The effect of mandatory GHG Disclosure regulation on GHG disclosure quality, corporate financial and environmental performance : a UK study

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Declaration

"I, Chendi Wang, declare that the PhD thesis entitled 'The effect of mandatory GHG Disclosure regulation on GHG disclosure quality, corporate financial and environmental performance : a UK study' is no more than 80,000 words in length. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work".

Signature: Chendi Wang
Date: July 2023

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Abstract

As one of the main sources of greenhouse gas (GHG) emissions, firms must take primary responsibility for emission reduction. The major motivation of this study is that the government, as a legislative, may supervise and control corporate emissions by implementing regulations. The implementation of mandatory disclosure policies demonstrates this. This research examines whether the Companies (Directors Reporting) and Limited Liability Partnerships (Energy and Carbon Reporting) Regulations 2018 (the 2018 regulations) in the UK have a substantial influence on the corporate GHG information disclosure quality (IDQ). Besides, under the mandatory disclosure context, the impact of changes in corporate GHG IDQ on company financial performance (FP) and environmental performance (EP) is also explored.

In this study, content analysis and quantitative research methods are combined. Content analysis is used to examine reports of firms and build an index framework of enterprise GHG disclosure content, which provides data sources for GHG IDQ. Quantitative research contains three models to explore the influence of the 2018 regulations on the GHG IDQ and the impact of IDQ on corporate FP and EP. For the purpose of this research, the annual reports, financial indicators, and GHG emission data of the Financial Times Stock Exchange 350 Index (FTSE350) listed companies are gathered. Based on the institutional theory, it is proposed that there is a positive correlation between the release of the 2018 regulations and the quality of corporate GHG information disclosure. The time-fixed and individual-fixed ordinary least squares (OLS) model is used to examine the influence of the 2018 regulations on the company GHG IDQ. The findings provide evidence that the 2018 regulations will positively affect the GHG IDQ. Similarly, based on agency theory, stakeholder theory, voluntary disclosure theory, legitimacy theory and signaling theory, it is proposed that under the influence of mandatory disclosure regulations, there is a positive correlation between corporate GHG disclosure and corporate FP and EP. This research utilizes panel data and the OLS interaction model to test hypotheses that corporate GHG IDQ positively affects their FP and EP. The results reveal that when corporate environmental IDQ progressively increases, company FP gradually improves, and GHG emissions decline. The findings of this study give investors, managers, regulators, and sustainability groups updated policy implications and new perspectives.

Abbreviations

AT	asset liquidity
CBI	Confederation of British Industry
CCA	Climate Change Act
CDP	Carbon Disclosure Project
CO_2	carbon dioxide
CSR	Corporate social responsibility
DEFRA	Department for Ecology, Food and Rural Affairs
EP	Environment performance
EU ETS	EU Emissions Trading Scheme
FL	financial liquidity
FP	financial performance
FR	financial risk
FTSE	Financial Times Stock Exchange
GC	firm growth capability
GHG	greenhouse gases
GHGP	GHG performance
GRI	the Global Reporting Initiative
ICB	Industry Classification Benchmark
IDQ	information disclosure quality
ISO	International Organization for Standardization
KPI	key performance indicators
LLPs	Limited Liability Partnerships
MCR	mandatory carbon reporting
$MtCO_2e$	million tons of carbon dioxide equivalent
OC	concentration of ownership
OLS	Ordinary Least Squares
PE	price-earnings ratio
ROA	return on assets
S&P 500	Standard & Poor's 500
SECR	streamlined energy and carbon reporting
Size	firm size
SMEs	medium-sized enterprises
The 2018 regulations/REG	the Companies (Directors' Report) and Limited Liability Partnerships (Energy and Carbon Report) Regulations 2018
UCS	the Union of Concerned Scientists
UK	United Kingdom
UKCCC	United Kingdom Climate Change Committee
US	United States

Tables

Chapter 1: Introduction

1.1 Introduction

This dissertation focuses primarily on the impact of one of the UK's most recent mandatory disclosure schemes, the Companies (Directors' Report) and Limited Liability Partnerships (LLPs) (Energy and Carbon Report) Regulations 2018 (the 2018 regulations), on the disclosure of companies' greenhouse gases (GHG) emissions and energy consumption information, as well as the relationship between information disclosure quality (IDQ) and corporate financial performance (FP) and environmental performance (EP). In response to global climate change and the need to cut carbon emissions, the disclosure of environmental information by companies has become a crucial method for attaining this objective. This chapter provides a summary of all chapters of the research and an overview of the dissertation, including the background, motivation, purpose, and importance of the study. In addition, this chapter discusses briefly the study's results and contributions, as well as the research methods used to perform the study.

1.2 Context of the research

Over the previous ten years, the global average temperature has risen by 1.2°C over pre-industrial levels, as discussed at the Leader Summit on Climate held via video conference on April 22, 2021. As early as 2015, member states of the United Nations signed the Paris Agreement, which focuses on the mitigation of the increase in GHG. This conference aims to control the global temperature rise within the pre-industrial level of 2 °C and further limit the temperature rise within the pre-industrial level of 1.5 °C (United Nations Framework Convention on Climate Change, 2015). Chevuturi et al. (2018) found that as the temperature rises by 1.5 degrees Celsius, extreme daily temperatures and changes in the weather will occur more frequently. Even though this is not a recent trend, it is hard to ignore the enormous harm to the ecosystem and human systems resulting

from future warming.

Corporate GHG emissions are regarded as the most influential factor in climate change. The challenges created by environmental changes in the 21st century and the foreseeable future emphasize the need for companies to boost their environmental obligations (Laufer, 2003). Nowadays, businesses view environmental issues as a strategic challenge, address external impact and reduce pollution as a strategic objective, and prioritize the disclosure of reliable information so that stakeholders can accurately assess the company's threats and opportunities related to climate change (Lewandowski, 2017). Due to the continual strengthening of laws and regulations, companies have begun to disclose carbon emission and energy consumption statistics through numerous channels.

1.2.1 Start with voluntary disclosure

Corporate environmental disclosure is defined by the Institute of Chartered Accountants in England and Wales as the "voluntary provision of information about business performance with respect to the broader field of corporate environmental practices" (Islam, 2009). Prior to the implementation of the mandated disclosure mechanism, different countries established diverse settings for enterprises. Thus, they implemented voluntary disclosure to address the environmental concerns of external stakeholders (Akbaş & Canakli, 2019). During the disclosure process, the national management system also identifies conflicts between multi-stakeholders from different sectors, allowing companies to voluntarily mitigate GHG changes based on their operations (Griffiths & Rassias, 2007).

Some academics have examined the voluntary disclosure of businesses under private supervision. The Carbon Disclosure Project (CDP) and the Global Reporting Initiative (GRI) are two private regulators that affect voluntary

disclosure by firms (Marcela et al., 2011). CDP is a successful voluntary reporting project that leverages the influence of investors to enable numerous firms globally to disclose voluntarily under its initiative. CDP submits yearly requests for information to Financial Times Stock Exchange (FTSE) listed firms on behalf of several institutional investors. Requests for data give information on the emissions, climate strategy, and action plans of businesses. The given information is used to build the annual Climate Leaders Index, which rates businesses according to their performance. Stanny and Ely (2008), for instance, utilised the replies of US corporations to CDP questionnaires to evaluate the degree of voluntary GHG disclosure. Besides, GRI is the most frequently used and comprehensive framework for voluntary environmental and social performance reporting by businesses and other organisations globally (Brown et al., 2009).

The benefit of voluntary reporting is that it allows businesses to establish a reporting strategy that satisfies the demands of stakeholders and to utilize the report's content to innovate. However, voluntary reporting also has shortcomings, as there is no uniform standard, and some still need to be verified and tested by third-party authorities, resulting in inconsistent and incomparable information. According to research by Kalesnik et al. (2021), in the absence of compulsory carbon disclosures, around half of enterprises report their carbon emissions voluntarily, while the other half reveal their carbon emissions using data provider estimates.

1.2.2 Voluntary disclosure and its qualities

Even though the report contains the most reliable information currently accessible to investors, the quality of carbon emissions data must be enhanced. There are three major concerns with the voluntary reporting of GHG data by enterprises. First, investment-friendly reporting is optional in the majority of nations, with limited data availability and reporting bias (Kalesnik et al., 2021).

Trucost (2009), for example, analyzed carbon risk in UK equity funds. He discovered that the lack of applicable methodological standards and organizational boundaries for carbon reporting are significant factors restricting UK equity fund managers' adoption of voluntary carbon disclosure reporting data.

Second, there is a significant disparity between the carbon emission measuring technique and the carbon disclosure standard, which diminishes the comparability of the company's GHG emission statistics. Additionally, the organization may be more inclined to provide information advantageous to its reputation and performance. In addition, it gives corporations a "green cleaning" chance to update their financial statements (Bowen, 2014; Kalesnik et al., 2021) while confusing investors. For instance, brown corporations may be misidentified as green companies, which is against their investment plan (Kalesnik et al., 2021).

Thirdly, there are discrepancies in the incorporation of carbon performance reporting data between firms and third-party providers, particularly for scope 3 carbon emissions data (Kolbel et al., 2020). Therefore, greater mandated corporate carbon emission data disclosure is required to satisfy regulatory obligations and increase data availability.

Therefore, proponents of obligatory reporting believe that it enables more reliable, comparable, consistent, and transparent information with the same methodology and set disclosure format used by all reporting agencies, thereby preventing the selective reporting of positive performance. Nonetheless, they will also consider that if mandatory reporting regulations are applied to all enterprises, this might lead to a return to the lowest common denominator in terms of scope and innovation and could eventually result in all companies meeting the required criteria. The distinction between voluntary and mandatory reporting has since

blurred, as some schemes have evolved into quasi-mandatory schemes. Some literature contends, for instance, that CDP reporting falls between voluntary and mandated since answers to CDP have been institutionalized in response to investor pressure on corporations (Ott et al., 2017). According to the collected data, CDP has consistently high response rates. Organizations will be requested to provide more information if their responses do not result in a comprehensive or comparable data collection. Therefore, it is very necessary to make more mandatory disclosure of regulatory requirements for corporate carbon emissions data to improve data availability.

1.2.3 Development of regulation of corporate GHG disclosures in the UK

Global climate change is tied to the survival and development of human beings and is a major challenge confronting the globe today. The concept of environmentally friendly development and the national plan for a low-carbon economy are of enormous significance for supporting the sustainable development of the UK and the globe. In order to stimulate business innovation and enhance EP in the field of carbon emissions, the UK government, as the first country in the world, compels listed firms to disclose relevant GHG emissions in their annual financial reports (Camilleri, 2015).

In 1997, the Department of the Environment of the UK produced “Environmental Reporting and Finance: Towards Good Practice,” which encouraged 350 of the UK’s top publicly traded firms to disclose their GHG emissions. In 2008, the CCA received official approval and went into effect. According to the Act, the Climate Change Commission was established to provide advice to the government on climate-related laws. The Act provides the UK the first nation in the world with a legally enforceable, long-term framework for lowering GHG emissions and combating climate change. This measure has established a long-term objective in the UK, clarified the implementation of tasks, strengthened the institutional framework, and clarified the specific and normative

responsibilities and obligations of the British Parliament and the Supreme Legislative Body, which paves the way for a new approach to climate change mitigation. The Act requires the government to issue guidelines by October 1, 2009 to help guide companies in reporting their GHG emissions. On December 1, 2010, the government needs to review the relevant report's contribution to GHG reduction in 2010. Under the premise of compliance with the Corporations Act, the government was expected to establish standards for the corporate GHG reporting system by April 6, 2012.

In December 2008, the Climate Change Council recommended that the government achieve an 80% reduction in emissions by 2050 from 1990 levels (Climate Change Council, 2018). The following September, the Department for Environment, Food, and Rural Affairs (DEFRA) published voluntary guidelines for measuring and disseminating emissions information. The Companies Act 2006 (Strategic Reports and Directors' Reports) Regulations 2013 (SI 2013/1970) (Secretary of State, 2013) took another important step by requiring publicly traded companies to share information about their GHG emissions.

In addition to the duty to minimize GHG emissions through the EU ETS, since April 2013, all firms listed on the London Stock Exchange are required by administrative regulations to declare their yearly GHG emissions in their annual reports. Under the law, yearly director's reports made by these corporations must now disclose at a minimum their annual CO_2 emissions and the method by which they were computed. The most recent disclosure law was enacted in 2018, and corporations are no longer subject to industry-specific disclosure obligations. In addition to the listed corporations stated in Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, major private and limited liability companies are expected to comply with the most recent energy and carbon reporting requirements. Listed firms, big unlisted enterprises, and limited liability corporations are required to declare in their financial reports their GHG

emissions, UK energy usage, energy efficiency efforts, intensity ratios, and calculation methods.

In 2019, the government of the UK enacted legislation to set a 2050 emission reduction goal level of at least 100 percent from the 1990 level, which is more ambitious than the 80 percent emission reduction previously committed to (committee on climate change, 2018). At the April 2021 climate conference for world leaders, the former British prime minister reaffirmed Britain's contribution to climate change. Boris Johnson, the former British prime minister and chairman of the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change, declared at the gathering that the UK intends to decrease carbon emissions by 78 percent between 1990 and 2035 (United Nations News, 2021). According to him, this would be the greatest pledge to reduce emissions among the world's major economies. In 2020, according to national figures, the UK's overall GHG emissions decreased by 8.9% to 414.1 million tonnes of CO_2 equivalent ($MtCO_2e$). Total GHG emissions are 48.8% below 1990 levels (2020 UK GHG emissions). This indicated that the UK has indeed achieved certain results in improving the environment. Jouvenot and Krueger (2019) examined publicly listed corporations. They discovered that under required disclosure supervision, UK-listed firms had embraced more clean technology. Simultaneously, the absolute level of GHG emissions and GHG intensity (measured as the emissions of each tangible asset) have decreased by approximately 16% and 21%, respectively.

1.3 The Evolution of UK Mandatory Disclosure Policy

1.3.1 Changes to UK climate policy

The UK has been playing a very active role in curbing environmental change and promoting international action to reduce GHG emissions (Bowen & Rydge, 2011), including strong support for international climate negotiations between the United Nations Framework Convention on Climate Change and EU channels,

as well as scientific research at the Intergovernmental Panel on Climate Change. This section explores the history of climate policy in the UK and, through an extensive review of government policy documents and related literature, provides an overview of disclosure policy affecting UK-listed companies, including a range of measures taken by the government and some changes from voluntary to mandatory disclosure.

Since the advent of climate change policy in the late 1980s, it has been elevated to the "main driver of public environmental policy" in the UK (Hulme & Turnpenny, 2004). The UK has taken the lead in focusing political and economic attention on climate conditions (Lorenzoni et al., 2007). For example, the UK played a leading role in the Kyoto Protocol negotiations and used its dominance as G8 chair to make climate change a high priority at the 2005 Gleneagles Summit (Carter, 2014). In 2000, to achieve all GHG reduction targets under the Kyoto Protocol (a 12.5% reduction from 1990 levels between 2008 and 2012), only the UK government set a 20% carbon dioxide (CO_2) reduction target (reducing emissions from 1990 levels by 2010). Notably, defining targets for specific categories of GHG emissions was an uncommon practice at the time, which made the UK's pledge innovative and pioneering.

Launched in 2000, the UK Climate Change Programme 2000 set a target of decreasing CO_2 to 20% below the 1990 limit level by 2010 and developed a number of policies and actions. In September 2004, a subsequent evaluation and review of the program's progress and efficacy were also released. In order to attain this emissions target, the government has enacted a variety of regulations (table 1.1) for the public and commercial sectors of the UK, requiring companies to reduce emissions and take into account the impact of environmental change. In other words, public and private companies are required to gather certain climate data and report it to designated government agencies for examination (e.g., UNEP, Defra, DECC).

Table 1.1: Key mandatory reporting requirements affecting the UK business community

Mandatory Reporting Requirement Name	Implementation date	Main content
Climate Change Levy	2001	A tax is imposed on the taxable supply of some energy products to non-residential users. Dutiable items include electricity, natural gas supplied by gas companies, liquefied petroleum gas, coal, and fuels used for lighting, heating, and power supply by commercial customers in industry, commerce, agriculture, public administration, and other service industries. The dutiable items do not apply to energy provided to residential customers or nonprofit organizations for noncommercial usage. If they join the Climate Change Agreements, energy-intensive customers can save as much as 10%. The initiative aims to promote energy efficiency and decrease emissions.
EU Emissions Trading Scheme (EU ETS)	2005	Replace the UK's Emissions Trading Scheme. On a cap-and-trade basis, the system establishes a "cap" or restriction on the total permissible GHG emissions for all system participants. It transforms this cap into tradable emission credits.
Carbon Reduction Commitment and Energy Efficiency Plan (CRC)	2010	Designed to address emissions that are not yet covered by Climate Change Act (CCA) and EU ETS. It includes a number of motivators designed to motivate enterprises to implement energy management plans and foster a better understanding of energy consumption.
Adaptive Reporting Power (ARP)	2010	Companies largely in the energy utilities, transportation, and water industries were requested to describe the predicted impact of present and future climate change on their organisations, as well as their adaptation suggestions.

Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013	2013	Companies listed on the Principal Market of the London Stock Exchange, New York Stock Exchange or the Nasdaq Stock Market are required to report in their annual (director's) report that they are responsible for Scope 1 (direct) and Scope 2 (energy indirect) levels of GHG emissions (defined by the GHG protocol[1]).
The 2018 regulations	2019	In addition to GHG emissions statistics, directors' reports of public and large private enterprises must contain disclosures of energy usage and energy efficiency efforts. Large LLPs are also obliged to produce a new type of report ("Energy and Carbon Report")

Note: organized by author.

[1] Greenhouse Gas Protocol: The GHG Protocol, jointly developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), sets out a global standard for how GHG emissions are measured and managed and reported across three broad areas. Scope 1 emissions are emissions from company-owned or controlled sources (including electricity generation, heat or steam, physical or chemical processing, company-owned/controlled vehicle transportation, no stationary emissions). Scope 2 emissions are emissions from purchased electricity, consumed in owned or controlled equipment or operations. Scope 3 emissions are emissions from other sources that the company does not own or control, such as business travel, external distribution, supply chains (for example, mining and production of purchased fuels and materials) or the use/disposal of the company's products and services" (WBCSD/WRI, 2004, p.26-34).

