include a brief disclosure of environmental and social information in the Board of Directors' Report section of the annual report.	ESG	Legislation	Mandatory	National	All	Certain listed companies	Annual report
	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
	2008	Guidelines for external reporting by state-owned companies, 2007	shall present a sustainability report based on the GRI Guidelines	ESG	Guidelines	Mandatory	National	All	State owned entities	Annual report
	2013	Guidelines on environmental information in the Directors' Report section of the Annual Report, 1998.	companies larger than certain criteria specified in the Annual Accounts Act; included in the general guidelines are specific guidelines concerning disclosure of non-financial information regarding environmental and social issues.	ESG	Guidelines	Voluntary	National	All	All reporting entities	Annual report
Switzerland	2015	NONFINANCIAL Action Plan, 2015	On 1 April 2015 the Swiss Federal Council adopted a position paper on corporate social responsibility	ESG	Plan	Voluntary	National	All	All organizations	Annual report
Turkey	2006	Environment Law No. 2872 (1983), amended by Law No 5491, 2006	Turkey's Environment Law addresses matters such as air pollution, water pollution, and waste management (e.g., batteries, tires, electric and electronic equipment).	Environment	Legislation	Mandatory	National	All	All organizations	report to regulator
	2016	Regulation on Monitoring of Greenhouse Gas Emissions, 2012	sets forth the principles and procedures of the tracing, verification and reporting of greenhouse gas (GHG) emissions resulting from the operations listed in Annex I of the Regulation.	Environment	Legislation	Mandatory	National	Specific	Large companies (listed & unlisted) - Mandatory monitoring and reporting by	report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
									facilities that were characterized by certain activities: Such facilities include oil refineries, certain steel and iron production plants, clinker facilities above certain capacities, and large paper product factories.	
Ukraine	2014	Decree of State Statistics Service of Ukraine no. 243, 2014	The decree provides standard report forms, covering the subjects of waste management, forests management and hunting grounds. The reports have to be submitted to the statistics authorities of Ukraine. It also defines categories of companies that are required to submit the said reports.	Environment	Legislation	Mandatory	National	All	All organizations - companies that use forests; companies that produce wastes; companies that manage hunting grounds	report to regulator
	2015	Decree of State Statistics Service of Ukraine no. 259, 2015	stipulates standard disclosures related to environmental expenditures. It defines categories of companies that are required to submit the related reports annually	Environment	Legislation	Mandatory	National	All	All organizations - companies that make environmental expenditures, i.e., operate waste treatment facilities, undertake environmental protection measures, pay fees for environmentally sensitive activities, conduct scientific research, or provide environmental services, etc.	report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2015	Decree of State Statistics Service of Ukraine no. 345, 2015	provides standard report forms related to air protection and emissions.	Environment	Legislation	Mandatory	National	All	All organizations - companies that operate stationary sources of air emissions	report to regulator
United Kingdom	2006	The European Pollutant Release and Transfer Register (PRTR), 2006	The Register was established on the basis of the European PRTR Regulation 166/2006/EC, which came into force in February 2006. The regulation incorporated the provisions of the UN-ECE Protocol on Pollutant Release and Transfer Register under the Aarhus Convention, which was adopted at the Ministerial Conference 'Environment for Europe' in Kiev in May 2003 and ratified for the EU by Council Decision 2006/61/EC. It requires operators of facilities undertaking activities specified in Annex 1 to report on emissions and specific substances.	Environment	Legislation	Mandatory	National	All	Facility level	Report to regulator