Reporting requirements are the initial step in engaging entities in environmental concerns (Jones & Levy, 2007; Gasbarro et al., 2013). Climate change Levy, EU ETS, CRC, as well as domestic climate policy in general, are largely focused on lowering carbon emissions by seeking to "place a price on emissions, promote the development and deployment of clean energy, and increase energy efficiency" (Bowen & Rydge, 2011). The climate regulations mentioned above compel big public and/or private sector organizations to declare their carbon emissions and explain how they are decreasing them. These statutory requirements are carbon-focused and, to a certain extent, place constraints on external environmental institutional policies. Businesses are expected to engage in carbon reporting and get acquainted with it in general.

The ARP is the only significant mandatory requirement for UK-listed corporations to complete an adaptation report. The ARP requires businesses to report on the adaptation process, which means they have to explain their climate risks and opportunities and how they plan to deal with them. Bowen and Rydge (2011) stated that mandatory disclosure approaches that focus on carbon disclosure while disregarding adaptation have resulted in a deficient policy agenda for fostering effective climate adaptation in the UK. By adopting adaptation strategies, governments (and their social stakeholders) are recognizing failure and (human) responsibility for climate change, making it simpler to address accountability and compensation in the future (Preston et al., 2011). Consequently, over the whole decade of the 1990s, the corporate community was more ambitious in responding to and mitigating environmental change, although the activities required to adapt to it were fairly subdued (Ford, 2008). Similarly, businesses may place a higher premium on compulsory carbon disclosure and disregard adaptation reports.

With the acknowledgment that environmental change is an unavoidable process (the Intergovernmental Panel on Climate Change, 2007), Ford (2008) argued that

adaptation to climate change could provide immediate advantages in the form of decreased sensitivity. The development and reform of particular policies have been propelled by the change and acceptance of people's expansive thought processes and academic scientific study. In order to preserve its leadership position in the face of external pressure, the UK has restructured its climate adaptation program, which includes ARP.

Domestic government initiatives to combat climate change were criticized for falling short of expectations by 2006. The UK's domestic climate policy is perceived to be more aspirational than operational (Jordan & Lorenzoni, 2007). The need for climate action that is both more forceful and more tangible is becoming increasingly urgent (the Intergovernmental Panel on Climate Change, 2007). On 26 November 2008, a climate change bill launched by the New Labour government to support a climate change law was introduced to Parliament, which was supported by the business community and ultimately endorsed by the British Royal Family. In this manner, the "CCA 2008" was approved, and the UK became the first nation in the world to enact legislation on climate change mitigation and adaptation.

The primary objective of the Act is to "guarantee that the UK's net carbon footprint in 2050 is at least 80% below the 1990 baseline" and "be more prepared" (CCA, 2008). The Act, therefore, establishes a number of provisions to achieve these ambitious goals. The Act empowers the government with two "reporting authorities," requiring selected stakeholders to (a) disclose GHG emissions from activities for which they are accountable and (b) offer separate narratives on how they are responding to climate change-related risks (CCA, 2008). The two authorities were implemented for the first time in 2013 and 2010, respectively. Certain corporations are legally required to reply, but they are not required or compelled to take action beyond reporting.

1.3.2. Mandatory carbon reporting regulations

In the regulation's ongoing evolution in UK, voluntary disclosure has eventually morphed into mandatory disclosure. The scope and execution of several mandatory disclosure regimes in the UK are summarized in table 1.2. It provides baseline knowledge for the research by reviewing and researching further the differences and evolution of various required disclosure regimes.

As shown in table 1.2, energy-intensive companies are required to conduct energy reporting as well as carbon reporting in response to the Climate change Levy and EU ETS, while non-energy-intensive companies are required to participate in the CRC. Following the issuance of the MCR, both types of businesses will be required to implement mandatory carbon-related disclosure reporting requirements. With the release of the latest regulation in 2019, companies are no longer required to comply with relevant legal requirements by industry category, and all quoted companies[2], large unquoted and LLPs are required to enforce the latest mandatory energy and carbon reporting.

The 2018 regulations deviate in two ways from the other four required reporting requirements. On the one hand, the MCR has increased the number of enterprises required to submit mandatory carbon reports. Companies registered on the main market of the London Stock Exchange would all be affected by the Act, which is not confined to a certain industry. There are more than 1,100 listed enterprises that satisfy applicable requirements, according to data (Tang, 2016). Based on the mandatory carbon reporting requirements, the 2018 regulations once again widened the scope of reporting organizations, affecting a greater number of organizations. The 2018 regulations target not just publicly traded firms subject to compulsory carbon reporting but also major private corporations and LLPs.

[2] Quoted companies in this respect are those whose equity share capital is officially listed on the main market of the London Stock Exchange; or is officially listed in an European Economic Area State; or is admitted to dealing on either the New York Stock Exchange or NASDAQ.

Table 1.2: Key features of various mandatory reporting requirements related to carbon and energy in the UK

Name	Climate change Levy	EU ETS	Carbon reduction commitment	MCR	The 2018 Regulations
Scope and boundaries	Focus on energy consumption and energy efficiency (in Scope 1 and 2 users) rather than CO_2 emissions or other GHG	Scope 1 emissions CO_2,N20, PFC	Scope 1 and 2 emission only CO_2 directly from on site fuels, process and imported electricity/heat	Scope 1 and 2 emission All 6 GHG	Scope 1 and 2 emission, Energy Consumption and Energy Efficiency Actions All 6 GHG,consider reporting on nitrogen trifluoride NF3
Companies affected	Energy intensive industries	Energy intensive industries, particularly Energy, Extractive, Industrial firms	large non-energy intensive firms and public sector organizations not covered by EU ETS or the CCAs	Companies listed on the main market of the London Stock Exchange	quoted companies, large unquoted companies and large LLPs
Assurance	Not specified	Data must be verified by a credited verifier	Not specified	Recommended	No statutory requirement but preferred to complement each other with two internationally recognized sustainability reporting verification standards

Reporting platform	Every 2 years, submitted to Environment Agency	Yearly submitted to Environment Agency	Yearly submitted to Environment Agency	include in the annual report yearly and reviewed by conduct Committee of the Financial Reporting Council	Include in the strategic reports annually and reviewed by conduct Committee of the Financial Reporting Council
Enforcement mechanisms	Removal of levy discount for non-compliance	Penalties for various non-compliant activities	Penalties for non-compliance	Failure to meet reporting standards may result in a revised report	Company directors who do not comply with the requirements will need to re-prepare a revised report and/or set of accounts

Note: organized by author

On the other hand, the 2018 regulations have also increased the content and requirements for related companies to report. The CRC requires companies to submit relevant information to the Information Environment Agency, while the MCR regulations obligate companies to disclose to the public carbon information generated by the company's operations. According to the most recent legislation, additional duties must be incorporated in the content of directors' reports for listed and big unlisted corporations, and a new form of reporting obligations—energy and carbon reporting—must be imposed on large LLPs (Environmental Reporting Guidelines, Including streamlined energy and carbon reporting guidance in 2019). For fiscal years beginning on or after April 1, 2019, listed firms are obliged to not only publish their Scope 1 (direct) and Scope 2 (energy indirect) GHG emissions in their directors' reports but also submit basic global energy consumption statistics to calculate their GHG emissions. Changes to the 2018 regulations mandate that large unlisted corporations publish their UK energy use and GHG emissions data in their reports. Large public and private corporations and LLPs are frequently required to disclose energy efficiency initiatives, intensity ratios, and calculation methods.

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energy consumption statistics to calculate their GHG emissions. Changes to the 2018 regulations mandate that large unlisted corporations publish their UK energy use and GHG emissions data in their reports. Large public and private corporations and LLPs are frequently required to disclose energy efficiency initiatives, intensity ratios, and calculation methods.

Consequently, adopting the 2018 requirements can provide the external public with more possibilities to comprehend the firm's EP and the company's status based on the information revealed by the company. According to the relevant environmental issues disclosed, the public can gain a deeper understanding of the risks and opportunities that the company will face. Stakeholders can also evaluate the company's possible impact on society based on the actions taken by the company and further determine whether to cooperate with related companies. The complete report contains not only the organization's strategy, governance, performance, and future development, but also the enterprise's short-, medium-, and long-term contributions to the external environment. Similarly, the outside world's reaction to the material provided by the corporation will have a substantial influence on the company's subsequent disclosure method, content, and improvement.

1.3.3 The 2018 regulations

In addition, the law provides more clearer directions and obligations. Following the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, the Companies (Directors' Report) and Limited Liability Partnerships (Energy and Carbon Report) Regulations 2018 is the most recent legal framework requiring companies to report mandatory carbon and energy disclosures. To a certain extent, the promulgation of this regulation makes enterprises aware of relevant environmental problems in collecting information and managing the company. On the one hand, it directly prompts companies to take action. On the other hand, it indirectly forces companies to manage the

emissions generated in their daily operations through the pressure of external stakeholders (Luo et al., 2012).

Among MCR, the official purposes of the Companies Act 2006 and the 2018 regulations mainly include the following three:

(1) Assisting the government in reaching its emission reduction goals;

(2) Meeting the needs of investors, shareholders, and other stakeholders who want to see relevant companies disclose environmental information in their annual reports and accounts. The environmental risks are closely related to companies' operations and supply chains. On the one hand, climate change creates physical risks for businesses, and on the other hand, the volatility of energy and commodity prices will bring commercial risks. Consequently, relevant investors may incorporate climate risks into business investment options based on revealed information, and early action to mitigate such risks can potentially provide new economic possibilities.

(3) Increasing the awareness and volume of GHG emissions reporting by enterprises to better discover possibilities to decrease energy and resource costs, establish leadership, improve green certification on the market, and promote emissions reductions as the guiding principles of strategy. In addition, it may assist businesses in using environmental key indicators to evaluate the link between EP and FP (SECR guidance, 2018).

The 2018 regulations went into effect on April 1, 2019, and apply to firm reports for fiscal years beginning after that date. The revised reporting requirements are effective for fiscal year reports submitted on or after 1 April 2019. If the typical reporting year is 1 January to 31 December, the first fiscal year for which the report must comply with the new requirements under the 2018 regulation is 1 January 2020 to 31 December 2020. If the typical reporting year is 1 April to 31 March, the first fiscal year for which the relevant reporting must comply with the new requirements under the 2018 regulation is 1 April 2019 to 31 March 2020.

Compliance monitoring of the application of current law falls within the jurisdiction of the Financial Reporting Council, an independent regulator in the UK tasked with promoting high-quality corporate governance and encouraging investment (Financial Reporting Council, 2014). The Conduct Committee of the Financial Reporting Council reviews compliance with the relevant reporting requirements for companies and the applicable reporting obligations for LLPs under part 15 of the Companies Act 2006. The committee has the authority to investigate situations when there appears to be no relevant disclosure. Under Section 456 of the Companies Act, the Commission has the authority to apply to the court for a declaration that the annual report or accounts of a company or LLPs are non-compliant and to require the directors to prepare revised reports and/or accounts (SECR guidance, 2018).

MCR is a reporting requirement, meaning that firms are simply required to report their emissions data, and there are no significant consequences for noncompliance. Members of an LLP who fail to comply with the energy and carbon reporting obligations or take reasonable efforts to guarantee compliance may be guilty of an offense and subject to fines under the 2018 regulations. Nevertheless, a few exceptional circumstances might prevent the disclosure of pertinent information. For instance, if the company consumes less than 40,000 kWh of energy during the preparation of the board report or if the board of directors believes that the disclosure of relevant information will significantly impact the company's interests, it is optional to disclose relevant information. Under these circumstances, it must be indicated in the report for these firms that the disclosure was not made for such reasons.

The government is mainly concerned with the practicality and efficacy of enacted policies, while simultaneously seeking to alleviate the burden on businesses as much as possible (Defra, 2013). In the first year of reporting,

certain organizations may be required to include data from before the 2018 laws, although not all companies can fulfil the requirements. However, if the public company's fiscal year begins before to April 1, 2019, it is needed to submit some necessary GHG statistics. In light of this, it is anticipated that the first version of the report that must conform with the 2018 requirements will be presented to the House of Companies in 2020. Companies who are unable to offer similar data may estimate their data or explain why they are unable to supply it, enabling stakeholders to compare and examine relevant data.

There are no clear restrictions in the relevant regulations about the form of reporting emissions, specific content and the measurement of emissions. In response to these more detailed disclosures, the government has further issued some guidelines to assist companies in reporting. The government has established more specific 'UK Government GHG Reporting Guidelines' and other universally acknowledged independent standard (with a reliable and accepted method) for businesses (such as GHG Protocol Corporate Standard, International Organization for Standardization (ISO 14064-1:2018), and GRI (Global Reporting Initiative) to measure their emissions. For mandatory reporting requirements in directors' reporting or energy and carbon reporting, relevant information from other national and international regulatory reporting processes, such as the Energy Savings Opportunity Scheme, Climate Change Agreements Scheme, EU ETS, may be utilized. In their directors' or energy and carbon reports, companies must disclose one or more of the methodologies employed and related criteria (SECR guidance, 2018).

The legislation does not require independent assurance of emissions and energy use data, nor the narrative of energy efficiency actions; however, the relevant guidance recommends that external independent assurance be included as part of the report. The inclusion of independent assurances or representations to external third parties in the relevant emissions and energy reports not only provides

guidance to the internal management of the company in the process of making relevant management and internal measures, but also provides assurance to external stakeholders. Relevant independent warranties and representations include the accuracy, completeness and consistency of energy usage data, GHG emissions data, and the effectiveness of corporate emission reduction measures and energy efficiency actions. Therefore, in the process of mandatory disclosure by enterprises, both the legal system and guidelines provide guidance for enterprises' report contents.

1.3.4 Comparison of International GHG Disclosure Regulations

Similar to the UK, other nations and organizations have made considerable contributions to motivate businesses to advance environmentally friendly technical and enhance the EP of companies and society as a whole. However, there are also several distinctions between them. Through study and analysis of environmental disclosure legislation from an international perspective, the development process and uniqueness of the UK's GHG disclosure regulation for businesses from voluntary to mandatory disclosure may be better understood.

Consistent with British disclosure legislation, carbon information disclosure by American corporations has shifted from voluntary disclosure to disclosure mandated by laws and regulations. The US Supreme Court classified CO_2 as an air contaminant in 2007. Subsequently, the 2008 US Congressional Appropriations Act proposed several Environmental Protection Agency regulation requirements. Support environmental programme and increased funding from the Environmental Protection Agency Administrative Account to develop and publish mandatory reporting of GHG emissions, and to test mandatory reporting for all sectors of the US economy that meet specified levels of GHG emission sources.

Under the Clean Air Act, the US Environmental Protection Agency announced

obligatory GHG reporting rules in the Federal Register on October 30, 2009, outlining the particular information that corporations are required to submit. It labels CO2 and five other GHG as air pollutants. In addition, the required GHG reporting system in the US encompasses 41 emission sources and has defined accounting rules for each kind of emission source. It also instructs US corporations on how to make necessary disclosures. Currently, with regards to the scope of the mandatory disclosure system, the US government does not categorize corporations as specifically as the UK. Instead, all US corporations, particularly major publicly traded companies in significantly polluting industries, must publish their carbon statistics, so that management and external stakeholders may better understand the company and make prudent production, operation, and investment decisions.

Australia has implemented disclosure requirements for enterprises' GHG emissions and energy use. It consists primarily of the “National GHG and Energy Reporting Act” enacted in 2007, offering an impartial reporting framework for Australian businesses to disclose GHG emissions, GHG projects, and energy production and consumption. It clarifies companies’ disclosure responsibilities and obligations. These are consistent with the UK Mandatory Disclosure Guidelines and can guide corporate disclosures. Although proper standards and procedures have been established for the information that must be disclosed, unlike the British mandatory regulations, it does not categorize the disclosure information for various sorts of businesses.

Japan also places a high priority on mitigating climate change. Similarly to the UK, business carbon information is mostly available via environmental information disclosure. The government’s environmental management and protection agencies, the Joint Accounting Standards Board, and the Japan Institute of Certified Public Accountants collaborate primarily to design environmental accounting and information disclosure standards and guidelines.

Since 1999, Japan's "Environmental Year," the Ministry of the Environment's Environmental Accounting Guidelines and Environmental Report Guidelines have undergone two revisions and are continually developing. Because the Japanese Ministry of the Environment has built a corporate environmental information disclosure system that encompasses the more complicated accounting of environmental costs and benefits, corporate environmental accounting and information disclosure has been successfully promoted. In April 2001, Japan also promulgated and enacted the "Registration System for the Movement and Emission of Environmental Pollutants," also known as the "PRTR Law", which mandated that businesses accurately comprehend and declare the quantities of 354 chemical substances listed as registration objects (including GHG).

First, unlike in the UK, Japan's environmental information disclosure is separate from the company's financial and accounting information disclosure, and the preparation of environmental reports follows a distinct disclosure paradigm. Second, the current environmental report is voluntary and generated by enterprises of their own will. Thirdly, the environmental report has a standard structure, which more properly represents the integrity and intuitiveness of environmental accounting information, and information consumers can grasp the environmental information of enterprises as a whole, including carbon information. Henceforth, the environmental reports of Japanese firms will only be acknowledged if they have been certified by an independent third party.

Unlike authorities in other nations, the Chinese government combines voluntary and compulsory procedures to enhance corporate social responsibility (CSR) (Camilleri, 2015). Due to the complexity of China's regulatory structure and the late start of research on environmental information disclosure, nuances within the system are easily ignored, and applicable legislation is still in the stage of

exploration and reference (Situ & Tilt, 2018).

As a developing nation that embraces worldwide social obligations, the Chinese government actively responds to the request of the United Nations Conference on Environment and Development, actively creates a low-carbon economy, effectively constructs low-carbon green production, lifestyle, and consumption patterns, and aggressively conducts GHG accounting and reporting. The National Development and Reform Commission released "guidelines for the Pilot Program of Accounting and Reporting of Corporate GHG Emissions" in October 2013 to assist the top ten industries and companies in their GHG accounting and reporting efforts. This laid the foundation for the considerable continued expansion of the compulsory disclosure policy. The National Development and Reform Commission and the National Bureau of Statistics produced "Opinions on Strengthening Climate Change Statistics" in the same year, which offered more explicit instructions on measuring GHG emissions. Simultaneously, the National Bureau of Statistics produced the "Statistical Work Plan for Addressing Climate Change," built a statistical indicator system for addressing climate change and a departmental statistical reporting process, and formed a leadership group for statistical work. To further assure data integrity, validity, and dependability, the measurement and reporting of revealed indicators should be governed by reporting criteria and statistical programs.