	2008	Climate Change Act (GHG reporting), 2008	Government exercises its powers under the 2006 Companies Act to require the inclusion of GHG reporting in a company's Directors' Report.	Environment	Legislation	Mandatory	National	All	All organizations except those in the public sector	Annual report
	2012	Sustainable Clothing Action Plan (SCAP), 2012	Commitment sees leading organizations from across clothing sector – supply, re-use and recycling – working together to reduce the environmental footprint of clothing in the UK.	Environment	Plan	Voluntary	National	Specific	All organizations - retail sector	Report to regulator
	2013	The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013. [Quoted companies GHG reporting, 2013]; DEFRA Environmental Reporting Guidelines: Including mandatory greenhouse gas emissions reporting guidance, 2013	to produce a standalone Strategic Report which replaces the existing Business Review. More onerous obligations on quoted companies to additionally report on their strategy and business model, as well as on Greenhouse Gas (GHG) emissions, human rights and diversity in the company	Environment	Legislation	Mandatory	National	All	All listed companies	Annual report
	2014	The Carbon Reduction Commitment (CRC) Energy Efficiency Scheme, 2010	a mandatory carbon emissions reduction scheme in the UK, the commitment requires companies to measure and report on all their emissions related to energy use to the Environment Agency.	Environment	Legislation	Mandatory	National	All	Large companies (listed & unlisted) - companies with GHG potential	report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
United States of America	2009	Presidential Executive Order 13514, 2009	requires all federal agencies to measure and report on their sustainability performance.	ESG	Legislation	Mandatory	National	All	Federal agencies	report to regulator
	2009	40 CFR Parts 86, 87, 89 et al. Mandatory Reporting of GHG emissions, 2009	In response to the FY2008 Consolidated Appropriations Act (H.R. 2764; Public Law 110-161), EPA issued the Mandatory Reporting of Greenhouse Gases Rule (74 FR 56260) which requires reporting of greenhouse gas (GHG) data and other relevant information from large sources and suppliers in the United State	Environment	Legislation	Mandatory	National	Specific	Large companies (listed & unlisted)	report to regulator
	2010	Regulation S-K, 2010	The 2010 SEC guidance on disclosure of environmental risks and compliance with environmental law helps to explain how disclosure requirements within Reg S-K are related to climate change concerns, though this is not explicitly stated in Reg S-K itself	Environment	Guidelines	Mandatory	National	All	Large companies (listed & unlisted) - all SEC filings	report to regulator
	2012	Benefit Corporation Legislation (B-Corp Legislation), 2012	to make available to the public an annual benefit report that assesses their overall social and environmental performance against a third-party standard	ESG	Legislation	Voluntary	National	All	As of March 2016, the Benefit Corporation legislation had been passed in 31 States and the District of Columbia. Legislation is pending review in at least 5 States.	Annual report
Argentina	2008	Law No. 2594, Social and Environmental Responsibility Balance	generate annual sustainability report	ESG	Legislation	Mandatory	Sub-national	All	All local and international companies in the Buenos Aires with over 300 employees	Annual report
	2012	Bill 0765-S/12, 2012.	introduces a national legal framework for sustainability reporting for companies operating in the country.	ESG	Legislation	Mandatory	National	All	All organizations except those in the public sector	Annual report
	2012	NONFINANCIAL Law No. 8488, 2012.	The Government of the Mendoza Province approved a law that requires an annual NONFINANCIAL Report (Balance de Responsabilidad Social y Ambiental)	ESG	Legislation	Mandatory	Sub-national	All	all local companies (national or international) with more than 300 employees, and a	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
									superior gross profit established by the Sepyme (Secretaría de la Pequeña y Mediana Empresa) for SMEs.	