France introduced a legislation entitled "Nouvelles Régulations Economiques" (New Economic Regulations) in 2002. The legislation mandates that all publicly traded corporations include in their annual reports important information regarding the environmental impact of their business activities. Although reporting is mandated by law, there are no specific requirements regarding the type of information that must be submitted. Subsequently, the implementation of the second Grenelle Act of 2009 in 2011 enlarged the scope of reporting companies. Companies with more than 500 employees are required to disclose

the environmental effect of their activities, including non-financial data on water, air, emissions, and energy.

French disclosure standards include a comprehensive list of environmental information. On the contrary, British company managers have broad discretion in the disclosure of their annual reports. In addition, the regulatory laws of France, and the UK have in common that they have no obligation to audit environmental information.

Compared with the China and France, the environmental disclosures in the UK are subject to more supervision. The British government was the first jurisdiction to require publicly listed companies to disclose their GHG emissions data in their annual financial reports (Samuel & David, 2017). Simultaneously, the UK's disclosure system is gradually becoming more uniform and reliable.

1.4 Research motivation

GHG emissions are the major cause of climate change (Luo, 2019), and enterprises are the main source of these emissions. As the impact of GHG emissions continues to increase, there is a growing interest among the public and academic communities in doing research in the field of emissions (Madkour, 2019). Combining prior practical experience and theoretical research on carbon emissions, companies and governments need to work together to tackle this problem in every nation. As the primary producer of GHG emissions, businesses must improve their awareness of the need to reduce emissions. Moreover, the government must enact policies that supervise businesses to assume greater responsibility for pollution reduction. The fundamental motivation of this study is to determine whether it was possible to integrate business and government actions to decrease GHG emission while also satisfying the needs of external stakeholders. The implementation of the mandatory disclosure regulation fulfills this need.

However, when analyzing disclosure requirements in different countries (where regulations may differ), an important question is whether disclosure should be voluntary by businesses (despite pressure from various parties) or should be required on some mandatory basis. At the same time, it is difficult or inappropriate to remove from the content elements that happen to be required in one country but not another if multiple national systems are mixed in the study of corporate information disclosure. In addition, even under the requirements of the mandatory disclosure regulations, many countries have given enterprises enough discretion. Therefore, it is necessary to conduct targeted research on the mandatory disclosure policies of a country that has changed from a voluntary emission system to a mandatory disclosure system, which can also provide a certain reference for other countries or create a comparison with other countries.

In addition, the study on the influence of mandatory disclosure regulations on the content of corporate disclosure is insufficient, according to the research on GHG emission regulation. Especially in selecting an appropriate measurement method, the other motivation of this research is the hope to find a relatively general, easy-to-understand, and reproducible method to measure corporate disclosure information.

Finally, the motivation for research exploring the impact of carbon disclosure quality on FP and EP in the context of a mandatory disclosure regime comes from the uncertainty surrounding it. There is no unanimous answer as to whether adopting GHG information disclosure methods by enterprises will actually impact the enterprises. At the same time, companies may disclose or not disclose information for various reasons. There is also a lack of quantitative research evidence on the impact of corporate environmental information disclosure on corporate FP and EP. Therefore, this research hopes to judge the changing trend of the actual performance of enterprises through the collection of objective data

and the establishment of models. A deeper knowledge of the interrelationships between various elements may aid businesses in their management and planning and serve as a resource for decision-makers.

1.5 Research questions

Most of the previous studies have focused unilaterally on the causes of corporate GHG disclosure (Hughes et al., 2001; Sutantoputra et al., 2012; Luo & Tang, 2014) or the possible impact of GHG disclosure (Popova et al., 2013; Ali et al., 2020; Downar et al., 2021).

According to the research on the drivers of corporate environmental information disclosure, varying EP results in varying levels of disclosure. Hughes et al. (2001), for instance, examined the disclosures of 51 American industrial firms. Disclosures made in the early 1990s demonstrate that organisations with differing ratings adopt diverse reporting strategies, with the lowest-performing corporations revealing the most information. Luo and Tang (2014) discovered that greater carbon disclosures were associated with improved EP despite only having data from a single year. In contrast to the majority of prior studies, Sutantoputra et al. (2012) examined the association between EP and outcomes using data from 53 Australian enterprises. They found no correlation between the quantity of disclosure and environmental efficiency.

Other research has shown that disclosure content has a real impact on companies' practical performance (Downar et al., 2021), firm value (Popova et al., 2013), cost of equity capital (Ali et al., 2020). According to research by Downar et al. (2021), the increase in transparency related to GHG reporting requirements such as the 2013 Act in the UK has led to a significant decline in corporate GHG emissions. Jouvenot and Krueger (2019) verified that UK listed companies with high GHG emissions showed higher operating costs after strengthening mandatory supervision.

In contrast to past research, this study does not examine whether high or low polluters disclose more or less carbon or if these reports correctly reflect real EP (Gray & Milne, 2015). The question of this research is whether the obligatory disclosure regulation is adequate to have a genuine influence and further affect the actual performance of corporations. For instance, if the 2018 rules that compelled corporations to report environmental information result in firms disclosing more information? Whether more corporate disclosure of information will result in enhanced FP and decreased GHG emissions. This subject has received minimal focus. Particularly in response to the fast growth of the economy and the growing emphasis on carbon emissions, applicable rules are expanding and improving. Understanding changes in the needs of environmental disclosure requirements for continuous improvement and the short-term and long-term impact on the organization will assist company managers in enhancing internal management and supporting decision-makers in comprehending the genuine impact of regulations.

1.6 Research aim and objectives

The aim of this research, according to the introduction of new obligatory environmental disclosure legislation and relevant literature, is to improve and update corporate environmental disclosure indicators and establishes a framework to assess the content and quality of disclosure contents. By utilizing this evaluation approach, the study may more precisely assess the real effect of mandatory regulations on the quality of company disclosure reports, firms' actual performance, including FP and EP. Chapter 2 presents theoretical frameworks for the link between environmental information disclosure and the FP and EP of corporations. Chapter 4 has more explanations of the filter and measurements of FP and EP.

In order to complete the research aim, this study will focus on four specific

objectives as follows:

(1) To comprehend the significance and impact of mandatory disclosure policies on enterprises and the practise of enterprises' environmental disclosure;

(2) To understand the most recent evolution and relevance of environmental information disclosure to corporation FP and EP;

(3) Conduct quantitative research to examine the influence of mandatory information disclosure legislation on company GHG information disclosure and to investigate further the association between corporate GHG information disclosure and corporate GHG emissions and the relationship between corporate GHG information disclosure and corporate FP;

(4) Consider the significance of the results for business managers and policymakers in terms of environmental information disclosures.

1.7 Importance of this study

This research is significant from several perspectives, including practical, academic, and policy. First, as demonstrated in paragraph 1.2, mandated disclosure policies are increasingly viewed as an effective means of preventing environmental degradation and drawing company attention to GHG emissions and environmental information disclosure management. However, there is no consensus on how to analyse and evaluate the precise impact of mandatory disclosure regulations on businesses; so, further study is required. For the rational disclosure of environmental information, it is crucial to examine the effect of the implementation of mandated disclosure rules on the quality of corporate GHG information disclosure. On the one hand, it can assist businesses in avoiding the risk of breaking relevant legislation. On the other hand, it may assist company managers in disclosing pertinent information more efficiently, allowing firms to satisfy the expectations of external stakeholders based on legality and get additional advantages.

Second, the scholarly importance is acknowledged. Due to the fact that the

majority of past research on the effects of environmental information disclosure stems from one-sided studies, researchers are unable to draw consistent conclusions (such as the causes of GHG information disclosure and specific impacts of environmental information disclosure). Few studies have examined the real impact of environmental IDQ on businesses' performance under mandatory disclosure regulations. This study constructs a chain of important variables in order to assess the influence of mandated GHG disclosure legislation on the quality of GHG information and the link between environmental disclosure and corporate FP, as well as the link between environmental disclosure and EP. The relationship chain provides a unique viewpoint on the literature. In addition, designing a quality measure of environmental information disclosure by integrating several policy criteria is a significant addition to the current literature because most published metrics of the quality of environmental disclosures disregard policy requirements.

Third, this research has value for policymakers. The report's environmental information is the most effective form of disclosure accessible to external stakeholders. Companies can communicate environmental information to external stakeholders through relevant reports. The designers of disclosure rules, policy guideline makers, and market regulators can get insight from a complete analysis of the actual content of information released by firms and the particular indicators reported by enterprises. In Chapter 6, its usefulness is explained.

Overall, it has been acknowledged that environmental disclosures can have varying implications on a company's actual performance. At the same time as mandatory disclosure regulations are implemented, external systems will exert pressure on businesses. A full evaluation of the advantages and risks that may result from corporate environmental information disclosure in accordance with the most recent regulations can greatly assist company operations.

1.8 A synopsis of research methods

This is an quantitative study applying a mix of content analysis and quantitative research methods conducted over a six-year period with a sample of 209 companies. The purpose of quantitative research is to test and evaluate hypotheses through the lens of objective experimental testing. Large quantities of data aid in establishing the causal relationship between correlated phenomena. The law of causality governs the existence of the facts, which exist regardless of people's opinions and thoughts. This is the nature of the universe people inhabit (Crotty, 1998). Quantitative research is an experimental method that combines logical reasoning and theoretical understanding of real-world occurrences to find the causal principles underlying general, predictable behavioral patterns. In order to obtain the most accurate estimate, it is of the highest significance in quantitative research to choose variables using the most objective way feasible. The connections between the variables are then examined to see how they interact and cause linked outcomes. Under the influence of this study method, a number of issues and reliable knowledge of social phenomena are generated on the basis of experimental science (Neuman, 2003). Quantitative research is more impartial, providing evidence via the digital collecting of actual facts (Sarantakos, 2005). The results of quantitative studies are verifiable and reproducible (Lincoln & Guba, 2005). Therefore, positivist research emphasizes the application of legitimate and reliable methods to describe and explain phenomena.

While positivism may not properly explain reality or phenomena, quantitative research is methodologically more objective and hence more dependable than qualitative research (Pham, 2018). This technique is more appropriate for research on the impact of corporate environmental information disclosure on firms. On the one hand, an objective relationship exists between corporate environmental information disclosure, FP, and EP that is unaffected by subjective human behaviour. By selecting appropriate sample data, the relationship between financial success and EP metrics may be assessed more objectively.

Choose the content analysis method when selecting disclosure metrics. Content analysis is more suitable for classifying and assessing textual material. As the key instrument for researching public information, it is frequently utilised in studies of annual reports, social responsibility reports, and sustainability reports. Qualitative content analysis can classify the majority of texts into fewer subject areas (Vaismoradi et al., 2013). This technique is suitable for categorising the environmental information in this research, as the qualitative and quantitative data disclosed by businesses in the report spans a wide range of categories. Finally, the gathered words, phrases, and other texts with similar meanings can be formatted as a quantitative index. This method selection is conducive to quantitative analysis and research on the impact of future disclosure requirements on corporate environmental IDQ.

1.9 Research findings

This study investigates the link between the mandatory disclosure rule and the quality of business GHG information disclosure, as well as the relationship between the quality of company GHG information disclosure and FP/EP. Based on institutional theory, this thesis explores the influence of mandatory disclosure systems on the quality of corporate environmental information disclosure in the context of institutional pressure from the outside. Organizational structure and behavior are constrained by external frameworks such as laws, rules, and beliefs (Meyer & Rowan, 1977). The framework does not completely govern the organisation but acts as normative guidance. In institutional theory, corporations are classified as pioneers, or late adopters of organizational practice (Dillard et al., 2004; Hollindale et al., 2019). In an environment of limited resources, obeying institutional laws and achieving technological efficiency may be contradictory. However, strict environmental regulations may stimulate corporations continuous greening innovation, increase their environmental competitiveness and obtain extra profits. Therefore, it is anticipated that the

transition from voluntary disclosure to mandatory disclosure would also improve the quality of GHG disclosure by firms.

In addition, this research examines the link between environmental information disclosure and FP from the viewpoints of cost, external stakeholders, and voluntary disclosure, drawing on agency theory, signaling theory, and voluntary disclosure theory. Despite the fact that short-term CSR efforts may raise agency costs, this unfavourable correlation decreases as spending becomes more stable and benefits become more apparent. Through enhanced stakeholder relationships, access to physical and intangible resources, and access to ethical reputational capital, CSR may positively impact a business's long-term FP. According to legitimacy theory and signaling theory, the relationship between environmental information disclosure and EP is analyzed from the perspectives of external stakeholders and corporate internal managers. It can help business managers increase environmental protection consciousness and the motivation to optimize EP, lowering GHG emissions. Based on this information and the notion of assessing the impact of time, sample data from 209 companies spanning six years was examined.

The research generated several findings. According to quantitative research, the 2018 regulations have had a significant impact on the quality of environmental information disclosure by businesses. In 2020, qualitative and quantitative indexes have increased to a certain extent, with the extent of the increase becoming increasingly apparent. In addition, categorization of businesses according to different industry groups demonstrates that the effect of different company types on the quality of disclosure is not statistically different, which is comparable to the findings for the full sample. Simultaneously, the link between environmental information disclosure and the FP and the link between environmental information disclosure and EP of the company are explored. Results shown that as corporate disclosure quality rises, the firm's FP steadily

improves, while GHG emissions gradually decrease.

1.10 Research contribution

This study contributes to both the quantitative and theoretical literature on mandatory disclosure policies and environmental disclosure. First, it tackles the absence of quantitative evidence on the influence of mandatory disclosure regulations on firms' disclosure quality of environmental information. In fact, as far as the author is aware, this is the first study on the influence of the 2018 regulations on the disclosure of corporate environmental information; hence, it can also cover research and literature gaps in this field. This study proposes a novel method for assessing the impact of external institutions on the disclosure incentives of enterprises through changes in the quality of environmental information disclosure, which is distinct from earlier studies on disclosure. Understanding that environmental disclosure requirements have a lasting impact on a company's ability to respond to needs for continual improvement, and disclosure indicators will assist stakeholders, investors, sustainability agencies, and regulators evaluate the disclosures of relevant organizations. In addition, the research can be used as a guide for future modifications of disclosure requirements by regulators.

Second, this research combines mandatory and voluntary disclosures to establish environmental information quality metrics. In designing the appropriate disclosure indicator system, the combination of voluntary disclosure content and the most recent compulsory disclosure requirements gives a novel perspective and overcomes the limitations of previous research. The number of indicators revealed by firms is used to assess the quality of environmental information reports. The strategy is straightforward, easily understandable, and simple to execute, with practical implications for additional settings and future improvements.

Thirdly, the findings add to both quantitative and theoretical studies on the relationship between environmental disclosure and corporate FP, as well as the relationship between environmental disclosure and EP. Specifically, it is discovered that different theoretical rationales may have varying effects on the interaction between diverse components, and that seemingly opposing views may provide consistent study results. The findings about the influence of the quality of GHG information disclosure on the FP and EP of corporations provide an quantitative basis for the investigation of their connection.

Lastly, earlier studies on carbon emissions were undertaken in the US (Fisher-Vanden & Thorburn, 2011; Hsu & Wang, 2013; Jacobs et al., 2010; Kim & Lyon, 2011). Few obligatory carbon emission studies have been done in developing nations (mostly China) (Zhang et al., 2019; Zhu et al., 2019). Although research on mandatory carbon disclosure has risen over the past several years, European markets, notably the UK, have given little attention to the diverse effects of carbon disclosure. Understanding the financial and environmental impact of environmental disclosure on the business, especially under the influence of mandatory disclosure policies in the UK, may fill the gap in this part of the research.

1.11 The structure of thesis

This dissertation is structured as follows. The first chapter presents an overview of this research, including its context, aim and objectives, a synopsis of the research methodology and major contributions. This chapter demonstrates the need for this research, provides background for the study, and highlights the importance of its contribution to the current body of knowledge.

Chapter 2 is a literature review that gives a theoretical and quantitative overview of corporate GHG disclosures, FP, and EP pertinent to the aims and scope of this study. Chapter 2 presents the definition of GHG disclosure, the relevant

theoretical framework, prior research, as well as a review of the factors that influence corporate GHG disclosure. This chapter primarily provides a theoretical foundation for companies' motivation to disclose GHG emission information. Sharing GHG emission information alongside the external pressure businesses encounter gives theoretical justification for the research. It introduces the potential implications and consequences of GHG disclosure on businesses to pave the way for the interaction between environmental information disclosure and enterprise FP and EP. Based on the previously stated theoretical viewpoints, the following part offers a comprehensive theoretical framework for the link between corporate environmental disclosures and FP and the link between corporate environmental disclosures and EP. Based on the relevant theories of predecessors, the research objective and significance, the hypotheses of this study are formulated, namely that the 2018 regulations will have a positive effect on corporate information disclosure and that there is a positive correlation between the implementation of social activities and corporate performance (FP and EP). These three hypotheses are also the primary concerns of this research.

Chapter 3 discusses the study's research methodology. It begins with a discussion of philosophical topics related to research, such as research paradigms, ontology, and epistemology, and highlights the significance of constructivism and quantitative research. Second, this chapter details the study's methodology. This study will employ content analysis and quantitative research as its analytical approaches. Thirdly, the chapter discusses in detail the use of content analysis, including document data collection, corporate (climate change) material assessment, sample selection criteria, and indicator design criteria. Fourth, based on the quantitative research approach developed in this study, some models for quantitative examination are then established.

Chapter 4 introduces the specifics of quantitative analysis. The quantitative study presents descriptive statistical findings about the relationship between the quality

of GHG disclosures made by UK-listed firms and their FP and EP. The annual reports of British listed businesses, sustainability reports, and GHG disclosure-related information on linked websites are selected for content analysis based on the company sample defined in chapter 3 and the selected sources and standards of GHG disclosure indicators. The GHG disclosure content indicators are then evaluated and categorized in depth. The research identifies relevant variables for the FP and EP of businesses and develops an econometric model based on hypotheses. The next section offers descriptive statistics.

Chapter 5 examines research hypotheses and presents quantitative results and critical analysis. First, it presents the findings of quantitative research indicating that the introduction of mandated environmental policies by publicly traded corporations in the UK enhances the disclosure of important environmental information about GHG emissions and energy consumption. Particularly following the announcement of the 2018 regulations, the relevant firms have substantially enhanced their disclosure of pertinent details. In addition, section 5.2 addresses the link between the environmental disclosure of GHG information by businesses and their economic performance and real EP, based on the quantitative study findings. Simultaneously, the sample is separated into nine groups based on industry, the sample results are investigated in greater depth, and the association between the 2018 regulations and the changes in the disclosure quality of various sectors of firms is summarized. The robustness of the research model is evaluated in Section 5.4. The final portion is an overview.

Chapter 6 is the concluding chapter and contains the summary and findings, the limits of the study, the implications of the study, and opportunities for further research. Overall, this study fulfills chapter 1 research objectives, supports pertinent hypotheses, and offers a significant contribution to the literature.

Chapter 2: Literature review

2.1 introduction

This chapter provides a theoretical and literature overview of mandatory disclosure regulations, corporate GHG information disclosures, and corporate FP and EP based on the scope and objectives of this study. This chapter is organized as follows. Section 2.2 stipulates the principles, contents, and indicators that enterprises need to disclose under the mandatory disclosure regulations. This part mainly provides background knowledge for the content of IDQ and the selection of indicators. Section 2.3 proposes the relevant theoretical framework of GHG information disclosure, which mainly provides a theoretical basis for the motivation and influence of companies to disclose GHG emission information. Section 2.4 reviews the factors that influence a company's GHG disclosures. When the internal and external pressures businesses face are added to the information about their GHG emissions, it gives the research some theoretical background. Section 2.5 focuses on the range of impacts and consequences that GHG information disclosure may have on businesses. In Section 2.6, environmental information disclosure and associated studies are defined to establish the context for the relationship between environmental information disclosure and corporate FP and EP. Based on the theoretical point of view presented earlier, Section 2.7 gives a brief summary of a theoretically integrated framework for the relationship between corporate environmental information disclosure and FP. Section 2.8 summarizes a theoretically integrated framework for the relationship between corporate environmental information disclosure and EP based on a theoretical perspective. Section 2.9 describes the impact of the institutional environment on corporate behaviour, including the implementation of social activities such as GHG disclosures and the impact on the relationship between GHG disclosures and FP. According to the previous relevant theoretical foreshadowing, this dissertation's purpose and significance are explained, the research's hypotheses are put forward, and the relevant summary is made.

2.2 Principles, content and indicators of mandatory GHG disclosure

The Mandatory Disclosure Law provides a wide range of relevant environmental information that companies must disclose. Enterprises must follow some guidelines when disclosing information, in addition to adhering to any regulations. Consequently, specific standards are also needed to guide various organization types toward appropriate disclosures. The disclosure guidelines serve as a foundation for the disclosure content and specifics of businesses.

2.2.1 Mandatory GHG disclosure principles

There are many global initiatives that companies can refer to when developing their environmental reports, such as GRI, ISO and DEFRA (Helfaya & Kotb, 2016). Companies typically include qualitative and quantitative information when making environmental disclosures to measure, calculate, or estimate the environmental impact of the company's actions, depending on the programme and legal requirements (Burrit & Schaltegger, 2010). Corresponding guidelines typically accompany the Mandatory Disclosure Act to help businesses disclose related information more effectively. For instance, DEFRA published "Guidance on how to measure and report your GHG emissions" in 2009, offering businesses guidance on determining and explaining their carbon footprint. This was done in response to the CCA. The 2018 regulations are tackled in the guideline on streamlined energy and carbon reporting, which aims to assist businesses around the UK in adhering to the legal requirements that took effect on 1 April 2019 within the context of the new regulations.

Companies can choose from different framework guidelines when making disclosures, and updated frameworks share some common and different principles. In the process of selecting disclosure content, enterprises need to follow corresponding principles according to the framework and guidelines so that the content in the report can be described effectively and comprehensively,

ensure a certain disclosure process for enterprises and stakeholders, and facilitate the verification and comparison of external review institutions. The relevant principles are summarized according to the different guidelines for the mandatory disclosure of carbon and energy by British companies.

Table 2.1: Principles Followed by Different Environmental Disclosure Guidelines

		DEFRA 2006	**DEFRA 2013**	**SECR 2018**
Principles to be followed in the environmental report disclosure process	Transparency	√	√	√
	Accountability	√		
	Credibility	√		
Principles for Disclosure in Environmental Reports	Quantitative	√	√	√
	Relevance	√	√	√
	Comparability	√	√	√
	Accuracy		√	√
	Completeness		√	
	Consistency		√	√

Note: organized by author.

In the process of disclosing environmental reports, businesses must adhere to three principles: transparency, accountability and credibility. The specific analysis is as follows:

(1) Transparency

This principle is essential to whether an organization can compile a report with high reliability because it is included in DEFRE 2006, DEFRA 2013, and SECR 2018. Companies must comply with the principle of transparency by preparing reports that outline the extent of their public disclosures, precisely define the scope of the companies involved, have relevant responsibilities for the environment or sustainable development, explain their internal processes and system risks, use relevant assumptions, provide sources of data and calculation methods, and provide documentation for why and how they gather the pertinent data.

(2) Accountability

This principle is contained in DEFRE 2006, and it essentially asserts that each activity may be traced back to the person who should be held accountable. Different managers are in charge of a company's management strategy and emission reduction efforts. The company's owners are ultimately responsible for the financial decisions made by the board of directors. As a result, in order to comply with this principle, businesses must consider factors such as the definition, nature, and extent of stakeholder participation in the reporting process, whether or not environmental reports should be included in annual reports, financial statements, and business reviews, the existence and calibre of third-party guarantee statements, the existence of communication strategies, and the extent to which information has been specifically compiled to meet the needs of institutional investors.

(3) Credibility

This principle, mentioned in DEFRE 2006, emphasizes that any report must be contextualized. The report's specific impact must be connected to the broader relationship between the business and society and integrated with sustainability principles. Businesses need to learn more about sustainability and its use in their operations. The company's supply, production, and marketing policies, efforts to manage product impacts, the existence of external certification and other environmental management systems, as well as the existence and description of other data collection, measurement, and management procedures, must all be made clear by the company at the same time.

The three aforementioned guidelines for environmental reporting must be followed, and it is also vital to choose appropriate indicators to evaluate the information revealed in the environmental report. The following criteria must be adhered to by these crucial and useful indicators:

(1) Quantitative

When creating key performance indicators (KPI), businesses must take into account whether they are quantifiable and measurable. According to this principle, which is outlined in DEFRE 2006, DEFRA 2013, and SECR 2018, organisations can only implement indicators effectively if they have measurable qualities. At the same time, by quantitatively expressing for a certain emission index, it is feasible to set targets to reduce the emissions of specific elements. Quantitative indicators can also aid in the efficient evaluation and validation of environmental management policies and systems by business managers.

(2) Relevance

This principle appears in DEFRE 2006, DEFRA 2013, and SECR 2018. In the process of defining corresponding indicators, businesses must ensure that the data gathered and provided accurately reflect the company's EP and impact based on the company's internal and external decision-making needs. In addition to quantitative information, the formulation of the relevant key indicators includes specific explanatory content, such as explanations of the goal and impact of the corresponding indicators, the changing process, the calculation technique, and the underlying assumptions. Concerning the enterprise's performance, the report must also reflect the enterprise's development relative to its goals, whether it has improved or regressed, and how to address these issues. The issues encountered by different businesses and the efforts they must make in the market environment are not always the same; for instance, environmental fines and related fees. Therefore, in the process of index selection, businesses must adhere to the idea of relevance based on their own firm features.

(3) Comparability

This principle appears in DEFRE 2006, DEFRA 2013, and SECR 2018. The rules and regulations do not require businesses to select a particular indicator but instead provide various options. Companies must report data using established

KPIs, not their own interpretation of the underlying standard metrics. Recognized KPIs serve as a benchmark for the business, and appropriate narratives help companies justify providing specific KPIs along with comparable data, which improves the data comparability of enterprises to some degree and enables enterprises to compare with their peers and evaluate their EP.

(4) Accuracy

This principle is featured in both DEFRA 2013 and SECR 2018, and it also helps firms in selecting indicators by minimizing the ambiguity in the data that appears in the report. External users can make their judgments and conclusions based on the comprehensive and accurate report information only when the data in the corporate report is sufficiently correct.

(5) Completeness

Only DEFRA 2013 has this principle, which essentially compels businesses to report on all sources of environmental impact within the reporting parameters they have established. In the disclosure process, enterprises cannot make any explicit exclusions and will provide certain explanations under unique conditions. This principle is also intended to aid external users in making appropriate and correct judgments while utilizing the report.

(6) Consistency

Both DEFRA 2013 and SECR 2018 contain this principle. This principle is crucial for the proper comparison of data inside corporate reports. This concept mandates the adoption of a consistent system for information collecting and reporting, enabling organizations to make meaningful comparisons of environmental impact data across time. When companies make appropriate modifications, they must also file specific disclosure reports.

2.2.2 Mandatory GHG disclosure content

Internationally influential carbon information disclosure initiatives, such as CDP, GRI, and The Climate Risk Disclosure Initiative, have proposed more specific disclosure content criteria. Regarding the content of mandated carbon disclosure, the research provides related explanations.

2.2.2.1 CDP

In 2000, institutional investors in London, England, spontaneously established the CDP, a global carbon information disclosure project. The project has established a rather comprehensive framework for carbon information disclosure, and it is currently a global standard for carbon information disclosure and a significant source of carbon information.

The operational objective of the CDP project is to provide information about the impact of climate change on corporate value by releasing to investors information about carbon emissions affecting the climate, which in turn presents enterprises with major risks and opportunities. On the one hand, it assists businesses in mainstreaming climate change and energy efficiency concepts, allowing them to comprehend better how to defend themselves from climate change and become more energy efficient. On the other hand, it assists investors in gaining a clearer and more comprehensive understanding of the risks associated with their investment portfolios, and in implementing the appropriate strategies and actions to reduce investment risks, achieve sustainable investments, and maximize investment returns.

Since 2003, on behalf of institutional investors, the initiative has used questionnaires to collect carbon-based climate change-related information from the world's top publicly listed companies in order to achieve the aforementioned aims. The initiative will have released twenty consecutive climate change survey reports by 2022, representing more than 680 investment institutions with total

assets of $130 trillion. Since there is no global standard for carbon information disclosure, the CDP project is devoted to examining and enhancing the content and disclosure requirements of climate change information disclosure.

In 2003, the first CDP questionnaire centred on publicly listed companies disclosing information on carbon emissions and emission reduction efforts. Later, the questionnaire's disclosure of relevant information such as corporate governance, company strategy, carbon emission calculation method, carbon emission trading, and carbon emission intensity expanded progressively as a result of its constant updating.

Since 2015, the content of climate change information provided by the CDP project has increasingly stabilized, with the following three areas comprising the majority of its information: First, the dissemination of information regarding climate change management. This information contains the company's efforts to combat climate change in terms of corporate governance, strategy, goals and activities, and communications. Second, the dissemination of information regarding climate change risks and opportunities. These details cover regulatory, physical, and other threats to companies posed by climate change, as well as regulatory, physical, and other possibilities. Third, the dissemination of information regarding GHG emissions. This includes GHG accounting methodology, emissions data boundaries, Scope 1 and Scope 2 emissions data, data accuracy, external validation of Scope 1 and 2 emissions data, biological carbon sequestration, Scope 1 emissions data decomposition, Scope 2 emissions data decomposition, energy consumption, emissions reduction performance, carbon emissions trading, and Scope 3 GHG emissions data.

2.2.2.2 GRI

The GRI was established in 1997 by the Coalition of Environmentally Responsible Economies and the United Nations Environment Programme, two

non-governmental organizations from the United States. It is an autonomous worldwide non-profit organization headquartered in Amsterdam, Netherlands. The program intends to establish a universally applicable reporting framework. The framework improves the quality, rigor, and utility of economic, environmental, and social sustainability reporting, raising the comparability and reliability of sustainability reporting on a global scale and, ideally, garnering worldwide adoption.

GRI released the first (G1), second (G2), third (G3) and fourth (G4) editions of the Sustainability Reporting Guidelines in 2000, 2002, 2006 and 2013 respectively. These guidelines provide the essential content and indicators of corporate sustainability reporting, which are valid regardless of the company's size, sector, or location. In 2016, GRI shifted from giving guidelines to producing the first worldwide sustainability reporting standard, the GRI Standard. The standard is continually revised with the inclusion of additional topic standards, such as tax (2019) and waste (2020).

According to the most recent edition of the Sustainability Reporting Guidelines and GRI Standards, the EP section provides disclosure guidelines and indicators for GHG emissions information. The majority of the first-level relevant indicators that businesses and organisations are required to disclose are five: direct GHG emissions in scope 1 (G4-EN15), indirect GHG emissions in scope 2 (G4-EN16), and other indirect GHG emissions in scope 3 (G4-EN17), GHG emission intensity (G4-EN18), and GHG reduction (G4-EN19).

Detailed categories exist for the elements that must be declared at each level, i.e., the precise disclosure items of each first-level indication. There are seven specific contents that must be disclosed for the direct GHG emissions of Scope 1, including the total amount of Scope 1 GHG emissions to be reported (CO2 equivalent tonnes), the types of GHG to be accounted for, the biological CO2

emissions, the reporting base year, selection basis and data, emission accounting standards, methods and settings, emission sources, and emission consolidation methods. There are six required contents for indirect GHG emissions in Scope 2, including the total amount of indirect GHG emissions from Scope 2 energy (in CO2 equivalent tonnes), the types of GHG to be accounted for, the reporting base year and its selection basis and data, criteria, methodologies, and settings for emission accounting, emission sources, and emission consolidation methods. 7 specific contents must be disclosed for other indirect GHG emissions in category 3, including the total amount of other indirect GHG emissions in category 3 (CO2 equivalent tonnes), the types of GHG that are accounted for, the amount of biological CO2 emissions, and the emission types and emission activities of other indirect GHG emissions in category 3, the reporting base year, its selection basis and data, emission accounting standards, methods, and settings, and the reporting base year, its selection basis and data. The GHG emission intensity ratio, the comparison basis (the denominator of the ratio) adopted when calculating the intensity ratio, the categories of GHGs included in the intensity ratio calculation, and the GHGs included are the 5 particular items of the GHG emission reduction disclosure. GHG emission reduction (tonnes of CO2 equivalent), categories of GHGs to be accounted for, reporting base year and its selection rationale, accounting standards, method setting, and emission reduction scope are the four particular items revealed in the GHG emission intensity.

2.2.2.3 The Climate Risk Disclosure Initiative

At the United Nations Climate Risk Summit in May 2005, fourteen large institutional investors, including Investor Group and other international organizations, proposed the Climate Risk Disclosure Initiative. They intend to build a set of reporting guidelines to aid global corporations in disclosing climate risk information, so that trustees may utilize this data to make investment decisions.

In October 2006, The Climate Risk Disclosure Initiative released a Global Framework for Climate Risk Disclosure, which gives standard recommendations on the characteristics of organizations that successfully report climate risk information. The framework directs corporations to disclose climate change risks and possibilities in a standardized manner, allowing investors to examine and compare the data. This disclosure framework encourages companies to: (1) disclose information on their historical emissions and projected future emissions of GHG, both direct and indirect; (2) disclose information on its climate risk strategy and emissions management, including (a) a statement of the company's current climate change response strategy, (b) an explanation of the steps the company is taking to reduce climate risk and identify climate opportunities (including the expected reductions in emissions from those measures), (c) describe the company's climate change governance; (3) assess the physical impact of climate change on the company's operations; (4) analyze the risks associated with the regulation of GHG emissions, including an assessment of the costs associated with reducing the company's GHG emissions.

2.2.3 Mandatory disclosure indicators in UK

2.2.3.1 Mandatory disclosure indicators recommended by DEFRA

The analysis of the UK's natural environment considers the value of many different ecosystems, as ecosystems and the biodiversity they contain provide essential goods and services to economic and social welfare. The UK government has set out a series of guidelines. In 2009, in accordance with the requirements of Section 83 of the UK's CCA, DEFRA published the "Guidance on how to measure and report your GHG emissions", which provides companies with advice on how to calculate and communicate their emissions footprint. This guidance is designed for use by all organizations and is based on the GHG Protocol Corporate Standard, the international reporting standard.

The regulations dictate that GHG reporting must be as uniform as feasible with

other kinds of corporate reporting, and that environmental information must be issued at the same time as the annual report and accounting report and belong to the same accounting period. Companies must publish relevant information in their own CSR or sustainability report in compliance with the Companies Act. These guidelines comprise 22 critical environmental KPIs. This is intended to assist firms to simplify the process in the absence of explicit disclosure rules; however, not all companies are required to publish these indicators, and the majority of organisations may have no more than five KPIs. This guide is primarily intended to assist businesses in considering the impact of their supply chain and product usage on the environment while simultaneously allowing more businesses to comprehend their environmental protection and enhance their environmental level (DEFRA, 2006).

KPIs are frequently used in absolute terms and span the whole organization for an extended time (typically one year), enabling stakeholders to understand the relative business performance of the organization. KPIs are often associated with a normalized component, such as the company's revenue and output, as well as environmental indicators, such as the quantity of GHG discharged into the atmosphere. This normative data enables stakeholders to assess a corporation's environmental effects and improvements reasonably. Among these, 22 key performance indicators are seen more significant by British businesses, as shown in Table 2.2:

This is in addition to environmental fines and costs that businesses may face as a result of their activities. Linking these expenditures to specific KPIs gives financial context for interested parties, particularly institutional investors. Expenses for and arising from certain KPIs, such as waste, should be explained alongside the revealed KPI information; other fines and expenses that are difficult to relate to particular KPIs should be reported separately.

Table 2.2: 22 key performance indicators

Emission to air	Emissions to water	Emissions to land	Resource use
1.GHG	7.Nutrients and Organic Pollutants	9.Pesticides and Fertilizers	14.Water Use and Abstraction
2.Acid Rain, Eutrophication and Smog Precursors	8.Metal emissions to water	10.Metal emissions to land	15.Natural Gas
3.Dust and Particles		11.Acids and Organic Pollutants	16.Oil
4.Ozone Depleting Substances		12.Waste(Landfill, Incinerated and Recycled)	17.Metals
5.Volatile Organic Compounds		13.Radioactive Waste	18.Coal
6.Metal emissions to air			19.Minerals
			20.Aggregates
			21.Forestry
			22.Agriculture

Sorce: DEFRA guidance.

The Climate Risk Disclosure Initiative introduced the Global Framework for Climate Risk Disclosure in 2006, which is a declaration of investor expectations about full corporate disclosure. Investors anticipate that climate risk disclosures will enable them to assess the risks and possibilities of a firm. It is strongly recommended that disclosures contain the following:

(1) Emissions: As an essential first step in tackling climate risk, businesses should publish their overall GHG emissions. These emissions statistics can assist investors in estimating the risks that firms may face from future climate change policies.