	2014	Law No. 10208. ENVIRONMENTAL POLICY LAW OF THE PROVINCE OF CORDOBA	establishes the provincial environmental policy	Environment	Legislation	Voluntary	Sub-national	All	All organizations except those in the public sector	Annual report
Bangladesh	2011	Policy guidelines for green banking – BRPD Circular No.02	promote green banking by developing this green banking policy and framework, Banks complying with this guidance will receive preferential treatments from BB: positive impact on bank rating, top ten green banks ranking, preferential treatment when according to opening permits.	ESG	Guidelines	Voluntary	National	Specific	Banks and financial institutions	Annual report
Bolivia (Plurinational State of)	2015	Ley No. +A295:Q307393 de Servicios Financieros	a Corporate Social Reponsibility Report is elaborated by the chairman	ESG	Legislation	Mandatory	National	Specific	Financial institutions	Annual report
Brazil	2006	Brazilian Accounting Norm NBC T 15, T 3.7 (2004)	establishes procedures for disclosure of social and environmental information,	ESG	Guidelines	Voluntary	National	All	All organizations	Annual report
	2006	Manual de Responsabilidade Socioambiental e Despacho no 3.034/2006, de 21 December 2006.	National Agency for Eletric Energy obliges all the energy utility companies to produce an annual sustainability report.	ESG	Guidelines	Mandatory	National	Specific	All organizations - energy and utilities	Annual report
	2008	Bill no. 3613, 2008.	requires state-owned companies, mixed companies, concessionaires and permissionaires, as well as private companies which have received public financial support, to disclose a NONFINANCIAL report,	ESG	Legislation	Mandatory	National	All	State-owned companies, mixed companies, concessionaires and permissionaires, as well as private companies which have received public financial support to disclose	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
									a NONFINANCIAL report,	
	2012	BM&FBOVESPA recommendations, 2012.	recommends that listed companies provide information on whether they publish a regular sustainability report, or explain why if they do not	ESG	Guidelines	Voluntary	National	All	All listed companies	Annual report
	2012	CODIM, Pronouncement no. 14, 2012.	recommends that companies disclose information on the integration of key sustainability issues to their strategy, including KPIs and goals,	ESG	Guidelines	Voluntary	National	All	All organizations	Annual report
	2012	Resolution no. 64, 2012.	issued by the Environmental State Agency (INEA), also establishes mandatory GHG reporting for obtaining environmental licenses in the state of Rio de Janeiro	Environment	Legislation	Mandatory	Sub-national	Specific	All organizations - oil and gas, mining and metals, energy and fossil fuels, and chemical sectors, among others	report to regulator
	2012	Resolution no. 254/2012/V/I, 2012.	this Resolution obliges companies from a series of industry sectors to submit an annual greenhouse gas inventory, for monitoring the developments in emission levels and the results of mitigation actions	Environment	Legislation	Mandatory	Sub-national	Specific	All organizations - a series of industries outlined in the document	report to regulator
	2014	Resolution on Socio-environmental Responsibility Policy Nº 4.327, 25 April 2014, Central Bank	all banks as part of their license to operate be required to issue annual social responsibility reports.	ESG	Legislation	Mandatory	National	Specific	All organizations - banks and financial institutions	Annual report
Chile	2015	Action plan on Corporate Social Responsibility 2015-2018	identifies gaps within the national NONFINANCIAL strategy and means to fill in these gaps	ESG	Plan	Voluntary	National	All	All organizations	Annual report
	2017	CIRCULAR N° 52. REF. LEGAL: Ley N° 20.780, 2014	introduced requirements for the declaration and payment of taxes on pollutant emissions by stationary sources	Environment	Legislation	Mandatory	National	Specific	stationary (large combustion and power) plants with a capacity equal to or greater than 50 MW	report to regulator
China	2008	Guidelines to the State-owned Enterprises Directly under the Central Government on	give the impetus to Central State-owned Enterprises (CSOEs) to fulfill corporate social responsibilities	ESG	Guidelines	Mandatory	National	All	State-owned enterprises directly under the	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
		Fulfilling Corporate Social Responsibilities, 2008.							central government	