(2) Strategic Analysis of Climate Risk and Emissions Management:

a. Climate Change Statement: A declaration of the company's current stance on climate change concerns, its obligations to tackle climate change, and its

collaboration with governments and advocacy groups to influence climate change legislation.

b. Emissions Management: Describes the company's primary efforts to mitigate climate risks and discover opportunities. This content should specifically include steps firms take to reduce, mitigate, or limit GHG emissions. Setting emission reduction objectives, engaging in emissions trading programs, investing in sustainable energy technology, and creating and designing new products are examples of actions that may be taken. Estimated emission reductions and schedules should be included in descriptions of GHG reduction efforts and mitigation initiatives.

c. Climate Change in Corporate Governance: Describes the company's corporate governance actions, including whether or not the board is participating in climate change and whether or not executives are tackling climate threats. In addition, corporations should disclose if executive compensation is tied to the achievement of corporate climate objectives and, if so, the nature of the connection between the two.

(3) Physical Risk Assessment of Climate Change: Climate change is beginning to create a variety of physical consequences, many of which might have substantial effects on companies and investors. To assist investors in analyzing these risks, investors are urging businesses to examine and report the substantial physical implications that climate change may have on their businesses, operations, and supply chains.

(4) Regulatory risk analysis: As authorities continue to enact new rules to reduce GHG emissions in response to climate change, corporations that release GHG directly or indirectly might face significant regulatory risks. Investors attempt to comprehend these risks and evaluate the prospective financial impact of climate

change rules on the organization.

2.2.3.2 Mandatory disclosure indicators required by Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013

The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 mandated that, when disclosing GHG emissions, companies must provide specific CO2 disclosures of the following:

(1) The annual emissions[3] (in tons of equivalent[4]) of the company's operations, including the consumption of fuels and the operation of any facilities, must be indicated in the report.

(2) The report must include the company's annual emissions (in tonnes of CO2 equivalent) from purchasing power, heat, steam, or cooling equipment for its own usage.

(3) Items (1) and (2) apply only to the extent that the firm has practical access to the necessary information; however, if the company is unable to collect part or all of the information, the report must specify what information is omitted and why.

(4) The directors' report must include a description of the method used to calculate the information reported under items 1 and 2.

(5) The ratio of at least one measurable component related to the company's activities and reflective of the listed company's yearly emissions must be included in the directors' reports.

(6) In addition to the information required by items 2, 3, and 5 in the directors' report for the first year, the corporate report must also include the information revealed in the report for the current and previous fiscal years corresponding to items 1, 2, and 5.

(7) The directors' report must indicate whether the reporting period for the information required by paragraphs 1 and 2 differs from the period for which the

[3] "Emissions" means the emissions into the atmosphere of GHG as defined in Section 92(2) of the CCA 2008 which are attributable to human activity.

[4] "tonnes of carbon dioxide equivalent" has the meaning given in section 93(2) of the CCA 2008.

report was compiled.

(8) For listed companies, the guidelines apply to the directors' report for the next financial year.

2.2.3.3 Mandatory disclosure indicators required by the 2018 Regulations

Under the changes introduced by the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, public companies of any size are required to report the activities they are responsible for as well as the GHG emissions from the purchase of electricity, heat, steam or cooling for the company's own use, the intensity ratio, figures for the previous year and the method used to calculate the required information. For fiscal years beginning on or after April 1, 2019, public companies must also report the underlying global energy use that forms the basis for reported GHG emissions. They must also state the proportion of their energy consumption and emissions linked to emissions from the UK and offshore, and report the energy efficiency-related information obtained for the current financial year. The main contents are as follows:

(1) Annual global emissions from activities for which the firm is responsible, such as fuel combustion and facility operation, plus annual emissions from the company's purchase of energy, heat, steam, or cooling for its own use (these emissions also fall under scopes 1 and 2 of the global GHG Protocol).

(2) At least one intensity ratio.

(3) Energy use and GHG emissions data for the previous year (except for the first year).

(4) The method used to calculate the disclosure.

In addition, for fiscal years beginning on or after April 1, 2019, public companies must also report:

(1) Basic worldwide energy consumption used to calculate GHG emissions, including prior year's data (in the first year, no previous numbers).

(2) Energy efficiency actions implemented by the business during the

organization's fiscal year.

(3) The proportion of its energy consumption and emissions in relation to emissions and energy consumption in the UK (including offshore areas).

Unlisted companies and LLPs within the scope of the legislation will be required to disclose energy and carbon information in their accounts and reports, including:

(1) UK energy use (at least purchases of electricity, gas and transport).

(2) Associated GHG emissions.

(3) At least one intensity ratio.

(4) Energy use and GHG emissions data for the previous year (except for the first year).

(5) Information on energy efficiency actions taken by the Organization during the fiscal year.

(6) The method used to calculate the disclosure.

If an offshore business (i.e. if the business's activities consist entirely or mainly of offshore activities as defined in the 2018 regulations), the business must disclose their emissions and energy use in the UK and offshore.

2.3 Theoretical basis for corporate GHG disclosures

Previous researchers have analyzed the internal and external factors that affect companies' GHG information disclosure and the impact of GHG information disclosure on the actual performance of companies from different theoretical perspectives. Based on these theoretical perspectives, this research sorted out the relevant literature, analyzed five basic theories in terms of social politics, system, signal, agency and voluntary disclosure, and laid a theoretical foundation for the factors and consequences of corporate GHG information disclosure.

2.3.1 Socio-political theories

The socio-political theory includes stakeholder theory and legitimacy theory.

According to these two theories, disclosed conduct provides the company with pertinent information regarding its social activities and improves the public's perception of its management status, hence enabling the enterprise to better withstand external pressure.

According to the stakeholder theory, businesses may have different effects when different stakeholders put different amounts of pressure on them because the types of control rights differ. Cotter and Najah (2012) discovered a correlation between the extent and quality of a company's carbon information disclosure and the expectations of institutional investors. Stakeholders mainly include creditors, the government, society, and the media. Creditors will consider the environmental protection information given by businesses when determining whether or not to continue extending loans to them. The government is in charge of both supervision and punishment. According to the enterprise's decades-long social reputation, it will earn consumers' trust to varying degrees, causing them to make distinct purchasing decisions. And social media reports carry out appropriate supervision of enterprises in different forms (He et al., 2019). Negative information reported by the media, newspapers, etc., will also have a huge impact and put a lot of pressure on businesses. This means that businesses will share as much positive information about their emissions as they can. Research conducted by Kim et al. (2014) showed that media reports would significantly impact the environmental information of enterprises. The same research results are also confirmed by Ding (2016), which found that the more localized and adverse media reports, the more significant the impact on enterprises.

Stakeholders can not be separated from the business, and the resources that different stakeholders put into the business are essential to its survival and growth. Therefore, in the continuous operation process, the business needs to meet the needs and expectations of the stakeholders. As all sectors of society

have become aware of the detrimental effects of climate change on the natural environment and human life, all stakeholders have gradually begun to pay close attention to information regarding corporate GHG emissions, such as the amount of GHG emissions and energy conservation and emission reduction measures implemented by relevant corporations. According to stakeholder theory, organizations must obtain the support of stakeholders and satisfy their expectations to maintain steady development (Akbaş & Canikli, 2019). The stronger the stakeholder and the greater the influence over the company, the more effort the company needs to put in to meet the environmental requirements of the stakeholder. So, under the framework of stakeholder theory, annual reports are a way for organizations to talk to their stakeholders. The disclosure of GHG emission data is an efficient means for firms to convey their environmental information and carbon reduction initiatives to stakeholders.

Stakeholder theory emphasizes the pressures and demands of specific stakeholders. In contrast, legitimacy theory considers businesses to be components of the social system and then considers their influence on society. The definition of legitimacy, proposed by Suchman in 1995, is “the conviction that an entity’s acts are proper within a wide perception or assumption, or within a socially built system of norms, values, beliefs, and definitions.” Legitimacy mechanisms or an ideological force that pushes or induces an organization to adopt legitimate conduct or structure (He et al., 2019).

The theoretical basis of organizational legitimacy is that, as a part of a broader social system, there is also an invisible social contract between enterprises and other stakeholders (He et al., 2019). Over the years, the progressive development in government and public awareness of decreasing carbon emissions has improved corporate disclosure of important information on social issues to fulfill the expectations of various social groups (Akbaş & Canbakli, 2019). When society’s expectations for firms to address climate change expand, a legitimacy

gap emerges (Wartick & Mahon, 1994). Companies with excessive carbon emissions will be seen as socially irresponsible, and their legitimacy will be severely challenged. If they lack adequate emission reduction strategies and measures, society or stakeholders may potentially penalize them (Pfeffer & Salancik, 2003; Bansal & Clelland, 2004). Consequently, the expectations of the outside world exert a certain binding influence on the conduct of businesses and, to a degree, govern the behavior of businesses. To achieve long-term and stable development, businesses must meet the values and expectations of society. Consequently, they will choose to meet the relevant requirements of the invisible social contract and demonstrate to the public that they have complied with the legitimacy of the business process. In response to concerns connected to environmental change, the government and the general public, as key stakeholders of businesses, are equal to signing an invisible environmental contract with businesses.

To maintain the long-term validity of environmental contracts, companies need to consider how to assess the daily generation of GHG and related pollution, make management decisions on their emissions, and then disclose the emissions and management of their production and operations. The economic legitimacy of firms is monitored by the market, while social legitimacy is monitored by public policy processes (Patten, 1992). When a company's value system does not align with the value system of the more extensive social system in which it operates, its legitimacy is threatened. Businesses are encouraged to take part in the policy process if they think their social legitimacy is or could be threatened. One way to get involved is through reporting disclosures. It was argued that companies can use disclosure as a means of legitimizing: (1) educating and informing the relevant public about (actual) changes in their performance, (2) changing perceptions of organizational performance, (3) highlighting other achievements related to social issues to divert attention from concerns, or (4) to seek to change public expectations of their performance (Gray et al., 1995). Therefore, GHG

information disclosures can be a powerful medium to influence stakeholder perceptions, thereby helping to maximize revenue potential.

2.3.2 Signal theory

Under the disclosure framework of social and political theory, external stakeholders need to make decisions and judgments based on the information about the environmental protection of enterprises. However, they need to obtain reliable information about the enterprises' GHG emissions, which may result in information asymmetry. On the one hand, signaling theory argues that to reduce information asymmetry, companies with good performance in GHG emissions are more motivated to disclose GHG emissions information proactively. Relevant information disclosed by firms can help stakeholders avoid adverse selection and differentiate them from under-performing firms. Companies with high carbon performance also implement various investments and take innovative measures, such as increased investment in low-carbon technologies, improved processes, and advanced carbon management systems, which can minimize environment-related risks. Encouraging businesses to disclose more reliable and objective environmental information to inform the public about their improved environmental technology configuration also plays a crucial role in accelerating the improvement of carbon performance for those businesses that have yet to implement appropriate emission reduction measures.

On the other hand, with the continuous improvement of transparency, companies that emit GHG emission signals will attract the attention and favor of investors and other stakeholders, thereby enhancing the company's image and reputation.

In theory, information disclosure can reduce information asymmetry among corporate stakeholders, reducing adverse selection risk and improving liquidity. Krishnamurti and Velayutham (2018) also mentioned that when more relevant information is publicly disclosed, stakeholders with less information usually care

less about transactions between stakeholders with more information. At the same time, the conclusions drawn by quantitative research are consistent with the theory, and there is a positive correlation between better voluntary disclosure and liquidity.

2.3.3 Institutional theory

Institutional theorists believe that institutions such as laws, rules, and beliefs in the external environment constrain the structure and behavior of organizations (Meyer & Rowan, 1977; DiMaggio & Powell, 1983; Scott, 2013). In its evolution, institutions provide organizations with standards and norms of behavior, define the conditions to be recognized, and limit organizational behavior choices (Chen & Yao, 2015). Organizations in a dynamic environment must adopt the organizational structure stipulated by the system and follow the behavior norms generally accepted by modern society if they want to meet the requirements of society and obtain the resources necessary for the survival and development of the organization at the same time (Cahaya et al., 2012).

Complying with institutional rules and pursuing technical efficiency often conflict with limited resources. In such cases, organizations often opt for "decoupling" behavior that only has signal properties (Chen & Yao, 2015). That is to say, only superficially implement the structure or behavior required by the system because the implementation of this structure or behavior is separated from the organization's core technology, which can alleviate the pressure brought by the conflict between the two to the organization to a certain extent. At the same time, it implies that the system does not have absolute control over the organization but instead plays a role of normative guidance. When the practice of GHG disclosure attracts stakeholders' attention and impacts the investment behavior of stakeholders, companies may pay attention to formalization in the disclosure process, which will lead to decoupling.

From the perspective of the system's function process, the system's constraints on organizational behavior will also make the operating logic between organizations more similar. This is also isomorphic behavior. Beginning with similar trends in organizational structure and behavior, Dimaggio and Powell (2002) argued that a convergent mechanism is an intrinsic mechanism that drives organizations to remain similar in many ways. Different organizations will be subject to the same external legal constraints under the standard institutional environment. Therefore, in the organization's continuous development, these companies affected by the same regulation gradually expand to form a sizeable organizational scope. When the inter-organizational structure contained within the organization gradually becomes stable, an invisible force will gradually form within the organization, which promotes the behavior and structure of the organizations to be more similar.

In institutional theory, organizations are defined as innovators or late adopters of organizational practices (Dillard et al., 2004; Hollindale et al., 2019). Business operations are driven, on the one hand, by the goal of profit maximization. On the other hand, national and government regulation is also a core factor driving it (Schwarz, 2008). In the theory of ecological modernization, enterprises' continuous growth and modernization process promote ecological rationality, and many enterprises also consider environmental impact an important consideration when making important decisions. Esty and Porter (2005) analyzed that strict environmental regulations can promote the continuous innovation of enterprises and enhance economic competitiveness. Similar findings point out that the more advanced the environmental regulatory system is, the more legal, economic, and social factors a company has to promote to become greener (Huber, 2000). However, for both inside and outside users to assess the degree to which businesses have innovated and improved their EP, it is still necessary to rely on the self-reporting of businesses. Therefore, establishing a reliable reporting system can affect the reporting activities of enterprises to a certain extent. In

addition to this, Kolk and Perego (2010) and Chen and Bouvain (2009) also argued that a country's institutional background and its arrangement with environmental issues can affect a firm's reporting strategy.

In addition, corporate actions to address climate change also depend on public attitudes and social norms, which are also influenced by institutional context and culture. Reid and Toffel (2009) argued that regulatory threats constitute a significant factor leading companies to adopt practices consistent with broader social movement goals. When implementing behaviors and taking measures, enterprises will consider improving mechanisms to meet the requirements of external systems and stakeholders (Meyer & Rowan, 1977). Therefore, high-level institutions at the national level also need to consider how to build the corresponding institutional framework for disclosure and decision-making at the lower (corporate) level.

Based on an analysis of cost-benefit trade-offs, disclosure's economic costs and benefits also depend on the specific institutional environment in which the organization operates. Different institutional backgrounds may have different impacts on corporate environmental disclosure. Under the same institutional background, the effects will be quite different depending on the type and nature of the company. To better understand the impact of a country's institutions on firms' disclosure decisions and performance, theoretical research on the link between a country's institutional context and corporate disclosure is needed. By focusing on different levels, the theoretical links established between the state agency and corporate-level decision-making can complement each other well. The related theoretical socio-political and economic frameworks are complementary rather than contradictory. For example, sending honest signals can improve a company's reputation only in organizational settings where stakeholders demand specific signals of legitimacy, consistent with the assumptions of signaling theory (Connelly et al., 2011).

2.3.4 Agency theory

Agency theory is similar to signaling theory in that company management and development are influenced by investors and creditors. According to Hill and Jones (1992), corporate managers are the only stakeholders linked with shareholders through contractual relationships and will have different interest orientations in decision-making. This unique feature also makes managers known as agents of other stakeholders. Agency theory assumes that there is information asymmetry between managers and shareholders, which leads to the failure to regulate the opportunistic behavior of managers, thereby increasing the cost of regulation (Adams, 1994).

Information disclosure is considered an effective tool for reducing information asymmetry and agency costs between company managers and external shareholders (Chang & Zhang, 2010). Reducing information asymmetry can also reduce the financing costs of institutions in the market (Lang & Lundholm, 2000). When the company's creditors and investors need information about environmental changes and GHG emissions, the company responds to this demand. It discloses the company's emission reduction behavior and management process to meet the interests to the extent acceptable to its stakeholders' needs (Deegan, 2002). This reduces information asymmetry and also reduces agency costs. Similarly, if companies conceal or refuse to provide relevant information, they will also be punished by the market (Luo et al., 2012).

2.3.5 Voluntary disclosure theory

According to the voluntary disclosure theory, an organization's EP positively affects environmental information disclosure, and companies with good EP tend to disclose more environmental-related information (Verrecchia, 1983; Li et al., 1997). These better-performing companies can differentiate themselves from other less-performing companies by disseminating more information through

increased disclosure. At the same time, companies with good EP can gain several benefits through disclosure: reducing the cost of capital of the company (Dhaliwal et al., 2011), improving the reputation of the company (Klynveld Peat Marwick Goerdeler, 2008) and reducing the attention and pressure from external regulators (Eleftheriadis & Anagnostopoulou, 2015). In addition, stakeholders obtain more accurate and relevant information based on the relevant environmental content voluntarily disclosed by the company and then pay more attention to and invest in related companies. Therefore, the expected benefits obtained by the company through disclosure will also be higher than its disclosure cost (Healy & Palepu, 2001).

On the other hand, companies with poor EP tend to disclose less or less information related to EP to be regarded as companies with average EP (Clarkson et al., 2008). Research by Clarkson et al. (2011) shows that companies with poor EP generally disseminate preliminary information that cannot be verified, which is also consistent with the empirical findings of Luo and Tang (2014). When companies choose whether to disclose information related to environmental changes, the voluntary disclosure theory will also be an essential factor in their research.

2.3.6 Summary

From the above theoretical perspectives, it can be found that the relevant theories of corporate environmental information disclosure are complementary rather than contradictory. On the one hand, the most important motivation for businesses to comply with legal requirements during operations and to provide environmental information is to respond to the demands of stakeholders, such as the public and the government, and to fulfill their requirements.

On the other hand, legitimacy and institutional theories represent macro and micro perspectives on the same subject. Faisal et al. (2018) believed that

institutional theory is a subset of legitimacy theory, and disclosure is a way for corporations to obtain legitimacy (Bansal & Roth, 2000). Some studies have shown that corporate carbon information disclosure activities are affected by the national system environment (Prado-Lorenzo & Garcia-Sanchez, 2010), and companies disclose carbon information in response to external institutional pressures (Grauel & Gotthardt, 2016).

2.4 Factors Influencing Companies' GHG Disclosures

Companies' GHG disclosures in this study are influenced not just by a single internal or external factor but also by a combination of internal and external variables. Research must integrate the drivers of corporate GHG disclosure with the above theories to better understand the impact of GHG emissions reporting and to predict outcomes. According to theoretical viewpoints and relevant research, the willingness of corporations to publish their environmental information and the frequency of disclosure depend on several variables. This thesis explores the influencing elements of GHG information disclosure from the perspectives of firm characteristics, corporate governance, EP, institutional features, and stakeholders.

2.4.1 Corporate characteristics

In previous studies, researchers wanted to explore the impact of corporate characteristics or corporate attributes on environmental information disclosure, and they did find some correlations: corporate with large corporate size (Faisal et al., 2018; Akbaş & Canikli, 2019), strong profitability (Faisal et al., 2018), high market value (Akbaş & Canikli, 2019), environmental sensitivity (Halkos & Skouloudis, 2016), low leverage (Faisal et al., 2018) tend to adopt environmental information disclosure.

Faisal et al. (2018) carried out a similar analysis of the content and drivers of GHG emissions disclosures. Using the annual reports of 37 listed businesses in

Indonesia between 2011 and 2014 as a sample, the findings indicated that companies in sensitive industries with lower leverage ratios, more resilient profitability, and greater enterprise size are likely to publish more GHG-related information. Akbaş and Canikli (2019) collaborated in a study on the drivers of GHG declarations by Turkish firms, utilising data from the CDP - Turkey annual survey report from 2014 to 2016. Enterprises with bigger sizes, more profitability, more institutional holdings, and better price-to-book ratios (as a reputation indicator) are more likely to answer the CDP questionnaire. According to the findings, they are more inclined to reveal GHG emissions information.

Similarly, from 2006 to 2010, Ott et al. (2017) surveyed 11,187 enterprises in 60 countries. They discovered that the response to carbon information disclosure was positively connected with company profitability, the publication of social responsibility reports, and ISO14000 certification.

However, Tauringana and Chithambo's (2015) study assessed the influence of DEFRA's 2009 disclosure standards. The sample consists of 215 businesses from the FTSE 350 index of the London Stock Exchange over four years (2008-2011). The association between GHG disclosures and business-specific control factors (profitability, liquidity, firm age, and capital expenditures) was not statistically significant. According to Akbaş and Canikli (2019), there is no correlation between leverage and a company's response to carbon information disclosure and its disclosure behaviour.

In addition, Peng et al. (2015) concluded that organizations with superior performance are more likely to share carbon information, but the disclosure content does not change considerably from that of companies with worse performance.

Halkos and Skouloudis (2016) investigated the present state of disclosure

procedures on the crucial problem of climate change mitigation by the 100 largest firms operating in Greece. They discovered that the influence of size is positive, although the trend is insignificant. In contrast, environmental sensitivity and global presence impact environmental change disclosure.

A great number of qualitative and quantitative studies on the characteristics of businesses have been conducted in earlier studies. The majority of prior research has demonstrated that company features are the primary factor influencing corporate environment-related disclosures, however a few studies have indicated the contrary. In addition, business characteristics are typically employed as control variables to aid quantitative study among the elements that influence environmental change information disclosure in recent studies.

2.4.2 Corporate Governance

Numerous studies have examined corporate disclosure of environmental information from the standpoint of corporate governance. Independent directors (Amran et al., 2014; Liao et al., 2015), female directors (Prado-Lorenzo & Garcia-Sanchez, 2010; Ben-Amar et al., 2017), and the introduction of environmental committees on boards (Peters & Romi, 2014) will have a good effect on environmental disclosures by corporations.

Prado-Lorenzo and Garcia-Sanchez (2010) conducted a study including 283 enterprises in 28 countries that participated in CDPs. They discovered that gender diversity on corporate boards enhances carbon information disclosure. Amran et al. (2014) similarly validated the same outcomes by analysing the sustainability reports of 111 corporations in 13 Asia-Pacific nations. The majority of enterprises with independent board members and female board members had more carbon disclosure. In contrast, dual-CEO organisations often have minimal carbon emissions. Nevertheless, the study of Akbaş and Canikli (2019) has shown that there is no direct link between industry members and boards,

independently of companies' responses to carbon disclosures and their disclosure behaviour.

There is a dispute around the effect of board size on corporations' disclosure of carbon information. According to Prado-Lorenzo and Garcia-Sánchez (2010), board size has a detrimental effect on carbon disclosure. However, based on the research of Tauringana and Chithambo (2015) and He et al. (2019), the degree of carbon disclosure was greater when the board size was larger.

Moreover, forming an environmental committee on the board of directors can facilitate the administration and growth of environmental information disclosure inside the organisation (Peters & Romi, 2014; Ben-Amar & McIlkenny, 2015). Peters and Romi (2014), after analysing the FT (Financial Times) 500 and S&P (Standard & Poor's) 500 companies from 2002 to 2006, proposed that the establishment of an environmental committee and a Chief Sustainability Officer has a positive effect on companies' willingness to disclose GHG emissions. The size of the environmental committee, the number of committee members, the frequency of committee meetings, and the knowledge of the chief sustainability officer all influence the chance that carbon disclosure will be implemented. Ben-Amar and McIlkenny (2015) used 200 Canadian CDP-participating enterprises as a sample and observed a favourable correlation between board effectiveness and carbon information sharing.

Above all, the majority of studies have concluded that the proportion of independent directors, the proportion of female directors, the establishment of environmental committees within the board of directors, and the effectiveness of the board of directors all have a positive effect on corporate GHG disclosures.

2.4.3 EP

Typical EP criteria include the level of a company's carbon emissions and its

overall EP. Existing relevant research focuses mostly on three perspectives.

According to some academics, firms with significant carbon emissions are more likely to undertake carbon information disclosure (Ben-Amar et al., 2017). Ben-Amar et al. (2017) found that corporations in industries with significant carbon emissions are more likely to respond to investor demands to disclose climate change risks. Meanwhile, in industries with high carbon emission levels, additional factors may substantially influence carbon disclosure (Peng et al., 2015; Jaggi et al., 2018). Jaggi et al. (2018) also indicated that the influence of environmental committees, institutional ownership, and board independence on company carbon disclosure would be more pronounced in industries with a high pollution level. Peng et al. (2015) discovered that companies in high-emitting industries are more likely to report carbon emissions and reveal more information. Businesses may follow their peers' lead when considering whether or not to release carbon information. Companies may be more inclined to share carbon information if the number of rivals in their field that do so grows.

Other researchers dispute this, claiming that corporations with low carbon emission levels and high environmental performance are more likely to report carbon information (Dawkins & Fraas, 2011; Guenther et al., 2016). Dawkins and Fraas (2011) studied the Standard & Poor's 500 corporations' CDP responses data. They discovered that the greater a company's overall EP, the more information it revealed about climate change. Ott et al. (2017) showed that the release of carbon information signals correlated favorably with business emissions performance and market concentration. Based on the CDP data of the worldwide top 500 firms from 2008 to 2011, Guenther et al. (2016) found a similar finding that the carbon emission performance of corporations is positively correlated with their carbon emission disclosure. Similarly, the degree of carbon information disclosure for companies with fewer carbon emissions in non-carbon-intensive industries, companies with fewer carbon emissions in

carbon-intensive industries, and companies with more carbon emissions and poor EP in non-carbon-intensive industries are ordered from high to low. In addition, Liao et al. (2015) noted that the establishment of corporate governance and environmental committees would substantially influence the disclosure of carbon information by corporations in industries with low carbon intensity.

In addition, several research have shown no correlation between EP or carbon performance at the enterprise level and environmental change declarations (Stanny & Ely, 2008). Stanny and Ely (2008) discovered no indication that firms in carbon-intensive industries are likely to increase their carbon disclosure practises.

In conclusion, the research findings on the influence of EP variables on the disclosure of carbon information by corporations must be more consistent. Recent research indicates, however, that the notion that corporations with large carbon emissions are more eager to disclose carbon statistics is somewhat popular. Therefore, further in-depth research and discourse on the interaction between these two aspects are required.

2.4.4 Stakeholders

Stakeholders and public opinion play a crucial role in how businesses manage and implement measures to minimise carbon emissions. The arguments of the study in this field may be summed up by the two aspects listed below.

On the one hand, investor, market, and societal factors have a significant influence in promoting voluntary GHG reporting. After analysing 500 businesses in the 2009 FTSE index, Cotter and Najah (2012) found that the volume and quality of carbon information disclosure are connected to institutional investors' expectations for this information. Based on the 2013 annual reports of 126 Malaysian real estate businesses, Kalu et al. (2016) concluded that societal forces

and financial markets are significant predictors of carbon disclosure. Additionally, Tang and Demeritt (2018) sampled 176 FTSE 100 businesses. They saw economic motives, societal pressure, and regulatory pressure as the three primary motivating elements for carbon information disclosure by corporations.

On the other hand, several academics have identified the impact of media coverage on corporate carbon information disclosure and argued that media coverage might successfully encourage information disclosure. As one of the stakeholders, Guenther et al. (2016) thought that the media had a beneficial effect on corporate carbon disclosure. Similarly, Li et al. (2017) found in their research on corporations in China's significantly polluting industries between 2009 and 2014 that the more the media's influence on public opinion, the more carbon information companies released. In addition, media coverage can mitigate the effect of carbon disclosure on equity financing costs. Based on a sample report of China's participation in CDP from 2008 to 2012, Li et al. (2018) evaluated media coverage to assess environmental legitimacy. They discovered that business environmental legitimacy substantially impacted the likelihood of carbon disclosure.

According to the two mentioned aspects, the influence of stakeholders on the disclosure of information on corporate environmental improvements is favourable, and businesses must carefully address the demands of external stakeholders in the GHG emission reduction and disclosure process.

2.4.5 Institutional characteristics

National context, government and regulatory bodies, laws and regulations, and company strategies have a crucial impact in the response of businesses to GHG reduction. According to some scholars, national background factors and public and government attitudes have a greater impact on environmental information disclosure than corporation features and stakeholders (Luo et al., 2012; Grauel &

Gotthardt, 2016). This study highlights the effect of five institutional features on the disclosure of carbon information by corporations.

First, a group of researchers noted that businesses in industrialized nations are more likely to undertake carbon information disclosure compared to businesses in developing nations. Amran et al. (2014) showed that corporations in rich nations are more likely to publish climate change information in their sustainability reports than those in developing countries. Grauel and Gotthardt (2016) analyzed the effect of the national context on the carbon disclosure decisions of publicly traded corporations using the 2011-2013 CDP answers of 2,379 firms in 51 countries. Their findings indicated that firms in European nations such as the UK and France are likely to include carbon statistics in their annual reports.

Second, according to some researchers, businesses in regions with strict government regulations are more likely to undertake carbon information disclosure (Reid & Toffel, 2009; Grauel & Gotthardt, 2016). For instance, Reid and Toffel (2009) showed, after reviewing the CDP questionnaires of S&P 500 businesses in 2007 and 2008, that corporations are more likely to publish carbon information in response to shareholder pressure and government legislation. Additionally, businesses with heavily regulated headquarters are more likely to report carbon data. Grauel and Gotthardt (2016) verified that the CDP response rate varies considerably between nations, and that the stringency and implementation of national environmental rules are positively connected with the propensity of businesses to report carbon information. In addition, Luo (2019) argued that strong carbon regulation weakens the negative link between carbon information disclosure and carbon performance. In other words, the viability of carbon information disclosure as a legal instrument is diminished.

Thirdly, some researchers have discovered that rules and regulations have a

favourable effect on the disclosure of carbon information by corporations. For instance, Cowan and Deegan (2011) demonstrated that environmental regulations, such as the National Greenhouse and Energy Reporting Act of 2007, may compel businesses to reveal huge volumes of carbon emissions voluntarily. Using a sample of 215 listed businesses from the FTSE 350 Index from 2008 to 2011, Tauringana and Chithambo (2015) revealed that the UK DEFRA guidance on GHG declarations in 2009 had a beneficial effect on the amount of corporate carbon disclosure in the UK.

Fourth, environmental regulations such as the Kyoto Protocol (Freedman & Jaggi, 2005) and carbon trading markets (Luo et al., 2012; Liesen et al., 2015; Schiemann & Sakhel, 2019) encourage enterprises to disclose carbon information or have a positive regulatory effect on carbon information disclosure. Freedman and Jaggi (2005) surveyed 120 firms from 20 nations. Corporations in nations that have ratified the Kyoto Protocol disclose more comprehensive carbon data than companies in countries that have not ratified the Kyoto Protocol. Luo et al. (2012) and Liesen et al. (2015) used the EU ETS as a control variable and discovered that the ETS positively influenced carbon disclosure. Schiemann and Sakhel (2019) contend that the ETS moderates the relationship between carbon risk disclosure and information asymmetry. The degree of carbon risk disclosure by ETS-participating firms is inversely connected with investors' information asymmetry, but the converse is true for non-participating firms. Additionally, corporate environmental management systems (Qian et al., 2018; Rankin et al., 2011) and CSR activities (Halkos & Skouloudis, 2016; Giannarakis et al., 2018) also affect carbon disclosure.

Fifthly, some studies have investigated the characteristics of corporations participating in carbon disclosures. Giannarakis et al. (2018) and He et al. (2019) demonstrated that state-owned firms are more likely than private enterprises to share climate change information. In contrast, Chu et al. (2013) believed that

state-owned firms report less GHG information than private enterprises. According to the research conducted by Peng et al. (2015), the effect of the government on the decision of Chinese companies to disclose their carbon emissions is likewise negligible.

To sum up, in the research on the influencing factors of carbon information disclosure, the research on institutional characteristics is relatively comprehensive, including the perspectives of developed countries, government regulation, policies and regulations. The theories used in these studies are mainly legitimacy and institutional and have reached a consistent point of view. Developed countries, government regulations, areas with strict policies and regulations, the "Kyoto Protocol", the carbon trading market and the state-owned nature of enterprises play an essential and positive role in corporate carbon information disclosure.

In general, the existing research on the influencing factors of GHG information disclosure mainly focuses on corporate characteristics, corporate governance, EP, institutional characteristics and the influence of stakeholders. Stakeholders have reached a relatively high consensus on the impact of corporate GHG disclosures. EP and the impact of corporate governance factors on carbon disclosure remain controversial. Institutional characteristics are often considered factors in current research. Most studies show that it may motivate companies to disclose environmental information, but further research is needed on the content and quality of disclosure. Corporate characteristics are primarily used as control variables in the research on other influencing factors.

2.5 Results of Corporate GHG Disclosures

Compared to the factors that influence firms' GHG information disclosure, existing research on the effects of GHG information disclosure needs to be more comprehensive. Relevant research focuses primarily on the influence of GHG

disclosure on company performance, the ecological environment, and investor behaviour.

2.5.1 Company performance

Regarding the influence of GHG information disclosure on corporate performance, the majority of study results indicate that GHG information disclosure will have a positive impact on multiple aspects of a company's performance, including corporate value (Hardiyansah et al., 2021; Anggraeni, 2015), firms FP (Ganda, 2018; Borghei et al., 2018), agency costs (Zhou et al., 2018; Elston & Yang, 2010; Juan & Dan, 2012), and other benefits (Fernández-Feijóo-Souto et al., 2012).

The value of a firm might reflect investors' perceptions of the company's managerial effectiveness. Investors are more optimistic about the company's performance and hopeful about its future prospects the greater the company's worth. Investors not only associate a company's sustained growth with its profitability but also prioritize its commitment to sustainability.

Hardiyansah et al. (2021) examined the influence of carbon emissions disclosure on business value using multiple linear regression. The results indicated that carbon emission information disclosure is a method through which corporations pay attention to the environment and actively respond to the market, which has a positive and substantial effect on company value. Anggraeni (2015) explored the moderating effect of EP on the connection between GHG emissions disclosure and business value. Although there is no indication that EP moderates the link between carbon emissions disclosure and company value, the findings showed that carbon emissions disclosure positively affects firm value. Similarly, Toly (2019) examined the influence of GHG emissions disclosure and EP on business value. A sampling of firms who participated in the environmental management of the Republic of Indonesia during the Indonesian Linking Period.

Secondary data from yearly reports and/or sustainability reports are utilized. Disclosure of GHG emissions and environmental performance has a favourable influence on firm value, according to the study.

Ganda (2018) used a panel regression approach to study the impact of carbon emissions reporting on the financial value of South African companies over the period 2010-2015. The findings showed that, in most cases, carbon emissions disclosures are positively correlated with return on assets (ROA), a measure of a firm's FP. Similarly, Borghei et al. (2018) analyzed the annual reports of Australian sample companies from 2009 to 2011. Among them, the ROA, return on equity and return on sales are used to represent the FP of the company, which indicates that after voluntary disclosure, the company has incurred a certain cost, but obtained the benefits of improving FP. According to Griffin et al. (2017), however, the content of GHG emissions submitted to CDP by an organization may be negative information for stakeholders. Therefore, the disclosure of the associated content will result in a fall in the value of the company's equity.

On the other hand, several studies have demonstrated that effective disclosure of GHG information may help firms minimise agency costs. Based on the principal-agent theory, Zhou et al. (2018) studied the impact of carbon disclosure on institutional costs and operations by analysing publicly listed Chinese manufacturing firms. The yearly report analysis results for 2010-2014 demonstrated a negative relationship between the quality of carbon disclosure and the agency expenses of businesses. Yang et al. (2010) discovered, based on their 2007 study of businesses listed on the Shanghai Stock Exchange in China, that the publication of internal control information had a completely inhibiting impact on agency expenses. Information disclosure has no substantial influence on explicit agency costs, but has a considerable effect on implicit agency costs. Similarly, Juan & Dan (2012) gathered the carbon information disclosure of listed businesses in the Shanghai and Shenzhen stock exchanges from 2008 to

2010. They found that high-quality information disclosure may effectively limit the hidden agency costs of listed companies.