	2008	Environmental Information Disclosure Act, 2008.	Corporations should disclose environmental information according to regulatory requirements. Environmental agencies are also encouraged to establish an environmental information disclosure system	Environment	Legislation	Voluntary	National	All	Large companies (listed & unlisted)	report to regulator
	2008	Green Securities Policy, 2008.	he issuance of the 'Green IPO' which requires enterprises in energy-intensive industries (Liang Gao industries) to undergo an environmental assessment by the MEP before initiating an IPO or obtaining refinancing from banks.	Environment	Legislation	Mandatory	National	Specific	All companies listed on the Shanghai SE	report to regulator
	2008	Guidelines on Environmental Information Disclosure by Companies Listed on the Shanghai Stock Exchange, 2008.	Three types of companies must disclose NONFINANCIAL practices	ESG	Guidelines	Mandatory	National	All	Large, listed companies	Annual report
	2009	Guidelines on Corporate Social Responsibility for Banking Financial Institutions in China, 2009.	The most pressing aspect of the guidelines is that CBA advises all banks to produce an annual NONFINANCIAL report	ESG	Guidelines	Voluntary	National	Specific	Banks and financial institutions	Annual report
	2011	Guidelines on Social Responsibility for Industrial Corporations and Federations, 2011.	According to the guidelines, all industrial companies and industrial federations of China are encouraged to establish a NONFINANCIAL system	ESG	Guidelines	Voluntary	National	Specific	All industrial companies	Annual report
	2012	Green Credit Guidelines	In February 2012, the China Banking Regulatory Commission updated the Green Credit Guidelines that regulate the environmental performance of Chinese banks	Environment	Guidelines	Voluntary	National	Specific	Banks and financial institutions	Annual report
Colombia	2012	National Program for Voluntary Report on GHG Emissions.	This is designed for enterprises to account, report and identify strategies to control their corporate GHG emissions, through technical support and subsequent recognition of their voluntary actions that contribute to climate change mitigation	Environment	Guidelines	Voluntary	National	All	All organizations except those in the public sector	report to regulator
	2015	Legal Guide to Do Business in Colombia 2015	recommends companies to adopt a NONFINANCIAL approach in order to improve their competitiveness.	ESG	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2015	Contrato de Concesión Estandar y Apéndices	demands that mega-infrastructure projects under public tender issue ESG plans and reporting using the *Equator Principles* and GRI	ESG	Legislation	Mandatory	National	All	All infrastructure projects	Annual report
Ecuador	2001	Environmental Regulation for Hydrocarbon Activities, 2001, Ministry of Environment, and Ministry of Energy and Mines.	submit annual environment report	Environment	Legislation	Mandatory	National	Specific	Large companies (listed & unlisted) - specific entities hydrocarbon activities	report to regulator
	2008	Transparent System of Indicators of Business Environment Best Practice, 2008, Guayaquil Stock Exchange (BVG) and the Business Council for Sustainable Development in Ecuador (CEMDES).	This initiative aims to develop a transparent system of business practice based on environmental values that allow companies listed on the BVG to assess their performance towards sustainable development on a permanent basis, thus contributing to the sustained success of their business. Companies that enter the system must collect information for environmental indicators proposed in the Sole Presentation Form (FUP). These indicators are taken from GRI. Certification can be granted to companies that complete the FUP appropriately. With this information at hand, companies may publish results that show a high level of responsibility towards stakeholders.	Environment	Guidelines	Voluntary	National	All	Large, listed companies	Annual report
	2009	Mining Law, 2009, Sector Ministry, the National Mining Company, and the Regulation and Control Body.	half-yearly environmental report	Environment	Legislation	Mandatory	National	Specific	Large companies (listed & unlisted) - mining sector	report to regulator
	2010	Ministerial Agreement 131.	State-owned institutions must report their management indicators in relation to good environmental practices, on a yearly basis	Environment	Legislation	Mandatory	National	All	Public sector and state-owned organizations	report to regulator
India	1986	Environment (Protection) Act, 1986.	It empowers the Central Government to establish authorities [under section 3(3)] charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country	Environment	Legislation	Mandatory	National	All	All companies with polluting potential	report to regulator