Other interests are composed mainly of operational, strategic, internal and external interests. Blanco et al. (2017) interviewed 38 enterprises in seven countries that reported information to CDP and discovered that the measurement and disclosure procedure might provide them with a wider range of advantages than anticipated. When engaging in disclosure-led processes, organisations must set aside their biases and not lose sight of the supply chain's opportunities.

2.5.2 Ecosystem

Based on economic theory assumptions, multiple studies have demonstrated that GHG disclosure benefits carbon emission reduction and environmental improvement (Akpalu et al., 2017; Qian & Schaltegger, 2017). For instance, Akpalu et al. (2017) conducted an experimental analysis of the strategic behaviour of African climate policymakers in reducing pollution. The analysis provided strong evidence that requiring companies to disclose pollution with a higher level publicly may result in a reduction in emissions.

Using the global top 500 companies from 2008 to 2012 as a sample, Qian and Schaltegger (2017) studied the carbon disclosure of these companies and their subsequent carbon performance via direct and indirect carbon emission intensity tests. They discovered that carbon disclosure could serve as an "outside-in" driver to improve the carbon performance of companies. Similarly, Zhu et al. (2021) investigated the impact of environmental information disclosure using data from 120 Chinese cities. The results indicated that, despite regional disparities, the government's environmental information disclosure may serve as an indicator of the region's EP; the greater the degree of transparency, the better the EP.

Despite this, several studies have demonstrated that GHG disclosure does not assist firms in reducing carbon emissions and improving the environment, or has a limited effect (Tang & Demeritt, 2018; Bewley & Li, 2000; Clarkson et al., 2008; Clarkson et al., 2011). Tang and Demeritt (2018) interviewed 176 large public companies listed on the FTSE 100 about their carbon reporting practices and related disclosures with stakeholder engagement and concluded that mandatory carbon disclosures have a small overall impact on companies' EP, which also depends primarily on industry category, the energy intensity of enterprises, and external regulatory requirements. Based on sociopolitical theory, corporations in environmentally sensitive industries or under intense societal pressure (Bewley & Li, 2000) selectively provide additional information to offset their negative effect or provide ambiguous (soft) information to substitute their actual performance (Clarkson et al., 2008; Clarkson et al., 2011). Briefly, sociopolitical theory suggests a negative association between corporate EP and environmental reporting.

2.5.3 Investors' decision-making

According to the signaling hypothesis, a company's environmental information disclosure might signal to the market or stakeholders that its EP is better or improved. Therefore, firms with greater transparency may attract investors. In the context of climate change, however, quantitative studies have reached contradictory conclusions regarding the relationship between GHG information disclosure and investor decision-making. This inconsistent conclusion may be due to the fact that investors are confronted with several uncertainties and obstacles in relation to corporate climate change disclosure. Other theoretical studies also demonstrate this.

On the one hand, the majority of research indicates that environmental information disclosure may positively influence investors' decisions (Griffin et al., 2017; Haigh & Shapiro, 2011; Liesen et al., 2017; Motoshita et al., 2015).

For instance, when investors acquire new emissions-related information, there is a large market reaction (Griffin et al., 2017). At the same time, Haigh and Shapiro (2011) contended that carbon emission reports play a role in investors' corporate governance assessments. When making investment decisions, investors should not disregard carbon disclosure and performance (Liesen et al., 2017). The research conducted by Motoshita et al. (2015) on an online survey of Japanese residents indicated that when consumers purchase, they tend to select consumption practices that minimise CO2 emissions. Publication of information about the CO2 emissions that may come from the production of a product can have a synergistic effect on consumers' purchase decisions.

On the other hand, environmental information disclosure may have a negative effect on investors' investing behaviour (Lee et al., 2015). Lee et al. (2015) investigated the market response to voluntary carbon disclosures by South Korean enterprises participating in CDPs in 2008 and 2009. Investors have responded negatively to carbon disclosures to a certain extent, viewing it as bad news since they are concerned about the regulatory expenses corporations may incur in the future to address environmental problems.

2.6 Environmental information disclosure

2.6.1 Definition of environmental information disclosure

Corporate environmental information disclosure is the activity of disclosing environmental information in annual or independent reports. Internally, environmental disclosure is a component of CSR reporting for the enterprise (Craig & Ben, 1996), and social responsibility activities include primarily compliance with environment-related laws, actions to reduce GHG emissions, investment in developing clean energy, and collaboration with stakeholders. Corporate disclosure of environmental information externally, as a diversification management tool for stakeholders like investors (Freedman & Jaggi, 1988), can assist users of financial statements in assessing their benefits and risks in the

context of a changing external climate.

Disclosure of environmental information is a component of social responsibility information disclosure. Unlike financial disclosures (i.e. audited annual reports, earnings announcements) which must adhere to a framework such as the Generally Accepted Accounting Principles or the International Financial Reporting System, the majority of social responsibility disclosure is not regulated by law. Social responsibility reporting is mostly voluntary, reporting styles vary within and across firms, and qualitative reporting is the norm. Consequently, it is challenging to objectively assess the quality of social responsibility reporting, as well as to evaluate, audit, and establish accountability.

GHG emission is regarded as one of the most extensive parts of CSR, particularly due to recent concerns about climate change. All stakeholders are impacted by GHG emissions in economic and other aspects (Ferraro & Beunza, 2018). In the process of disclosing CSR, it is vital to be accountable to shareholders (Friedman, 1970) since corporations utilize shareholder funds for CSR activities, and it is also necessary to be accountable to non-shareholders because they are impacted by the company's behaviour and actions (Freeman, 1984). Consequently, shareholder pressure (Michelon et al., 2020) and stakeholder pressure (Liesen et al., 2015) will affect the quantity of environmental information-related disclosures. In addition, in response to the UK government's constant emphasis on GHG emissions, the disclosure of relevant environmental information has changed from voluntary disclosure to mandatory disclosure. As a result, companies will gain legitimacy by disclosing relevant information about their environment and carbon emission reduction activities to the public.

This dissertation presents a general text-based approach to objectively classify environmental disclosures in reporting by summarizing sustainability-related

disclosures over the last decade. Common standards facilitate repeatability and scalability, which are essential for success and objectively analyzing GHG reports by corporations.

2.6.2 Past research on corporate environmental information disclosure

Companies are compelled to take environmental protection into account when establishing sustainability strategies due to the growing awareness of corporate sustainability. Companies demonstrate their commitment to environmental sustainability development through information related to climate change disclosures, including GHG information (Giannarakis et al., 2018). The extent of business engagement in sustainable activities and the scope of strategy design have a positive and substantial effect on the quantity and quality of relevant environmental disclosures (Helfaya & Moussa, 2017).

Environmental disclosure was initially at a comparatively low level. Guthrie and Parker (1989) discovered that environmental information was not given entirely until around 1950, and since then, environmental disclosure has gained steady attention. In the 1970s, environmentalists criticised the mining, steel, and oil sectors, coinciding with these disclosures' peak. According to research undertaken by Trotman (1979), the amount of social responsibility information supplied by Australian corporations between 1967 and 1977 rose gradually. In response to this result, he postulated that corporations disclosing information about their social responsibility might enhance their reputation, increase public acceptability, and diminish resistance and negative feedback.

Previous research on environmental disclosure has demonstrated that environmental reports are frequently qualitative and primarily self-praising (Giannarakis et al., 2018). Companies in Australia, the UK, and the US tend to prioritise social disclosures. Human resource disclosures were the most prevalent, followed by community involvement disclosures and

environmental disclosures (Kamal & Deegan, 2013). Guthrie and Parker (1989) found that none of the Australian firms conveyed "negative news" regarding expected activities. They thought that most social disclosures result from external pressure on businesses, and corporate implement disclosure procedures and methods to counteract the bad feelings that the outside world may have about them. In addition, according to Guthrie and Parker's (1989) research, corporations promote their positive contributions to social welfare through disclosure strategies while emphasizing that their actions are increasingly less destructive to society and reduce societal pressure. Combined with stakeholder theory, companies can avoid additional disclosure regulations and gain support from external stakeholders through proactive environmental information disclosure.

There is also a greening of the image in the disclosure procedures of Chinese corporations (Chu et al., 2013), whose annual reports tend to emphasise only positive or neutral information. Similarly, Stanny (2013) demonstrated that Fortune 500 corporations seek to conceal information regarding their climate performance and release the bare minimum of data to avoid criticism. This lack of transparency was also revealed in Talbot and Boiral's (2013) study of the credibility of Canada's major emission GHG inventories: in 35% of the sample companies, managers admitted to having disclosed misleading or incomplete information in the past, particularly to protect sensitive data regarding energy efficiency and financial relationships with government authorities.

Craig & Amernic (2001) selected the environmental information disclosure of 197 firms between 1983 and 1991 for their research and interpreted the environmental information given by businesses in a self-praising way from a legality standpoint. This study provided more evidence for companies to disclose more positive news. They reviewed the 1991 Annual Reports of 197 firms controlled by the Australian Graduate School of Management and found that the

majority of environmental disclosures were qualitative. Relevant information is often contained in the report of the company's chairman, general manager, or equivalent. Individual words are the primary unit of measurement when employing content analysis to categorize relevant information into positive and negative categories. By counting the number of words, the lowest feasible unit of analysis, the number of disclosures may be calculated with the highest precision (Zegal & Ahmed, 1990). Through qualitative research, it is concluded that companies are more inclined to disclose good news.

In addition to the study on the substance of corporate disclosure of environmental information, earlier studies have also examined the quality of disclosure. Some researchers identified significant difficulties with the comparability and quality of the information released (Dragomir, 2012; Green & Li, 2012; Kolk et al., 2008; Talbot & Boiral, 2013; Heras-Saizarbitoria & Boiral, 2015). When sustainability reporting fails to offer valid and verified data, stakeholders, including investors and policymakers, lose confidence in the revealed information (O'Dwyer et al., 2005). According to research by Kolk et al. (2008), the information revealed by firms in the CDP is valuable to investors. The authors noted several measurement and comparability difficulties. The most often cited issues were a lack of data, inconsistency in the emissions examined, inconsistency in the methodology employed, and the absence of external validation of the data (Kolk et al., 2008). Additional analyses using CDP data have reached the same conclusion. It appears that the multiplicity of approaches adopted makes it hard to compare data and diminishes the value of the provided information (Andrew & Cortese, 2011; Sullivan & Gouldson, 2012).

Previous researchers have looked into sustainability reporting content and quality, albeit with a limited collection of sustainability report indicators (Berrone et al., 2013; Roca & Searcy, 2012; Adams & Frost, 2008; Daub, 2007; Tate et al., 2010). Content analysis studies of sustainability reporting have investigated changes in

the quality of reported material (Guidry & Patten, 2010; Kolk, 2004) or patterns in sustainability reporting by industry or nation (Gray et al., 1995; Patten & Zhao, 2014). Several voluntary recommendations have been released by organizations such as GRI, UN Global Compact, and ISO 26000 (Bonsón & Bednárová, 2015) to assist businesses in reporting on their sustainability efforts. Few studies utilized metrics beyond those in the GRI, although other studies evaluated how well reports complied with GRI requirements. The GRI is an underlying framework that represents numerous elements of company environmental operations and provides a means for summarizing and evaluating corporate environmental information disclosure (Clarkson et al., 2008). This under-utilization of metrics indicates a major gap, as measurements play a key role in expressing a company's sustainability goals (Kozlowski et al., 2015). Given the limited number of studies that have gone beyond the GRI in terms of utilizing metrics, this study attempts to analyse more extensively what corporations report, with additional information on the GRI, to supplement the limited prior work.

Indicators' studies beyond the GRI included that of Tate et al. (2010), who used automated software to analyze sustainability reports, focusing on supply chain sustainability topics compared to a company's geographic location and revenue. Montabon et al. (2007) additionally evaluate the association between these practices and four metrics of company performance using a content analysis of 20 environmental management practices (excluding social sustainability practices) collected from the literature as opposed to GRI.

In addition to potential issues resulting from the restricted number of indicators used, there is also the issue of how to conduct the analysis. Some prior studies have examined a company's level of transparency by counting the number of relevant words, phrases, or pages in sustainability reports on various themes (Patten & Zhao, 2014). The disadvantage of determining the count space

allocation for certain words or themes is that this method does not capture the report's content. Similarly, some scholars have used computer-assisted text analysis to learn about supply chain sustainability (Tate et al., 2010). However, many sustainability reports show information graphically, limiting the effectiveness of computer-assisted text analysis.

2.6.3 Overview

Through the study of prior studies, this research is not confined to particular metrics suggested by the specific rules, but rather involves the examination of all firms' GHG disclosure reports, not simply their word counts or computerized text analysis. In order to identify the most significant variables based on the content of the environmental report, a comprehensive checklist of operational practices was compiled from relevant operational literature and reporting guidelines. Similar to research employing content analysis, a 0-1 grading system was implemented. Consequently, by integrating the disclosure rules and the actual disclosure report content, it is feasible to search for environmental information disclosure indicators comprehensively and assess the quality of corporate disclosure reports more accurately and objectively.

In this research, GHG disclosure represents CSR and a commitment to and attention to sustainability. The amount of GHG information indicators revealed in the report is chosen to indicate the quantity and quality of corporate environmental disclosures. The quality of GHG disclosure is also employed as an independent variable to test its link with FP/EP in the future.

2.7 GHG information disclosures and FP

2.7.1 The impact of GHG information disclosures on FP

Based on basic theories proposed in 2.3 and reviewing the existing research literature, it can be found that most scholars rely on cost theory, stakeholder theory and voluntary disclosure theory to explain the internal logical relationship

between corporate GHG information disclosure and FP. These three theories seem to be contradictory but in fact complement each other. This study will further integrate the theoretical framework of the impact of corporate GHG information disclosure on FP from three different aspects, which will lay the theoretical foundation for subsequent hypotheses.

2.7.1.1 Cost perspective

In prior studies from the perspective of cost, researchers led by Friedman (1970) opposed a range of social responsibility initiatives, such as corporate environmental disclosure, from the perspective of cost theory and proxy-agent theory. They thought a company's sole social obligation was to obey the norms of the market, aiming to increase corporate profits and produce products as efficiently as possible (Friedman, 1970). Investing a company's limited resources in environmental information disclosure will increase its expenses and erode its competitive advantage (Aupperle et al., 1985). Even if a business has redundant resources and no viable investment opportunities, environmental disclosure and improvement costs will diminish its competitiveness (Barnett, 2007).

Specifically, scientists who oppose firms' environmental information disclosure from the perspectives of cost theory and principal-agent theory primarily use two avenues to justify their theoretical stances: (1) cost theory and (2) principal-agent theory. On the one hand, it is the direct cost caused by the disclosure, and on the other, it is the agency cost caused by the principal-agent dilemma. Corporate environmental disclosure will raise expenditures for personnel and management, as well as production and investment in emission-reduction technologies. When a company reaches a higher degree of disclosure, distinct departments, teams, and executives must be developed to oversee emissions and disclosure programme. Some emission reduction schemes need employee engagement, raising the company's administrative and human resource management expenditures.

According to the principal-agent theory in neoclassical economics, the principal can only partially control and oversee the agent, and the principle's and agent's decisions will disagree. The principal-agent perspective predicts that company managers would engage in opportunistic conduct. They may devote business resources to pursue personal reputation at the expense of the corporation's FP (Navarro, 1988). The purpose of managers' active promotion of social responsibility activities or environmental information disclosure may be to build their own reputation in the social circle or to create opportunities for their political future or career, but the company will pay for the managers' personal objectives (Friedman, 1970). At this moment, shareholders may withdraw their invested money or implement more strict supervision mechanisms, resulting in a rise in agency expenses.

2.7.1.2 Stakeholder Management Perspective

Proponents of corporate disclosure of environmental information believe that if businesses consider this issue from a broader perspective, they will discover that corporate disclosure of relevant GHG information may be advantageous to the business. The stakeholder theory highlights the need for corporate governance to balance the interests of all stakeholders thoroughly. In contrast to the traditional shareholder primacy, this theory asserts that the growth of any organization is inextricably linked to the input or involvement of diverse stakeholders, and that the enterprise should promote the overall interests of stakeholders (Freeman, 1984; Clarkson, 1995). According to this viewpoint, the firm is responsible for reducing the environmental pollution.

Instrumental stakeholder theory further posits that CSR action may increase stakeholders' trust in the organization, strengthen the connection with important stakeholders, and improve corporate FP (Jones, 1995). Positive disclosure of GHG emissions by corporations, for instance, can lessen unfavourable restrictions from government relations standpoint. A business with a positive

public image will be able to recruit, retain, and motivate high-quality personnel, as well as increase its productivity and profit rate, from the standpoint of its employment relationships (Turban & Greening, 1997). From the standpoint of customer relationships, engaging in social responsibility is favourable to recruiting consumers with high social responsibility sensitivity, so helping to distinguish products and services and increase customers' propensity to purchase and pay (Bhattacharya & Sen, 2004). Active participation in disclosure activities is conducive to attracting investors with high sensitivity to environmental protection projects and obtaining capital resources (Barnett & Salomon, 2006; Graves & Waddock, 1994) because businesses that actively disclose are frequently able to receive tax breaks from local communities or use public facilities.

On the other hand, the proponents of corporate environmental information disclosure have addressed the principal-agent dilemma stated by the opponents using the stakeholder management philosophy. According to the theory of stakeholder management, managers and stakeholders have established a mutually beneficial relationship through covert and overt negotiations and contracts. This bilateral connection may effectively supervise and prevent managers from pursuing objectives other than increasing shareholder value (Hill & Jones, 1992; Jones, 1995). Moreover, by satisfying and balancing the needs of numerous stakeholders (Freeman & Evan, 1990), managers may successfully enhance the organization's ability to respond quickly to external demands (Orlitzky et al., 2003).

With the deepening of research on corporate GHG disclosure, some scholars have begun to explore the internal mechanism of GHG disclosure affecting corporate FP from the perspective of stakeholders, the so-called mediation effect (Hansen et al., 2011). In general, scholars have made an in-depth analysis of the two intermediary mechanisms of customer satisfaction and employee

commitment by drawing on the relevant viewpoints of social identity theory, social exchange theory, and signaling theory. These works provide a more solid theoretical foundation for relational research and make the research on this topic better connect with other mainstream organizational and management research topics.