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2003	Corporate Responsibility for Environmental Protection (CREP), 2003.	A charter promoted by the Central Pollution Control Board of India, this initiative aims to go beyond compliance with regulatory norms for prevention and control of pollution, through various measures including waste minimization, in-plant process control, and adoption of clean technologies in environmentally intensive industries	Environment	Guidelines	Mandatory	National	Specific	Mandatory for large businesses in the 17 highest polluting sectors in India.	report to regulator
	2009	National Voluntary Guidelines on Social, Environmental & Economic Responsibilities of Business, 2011 (1st edition 2009).	The Ministry of Corporate Affairs in India launched the National Voluntary Guidelines on Social, Environmental & Economic Responsibilities of Business.	ESG	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report
	2011	Guidance Note on Non-Financial Disclosures, 2011.	The purpose is to help those responsible for preparing company annual reports to make appropriate non-financial disclosures that address the major concerns of various report users.	ESG	Guidelines	Voluntary	National	All	All listed companies	Annual report
	2012	BSE	BSE launched the S&P BSE GREENEX index in February 2012.This is a leader's index that comprises of twenty-five companies that are good in terms of the Green House Gases (GHG) emissions including offsetting, Market Capitalization and the Liquidity in the market.	Environment	Guidelines	Voluntary	National	All	Large companies and public sector companies - BSE 100 universe	Annual report
	2013	Department of Public Enterprises (DPE) Guidelines on Corporate Social Responsibility and Sustainability for Central Public Sector Enterprises , 2013.	The DPE Guidelines have been developed for CPSEs in committing to and achieving their respective targets in a manner that is beneficial to them and their stakeholders.	ESG	Guidelines	Mandatory	National	All	Public sector and state-owned organizations	Annual report
	2015	The Securities and Exchange Board of India (SEBI), Business Responsibility Reports, 2015.	to submit Business Responsibility Reports, describing measures taken along the key principles enunciated in the 'National Voluntary Guidelines on Social, Environmental and Economic Responsibilities of Business' framed by the Ministry of Corporate Affairs (MCA).	ESG	Legislation	Mandatory	National	All	Large, listed companies	Annual report
Indonesia	2012	Decision of the Chairman of the Capital Markets	disclosures on corporate social responsibility should include policies, types of programs, and	ESG	Legislation	Mandatory	National	All	Large, listed companies	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
		Supervisory Agency No.KEP-431/BL/2012, 2012, concerning the obligation to submit annual reports for issuers of public companies.	expenditure on, environmental performance, labor practices, social and community empowerment, and product responsibility.							
Israel	2009	Securities Law Regulations (Details of a Prospectus, its Form and Structure) – 1969	The relevant amendment to the Securities Law Regulation (2009 and 2010) requires any corporation listed for trade in Israel Stock Exchange, to report on material Environmental Risk and the management of those risks, including relevant litigation processes, policies and future expenses relate to those risks.	Environment	Legislation	Mandatory	National	All	All listed companies	Annual report
	2009	Strategic Sustainable Development Implementation	all companies are required to establish a sustainable development program which includes relevant strategy, goals, appointing a dedicated management member for sustainable development and reporting on a regular basis on current and future state of the program.	ESG	Legislation	Mandatory	National	All	State owned entities	Annual report
	2010	Greenhouse gas (GHG) registry	a voluntary national greenhouse gas registry in July 2010	Environment	Guidelines	Voluntary	National	All	All organizations	report to regulator
	2011	Annual Report of a Banking Corporation	provide disclosure for those matters that are relevant to its activity in the area of corporate responsibility for the period of up to two years ending on the date of the report	ESG	Legislation	Mandatory	National	Specific	Banks	Annual report
	2013	Environmental Protection Law	Israel's PRTR system was established under the 2012 Environmental Protection Law. The guidelines for the system were set in the Kiev Protocol on Pollutant Release and Transfer Registers, which Israel acceded in January 2013.	Environment	Legislation	Mandatory	National	All	All organizations	report to regulator
Kenya	2015	Capital Markets Act – Code of Corporate Governance Practices for Issuers of Securities, 2015	It seeks to promote sustainability and the ESG agenda. A Board is expected to have formal strategies to promote sustainability, paying attention to Environmental, Social and Governance (ESG) aspects of the business that underpin sustainability.	ESG	Guidelines	Mandatory	National	All	All public issuers	Annual report
Malaysia	2007	NONFINANCIAL Framework for voluntary reporting – Listing Requirements, 2007	Malaysian public listed companies are required to report NONFINANCIAL activities or practices undertaken by the listed issuer and its subsidiaries or, if there are none, a statement to that effect.	ESG	Legislation	Mandatory	National	All	All listed companies	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2010	Powering Business Sustainability – A Guide for Directors, 2010	The Guide encourages sustainability reporting, and states that a "robust reporting process will ensure data reported is easily verifiable and assured by independent parties and sustainability stakeholders"	ESG	Guidelines	Voluntary	National	All	All listed companies	Annual report
	2012	Environmental Quality Act, 1974	provides for the prevention, abatement and control of pollution through licensing, as well as the conservation of the environment. As evidenced by a 2012 amendment to the Act, the results of an environmental impact assessment or environmental audit shall be submitted as report to the government Director-General of Environmental Quality	Environment	Legislation	Mandatory	National	All	All organizations	report to regulator
	2018	Bursa Malaysia Amendments to Listing Requirements for Sustainability Statement in annual reporting, 2015	amendment on using GRI reporting	ESG	Legislation	Mandatory	National	All	All listed companies	Annual report
Maldives	2014	Corporate Governance Code, 2014	to include, among other changes, new voluntary provision on sustainability reporting.	ESG	Guidelines	Voluntary	National	All	Large, listed companies	Annual report
Mexico	1997	Clean Industry Certificate (CIL), 1997	Clean Industry certification is for companies that demonstrate satisfactory accomplishment of legal requirements regarding environmental protection.	Environment	Legislation	Voluntary	National	All	All organizations except those in the public sector - particularly companies generating a high concentration of toxic waste	report to regulator
	2014	National Emissions Register (RENE), 2014	the National Emission Register (RENE) was established by the General Law on Climate Change (2012)	Environment	Legislation	Mandatory	National	All	All sectors / organizations with high GHG emissions potential	report to regulator
Nigeria	2008	Code of Corporate Governance for Public Companies of Nigeria, 2008	A key addition to the revised code was the inclusion of sustainability disclosures to be made by companies	Environment	Guidelines	Mandatory	National	All	1) Public Companies listed on the Nigerian Stock Exchange;2) All companies seeking to raise funds from the capital market	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
									through securities issuance or listing; and 3) All other public companies.	
	2012	Nigerian Sustainable Banking Principles, 2012	The Principles among others require banks to respect human rights in their business activities, to promote financial inclusion and women's economic empowerment, and to integrate environmental and social considerations into all bank decision-making processes.	ESG	Guidelines	Mandatory	National	Specific	Financial institutions	Annual report
	2015	Exposure Draft of the National Code of Corporate Governance for Public Sector Entities, 2015	Section 38 on Disclosure requires the Annual Report to address (i) Governance and Board Oversight, (ii) Accounting, (iii) External Audit, (iv) Risk Management and Control, (v) Conflict of Interest and Related Party Transactions, as well as (vi) Sustainability. The latter should reflect acknowledgement of the enterprise's wider social responsibility including matters such as environmental impact and climate change.	ESG	Guidelines	Mandatory	National	All	All listed companies	Annual report
Pakistan	2009	Companies (NONFINANCIAL) General Order, 2009	requires all public companies to provide descriptive (non-financial) as well as monetary (financial) disclosures on NONFINANCIAL activities undertaken during each financial year.	ESG	Legislation	Mandatory	National	All	All listed companies	Annual report
	2013	Corporate Social Responsibility (NONFINANCIAL) Voluntary Guidelines, 2013	launched the draft NONFINANCIAL Voluntary Guidelines 2012 with a focus on streamlining diverse elements of corporate disclosure, transparency and accountability.	ESG	Guidelines	Voluntary	National	All	Listed companies	Annual report
Peru	2015	Resolution SMV No 033-2015-SMV/01, 2015	The intention is for companies to report on environmental, social and governance (ESG) impacts.	ESG	Legislation	Mandatory	National	All	Listed companies	Annual report
Philippines	2014	SEC Financial Disclosure Checklist, 2004	encourages listed companies to make additional statements, such as environmental reports and value-added statements when management believes they will assist users in making economic decisions. This applies in particular to industries where environmental factors are significant and where employees are considered to be an important user group.	Environment	Guidelines	Voluntary	National	All	Large, listed companies	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2015	Philippine Corporate Governance Blueprint, 2015	It foresees further examination by the regulators (SEC, PSE) on the inclusion of sustainability or integrated reporting in the PSE Listing Requirements or Disclosure Rules on the basis of a "comply or explain" approach.	ESG	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report
Qatar	2010	Sustainable Development Industry Reporting (SDIR), 2010	overseeing a sector-wide initiative led by the Minister of Energy and Industry. Collecting data from over 35 companies, its aggregated sectoral reporting is based on the SDIR framework which references the Global Reporting Initiative (GRI) guidelines, GRI Oil & Gas Sector Supplement as well as the oil & gas sector specific reporting guidelines of IPIECA.	ESG	Guidelines	Mandatory	National	Specific	Primarily oil & gas companies, but also covers manufacturing and industrial companies	Annual report
Republic of Korea	2007	Environmental Reporting Guidelines, 2007	this guidance contains Environmental Risk Evaluation guidelines, Environmental Performance Evaluation guidelines, and Environmental Accounting guidelines. The Ministry issued the initial environmental reporting guidelines (2004) based on the GRI G3 Guidelines.	Environment	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report
	2011	Regulations on Issuance, Public Disclosure, etc. of Securities, 2011	South Korea's Financial Supervisory Service provides for the voluntary disclosure of information on environmental management by listed companies.	Environment	Legislation	Voluntary	National	All	All listed companies	Annual report
	2012	Green Posting System, 2012	The Financial Services Commission required around 500 firms to post their levels of GHG emissions and energy usage, as well as certification of green technology and green business. If the firms are listed on the Korean Stock Exchange, they are required to include the information in their annual reports.	Environment	Legislation	Mandatory	National	All	All listed companies	report to regulator
	2012	Environmental Information Disclosure Policy, 2012	requires private sector companies and public organizations to disclose environmental information.	Environment	Legislation	Mandatory	National	All	All?	report to regulator
Singapore	2011	Guide to Sustainability Reporting for Listed Companies, 2011	describes sustainability reporting and sets out broad principles to guide listed companies in formulating their sustainability reporting frameworks. The Exchange encourages its listed companies to disclose sustainability information that deepens stakeholders' understanding of corporate performance.	ESG	Guidelines	Voluntary	National	All	All listed companies	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2012	Revised Code of Corporate Governance, 2012	The amended code also included in the preamble that the responsibility of the board of directors includes the consideration of environmental and social risks to the company.	ESG	Guidelines	Mandatory	National	All	All listed companies	Annual report
South Africa	1998	National Environmental Management Act (NEMA), 1998	requires that activities' potential impact on the environment be assessed and reported to competent authorities. As is the case with various environmental topics, disclosure of information is often only to the authorities, and related public reporting is voluntary. The public is however entitled to get access to the information	Environment	Legislation	Voluntary	National	All	All organizations	report to regulator
	2004	Air Quality Act, 2004	introduced a shift from source-based air pollution control to a receiving environment and air quality management approach. It requires the setting of air quality targets, complemented by air quality management plans, pollution prevention plans, access to information (including atmospheric impact reports), and public consultation.	Environment	Legislation	Voluntary	National	All	All organizations	report to regulator
	2004	Johannesburg Stock Exchange (JSE) Socially Responsible Investment Index (SRI Index), 2004	The Index encourages companies of the FTSE/JSE All Share Index that choose to participate to report publicly on sustainability issues.	ESG	Legislation	Voluntary	National	All	Large, listed companies	Annual report
	2010	King Code and Report on Corporate Governance, 1994, 2002 and 2010	requiring business to integrate the management of financial and non-financial issues (risk management and audit)	ESG	Guidelines	Voluntary	National	All	All organizations except those in the public sector	Annual report
	2010	Johannesburg Stock Exchange (JSE) Listing Requirement, 2010	required to annually produce an integrated report in place of or in addition to their annual financial and sustainability reports as a consequence of the adoption of the King III Code, on an 'apply or explain' basis.	ESG	Legislation	Mandatory	National	All	Large, listed companies	Annual report
Thailand	2012	Guidelines on social responsibility and reporting, 2012	Published by the Stock Exchange of Thailand (SET), the guidance on social responsibility and reporting comprises three parts: 1. Approach to Social Responsibility Implementation for Corporations (based on ISO 26000 and adapted for Thailand); 2. Sustainability Reporting Guidelines; and 3. A Thai translation of the GRI G3.1 Guidelines.	ESG	Guidelines	Voluntary	National	All	Large, listed companies - securities issuers	Annual report

Country	Year	Reporting instrument	Description	Scope	Type	Mandatory or Voluntary	Geographical scope	Industry sectors	Organizations covered	Disclosure location
	2014	Rules, Conditions and Procedures for Disclosure regarding Financial and Non-financial Information of Securities Issuers, 2014	introduced these mandatory NONFINANCIAL discloses to be included by listed companies in their annual registration statement (Form 56-1) and their annual report (Form 56-2).	ESG	Legislation	Mandatory	National	All	Large, listed companies-securities issuers	Annual report
United Arab Emirates	1999	Federal Law No. (24) for Protection and Development of the Environment, 1999	provides the legislative framework for environmental regulation within the UAE. It among others provides for environmental impacts assessments (IEAs) for project development and environmental monitoring (including measurement and reporting of relevant data to the Federal Environment Agency).	Environment	Legislation	Mandatory	National	All	All organizations	report to regulator
	2011	Green Building Regulations and Specifications, 2010	The regulations were written as a code listing green features and a methodology that need to be met in the design stage and implemented in the construction stage	Environment	Guidelines	Mandatory	National	All	All organizations	report to regulator
Venezuela (Bolivarian Republic of)	1995	DECREE 883,638 -N° 1.257	Issued by the Presidency in 1995, this decree established standards for improving air quality and the prevention and control of air pollution from stationary and mobile sources.	Environment	Legislation	Mandatory	Sub-national	All	All organizations except those in the public sector	report to regulator
Viet Nam	2015	Circular No. 155/2015/TT-BTC on Public Disclosure for listed companies	his circular requires listed companies to report on their impacts on the environment and society. Impact areas specified include management of raw materials, energy consumption, water consumption, compliance with the law on environmental protection, policies related to employees, responsibility for local communities, as well as green capital market activities under guidance of the SSC.	Environment	Legislation	Mandatory	National	All	Large, listed companies	Annual report
Zimbabwe	2015	National Code on Corporate Governance, 2015	chapter 5 now requiring companies to produce integrated sustainability reports based on use of the GRI or IIRC framework standards	ESG	Guidelines	Mandatory	National	All	Large companies (listed & unlisted)	Annual report
	2015	Zimbabwe Stock Exchange (ZSE) Listing Requirements of Securities and Exchange Commission (SECZ), 2015	require companies to disclose material environmental and social aspects of their organizational performance in their annual reports (either integrated or separately), alongside with financial and corporate governance aspects.	ESG	Legislation	Mandatory	National	All	Large, listed companies	Annual report