First, from the perspective of consumer satisfaction, academics think that the behavioral decisions of individual buyers differ from those of corporate and government purchasers, and that advertising has a greater influence on their purchasing decisions. Environmental protection-focused businesses can play a role in improving company brand recognition through advertising (Staniskis & Stasiskiene, 2006). Particularly, product quality, internal management, etc., are not easily discernible; thus, more transparency will assist in enhancing the company's reputation, sending a signal of product environmental protection, and assisting customers in making purchase decisions (Bhattacharya & Sen, 2004). Enterprises with active environmental disclosure are more likely to place a premium on the requirements of external stakeholders, actively monitor consumer satisfaction, rigidly guarantee product quality, and give enough product information (Maignan et al., 1999).

Second, existing research has investigated, from the standpoint of employee commitment routes, the mediating function of the organizational commitment of potential workers and internal employees on the link between the two. Fombrun and Shanley (1990) and Olian and Rynes (1991) theorized that an organization's appeal to prospective workers depends on candidates' impressions of the organization's image, which is impacted by the company's social responsibility through transparency. According to the signaling theory, there is an information asymmetry in the applicant's comprehension of the enterprise. The organization can signal the applicant regarding its environmental consciousness by revealing pertinent information and undertaking certain public initiatives. After acquiring

this information, applicants construct knowledge of company sustainability behaviour by processing the information (Breaugh, 1992). For instance, a company's GHG emissions performance conveys the organization's values and behavioral standards to the outside world. Chatman (1989) noted that businesses would attract prospective employees if they upheld values and conduct standards that these candidates appreciate. According to social identity theory, "the individual realizes that he or she belongs to a certain social group and also acknowledges the emotional and value meaning that he or she gives to the group" This theory posits that an individual's identification with a group is the foundation of group behaviour and that the awareness of belonging to a particular group has a profound effect on an individual's perception, attitude, and conduct. Through information sharing, companies engage in socially responsible practices. Compared to other business acts, information disclosed by a corporation can more properly reflect its ideals, continuity, and individuality (Sen & Bhattacharya, 2001).

Hansen et al. (2011) predicted that workers' perceptions of the company's performance influence their attitudes and behaviour. Employees respond to corporate environmental duties in accordance with their conceptions of "normative treatment" and "deontic justice" (Folger et al., 2005). Greenberg et al. (2001) proposed the "moral fairness" idea, which asserts that humans have an innate moral desire to treat others fairly. When others are treated unfairly, individuals will also perceive that they are being treated unfairly. Hansen et al. (2011) argued that employees would not only respond to the organization based on how the organization treats them, but also based on how the organization treats others outside of the organization (Greenberg et al., 2001). For instance, when employees perceive that a company's actions are harmful to the environment, they will demonstrate negative work attitudes and behaviors; when employees perceive that a company complies with regulations and discloses environmental information objectively, they will demonstrate positive work

attitudes and work more efficiently (Rupp et al., 2006).

2.7.1.3 Voluntary Disclosure Perspective

In contrast to the cost principle, from the standpoint of voluntary disclosure, since an increase in the disclosure can minimize the existence of information asymmetry, it can lower costs and raise the firm's FP to a certain degree. Although current research has not discovered conclusive evidence that accounting disclosures keep their value relevant over time, there is evidence that company disclosures (whether required or voluntary) provide value to capital markets. In addition to annual reports, these disclosures also include management meetings with analysts, press releases, and other kinds of communication (Francis et al., 1997). There are two paths of thought about the relationship between corporate disclosure and market value. Also supported by Botosan (2000) study was the notion that enhancing public transparency might lower the cost of capital for a corporation in two ways.

The first pathway includes: (1) minimizing information asymmetry between investors and firm management; (2) minimizing estimation risk; and (3) minimizing the cost of equity. Verrecchia (1983), Handa and Linn (1993), and Clarkson et al. (1996) have presented theoretical arguments for this method.

The second pathway involves: (1) decreasing investor information asymmetry (through public disclosure); (2) enhancing market liquidity for securities; and (3) decreasing the cost of equity. Brennan and Tamarowksi (2000) provided a summary of this path's linkages, while Amihud and Mendelson (1986) and Diamond and Verrecchia (1991) offered theoretical justifications.

Under the first option, the disclosure of relevant information should be value-added because enterprises have discretion regarding information disclosure (Verrecchia, 1983). Under particular circumstances, more transparency by

businesses can lessen information asymmetry and further decrease the cost of capital. In other (less frequent) circumstances, this lessened knowledge asymmetry may have the opposite impact.

Under the second pathway, in a completely competitive and liquid market, shareholder welfare can be increased by revealing information that lessens information asymmetry among investors, according to Diamond and Verrecchia (1991).

In a cross-sectional setting, Lang and Lundholm (1996), Botosan (1997), Sengupta (1998), and Healy et al. (1999) offered quantitative evidence for the statement that greater public transparency is related to reduced costs of capital. Lang and Lundholm (1996) discovered that organizations with more comprehensive disclosure practices had higher analyst concentration, more accurate analyst earnings estimates, less forecast dispersion, and less forecast revision volatility. Botosan (1997) utilized a disclosure index (comprising around 65 elements) to examine the level of disclosure to sample corporations in annual reports for the 1990 fiscal year. Botosan (1997) discovered that enterprises with low analyst attention could cut their cost of capital by as much as 9% (compared to the cross-sectional average of 20.1%). There was no such advantage discovered for firms with extensive analyst coverage through annual report disclosure.

Sengupta (1998) expanded the analysis to the cost of debt and found that enterprises with greater levels of transparency (from yearly and quarterly reports, press releases, and analyst conversations) had lower financing costs. In particular, he discovered that a 1% rise in the disclosure index was connected with a 0.02% drop in the company's overall interest expense. Healy et al. (1999) investigated the elements that influence the increase of analysts' disclosure ratings of corporations. This rise was related to higher stock returns, analyst tracking,

institutional ownership, and stock liquidity. These effects persisted even after accounting for variables such as risk, growth, and firm size. In addition, they discovered that the median (but not the average) industry-adjusted dispersion of analysts decreased dramatically around disclosure expectations. This conclusion, however, was not maintained in the presence of the control variable sales growth.

The voluntary disclosure approach entails that business managers use discretion in information disclosure and determine whether or not to share information depending on its influence on asset market values. There is a significant stage in the disclosure process (Verrecchia, 1983) at which company managers exercise discretion by selecting the quality level or point of information. Above the crucial level, he discloses what he observes, but below the critical level, he keeps his observations to himself.

Economists of the past have also investigated the concept that a person with superior information or insight will demonstrate, either directly or by his actions, what he knows in order to acquire an economic advantage. Grossman (1981) demonstrated that anyone with access to information about a product or asset must adhere to full disclosure policies (such as salesmen, managers, and sellers). The sales of a company's products and reputation are affected by the concealment of information, as consumers' suspicions can be aroused. However, disclosure has both positive and negative aspects, and quantitative research demonstrates that companies exercise discretion when choosing voluntary disclosure. For instance, a positive difference between actual reported returns and market expected returns is regarded as "good news," whereas the opposite is regarded as "bad news" (Ball & Brown, 1968). In an analysis of annual reports, Patell and Wolfson (1982) discovered that "good news" is typically published before a deal closes, whereas "bad news" is typically published after a deal closes. Using Australian data, Dyer and McHugh (1975) discovered a negative but insignificant correlation between accounting return data and reporting delays.

According to a study by Blacconiere and Northcut (1997), when environmental rules are reinforced, corporations who disclose more information about their EP see fewer adverse stock price reactions than other companies in the same chemical industry. This is also an indication of the effect of corporate information disclosure on FP.

2.7.2 An integrated framework for the relationship between GHG disclosure and FP

After analyzing the mechanisms of action from diverse theoretical viewpoints in current studies, this study contends that the time of distinct mechanisms may significantly contribute to the diversity of research findings. Disclosure of GHG information as a CSR is unlikely to provide consistent and uniformly positive returns across all periods (Barnett, 2007). Brammer and Millington (2008) claimed that the link between corporate GHG disclosure and corporate FP is contingent on the temporal relationship between the costs and rewards of GHG disclosure investment. Next, a brief study of the temporal effects revealed by the research from several theoretical viewpoints will be conducted.

Previous studies based on the perspective of agency costs have generally found a negative relationship between environmental information disclosure and FP, but the outcome variables predicted from this perspective focus on the initial stage of environmental information disclosure. Engaging in CSR activities is a cost burden for companies with little financial benefit because companies that undertake environmental responsibility are economically disadvantaged relative to those who do not incur such costs. But as pointed out by Wang et al. (2008a), the costs and benefits of companies' attention to environmental change and subsequent mitigation actions are not synchronized. In the early stage of the project, a large amount of human, material and financial support is often required, which directly reduces the cash flow of the enterprise and occupies the enterprise resources of production and investment. However, with the increase of

enterprises' participation in relevant emission reduction projects, a learning curve effect is formed, and the cost of enterprises will not show a linear state of increasing all the time, but will stabilize after reaching a certain stage.

However, from the perspective of reputation, the purpose of corporate commitment to social responsibility behavior is to protect the corporate reputation that the company has established. Reputation usually requires long-term and sustained investment to be obtained (Muller & Kraussl, 2011), and obtaining a higher reputation can bring more benefits to the enterprise.

At the same time, according to the theory of stakeholder management, the improvement of the relationship between enterprises and stakeholders also depends on the relationship that enterprises have established with stakeholders through the disclosure of GHG information in the past. The same level of corporate GHG disclosure investment will also lead to different FP of different companies at different time points. A company's investment in GHG information disclosure for a period of time can convey more corporate responsibility to stakeholders, deepen the relationship with internal and external investors, and further enhance the reputation gained through social responsibility, bringing more benefits to the company.

To sum up, the negative impact of corporate environmental information disclosure on FP is mainly due to the fact that in the short term, this CSR behavior increases the agency cost of the company. However, this negative relationship will change with the gradual stabilization of costs and the gradual emergence of benefits. In the long run, there is no contradiction between corporate environmental information disclosure and corporate FP. The positive impact of CSR on the long-term FP of an enterprise is mainly achieved by improving stakeholder relations, acquiring tangible and intangible resources, and gaining moral reputation capital. Based on this understanding and the previous

systematic review of the existing research, this research tried to make an exploratory integration of the explanation mechanisms from different theoretical perspectives under the premise of considering the time effect. Hopefully, these works will help people find the main threads in the complex and slightly confusing relationship map and finally find the appropriate outlet through their own research.

2.7.3 Summary

The link between corporate GHG disclosure and corporate FP has long been the key study question in the field of social responsibility research. However, there is still no unanimity among experts after years of growth. This chapter's analysis of the link between corporate GHG disclosure and corporate FP from several theoretical perspectives facilitates a more systematic and thorough understanding of the interaction between the two. With the emergence of many theoretical views, the link between GHG disclosure and corporate FP has gotten increasingly complex. However, the "mainline" on this map and the underlying logical links between them are not yet sorted out, resulting in a confusing and tangled appearance.

Based on a comprehensive evaluation of the available research literature, this chapter proposes that adding the time effects between the processes underlying distinct theoretical viewpoints into the analytical framework would assist in dispelling the haze around this relationship map. In light of this, and under the premise of fully considering the time effects of various mechanisms, this study constructs an integrated framework on the impact of corporate GHG disclosure on corporate FP to provide a theoretical reference to promote a precise understanding of the phenomenon of corporate GHG disclosure in academia and industry. This section emphasizes, from a theoretical standpoint, the underlying logical link between distinct theoretical viewpoints and their explanatory processes, assisting scholars in understanding the numerous contexts of the

relationship between the two.

In addition to the discrepancy in the assessment of corporate FP, the backdrop may also be a factor in the inconsistency of the link between the two variables. Numerous studies have demonstrated that the link between environmental disclosure and corporate FP is regulated by a variety of contextual characteristics, including industrial environment, social orientation (Griffin & Mahon, 1997; Margolis & Walsh, 2003). When economic conditions improve, managers are typically more inclined to disclose comprehensive environmental data. During prosperous economic times, businesses are able to participate in socially responsible activities and provide extensive social information without fearing unfavourable investor reaction. However, when a firm is in trouble, management may be concerned about a negative investor reaction to such activities, so it discloses pertinent environmental information in reports with greater caution.

The extremely essential institutional factors among the situational components have not gotten sufficient attention and study from academics. To some degree, all companies are enmeshed in an institutionalized environment, and different types of institutional contexts can substantially affect corporate decision-making and the outcomes of corporate behavior. Enterprise environmental disclosure is a behavioral decision in a social context influenced by the context's system. In the future study, it will be crucial to determine the influence of the institutional environment in greater detail. The ninth subsection of this chapter will investigate the institutional environment's effect on corporate conduct's outcomes, focusing primarily on the effect of the institutional environment on corporate environmental information disclosure. In addition, it categorizes the dominant institutional theories and offers theoretical direction for the quantitative examination of the moderating influence of the institutional environment.

2.7.4 Measurement of FP

The disclosure of GHG in the process of firms' sustainable development is the situation of minimizing environmental pollution while simultaneously aiming to maximize market value. Despite the rising awareness of environmental change containment and the impact of GHG emissions, as the institutional environment continues to evolve, the evaluation of the FP of businesses must be enhanced. Despite the fact that measuring FP is regarded as a less complicated operation, it has its unique difficulties. It is primarily owing to the lack of consensus over the FP measurement instrument.

In the financial literature, there are several metrics for measuring business FP. However, the most commonly employed measures in research fall into two broad categories: (1) short-term measures related to accounting value ratios and profitability coefficients (Waddock & Graves, 1997; Cochran & Wood, 1984); (2) Long-term indicators related to market value factors (Alexander & Buchholz, 1978), also known as asset growth factors. Some researchers employ both measurements simultaneously (McGuire et al., 1988). These two indicators indicate alternative viewpoints on how to evaluate a company's FP, have distinct theoretical ramifications (Hillman & Keim, 2001), and each has a distinct bias (McGuire et al., 1986). Using diverse measurements might make it difficult to compare the outcomes of different studies.

Financial metrics indicate past characteristics of a company's performance (McGuire et al., 1986). They are susceptible to some extent to managerial manipulation and variations in accounting practices (Hopwood, 1972). Market measurements are prospective and centered on market performance. They are less subject to differing accounting techniques but often reflect investors' evaluations of a company's capacity to deliver future economic returns (McGuire et al., 1988).

In terms of future market value, the Q-factors of Marris and Tobin are often regarded as useful metrics for evaluating long-term business FP. The first component is the overall market value of the equity relative to its book value; the second element is the stock's market value plus the book value of debt paid versus the book value of the total assets. Marris and Tobin's Q ratios may be used to predict future corporate FP since they represent the market's perception of underlying profitability as reflected in stock market pricing. ROA and ROE are the most widely utilized profit metrics. ROA and ROE are excellent indicators for analyzing current business FP since they represent a company's historical profitability. To construct these two indices, utilize the available net profit (before or after taxes) (Tian & Estrin, 2008). However, the researchers suggest utilizing profits before interest, which includes interest, taxes, depreciation, and amortization. This decision will have many financial repercussions. This alternative technique of calculating profits may be due to database restrictions. In many instances, an inadequate database will cause different computations to be performed by various researchers.

2.8 GHG disclosures and EP

2.8.1 The impact of GHG disclosures on EP

In the present study literature, scientists rely mostly on the legitimacy and signaling theory to explain the logical connection between corporate GHG disclosure and EP. Each has a unique perspective, and the quantitative results are inconsistent. Following are summaries of the studies from various perspectives.

2.8.1.1 Legitimacy theory perspective

From a legitimacy standpoint, commercial businesses and their operations must or should appear to be congruent with the values of the operating social system (Deegan, 2002; Dowling & Pfeffer, 1975). Suchman (1995) defined legitimacy as the action of an entity deemed desirable or suitable within a socially formed system of norms, values, beliefs, and definitions. According to the assumptions

of legitimacy theory, organizations function within a spectrum judged proper by a given society; otherwise, their actions would be declared illegal and disrupt their normal operations (Deegan & Rankin, 1997). When a business's legal position is endangered, it must employ the necessary response tactics. For instance, when corporate carbon emissions are notably high, firms must take the necessary steps to reduce the gap between corporate performance and larger societal ideals (Gray et al., 1995). Organizational legitimacy is eventually conferred by the relevant "public" (Buhr, 1998), who has the authority to determine if a corporation is legitimate and express its opinions on its conduct. Consequently, businesses must continuously watch any shifts in external societal norms and beliefs that might precipitate a legitimacy crisis (Deegan, 2010).

As government and public knowledge of climate change, the necessity to reduce carbon emissions, and society's expectations on businesses to address climate change expand, legitimacy gaps emerge (Wartick & Mahon, 1994). Businesses with high carbon emissions, no effective emission reduction programs, or sufficient adaptation measures are considered socially irresponsible. Consequently, their legal standing will be significantly contested. Unless plans are implemented, society or stakeholders may penalize these companies (Pfeffer & Salancik, 2003; Bansal & Clelland, 2004). Legitimacy theory assumes that social and environmental disclosures are associated with external stakeholder pressure (overlapping with stakeholder theory), and thus firms will adopt a variety of coping strategies to counter or offset negative publicity by repairing, maintaining, or gaining legitimacy (Bebbington et al., 2008; O'Donovan, 2002).

Carbon disclosure is an excellent instrument for determining if a firm adheres to the principles of legality. According to a survey by Klynveld Peat Marwick Goerdeler (2008), more than half of the 250 largest corporations cited improved stakeholder relations as a rationale for reporting. This result showed that disclosure might act as a legitimate tool to demonstrate a corporation's

compliance with social norms and meet stakeholders' expectations, further ensuring the social survival and success of the organization (Deegan, 2002; Zimmerman & Zeitz, 2002). Deegan (2002), O'Donovan (2002), and Patten (2002) confirmed that businesses employ information disclosure to establish, maintain, and restore their social legitimacy in the course of business.

As it is sometimes simpler to maintain an image than to commit to sustainable performance, affected organizations may influence stakeholders by sharing information to seek their support and approval (Dowling & Pfeffer, 1975; Lyon & Maxwell, 2011; Neu et al., 1998). Consistently, researchers have discovered that companies with poor EP make relatively broader disclosures to maintain their environmental reputation, implying that companies with good EP do not use corporate disclosure to demonstrate their performance and further improvement their EP. In contrast, companies with poor EP use corporate disclosure as a means of satisfying legitimacy (Cho et al., 2012). In a similar vein, Cowan and Deegan (2011) discovered that carbon disclosures have increased during the implementation of Australia's National Pollutant Inventory. However, these disclosures appear to be offered as a purely reactive act to reduce the legitimacy gap between community and government expectations regarding carbon emissions levels and corporate carbon performance. Comparing the quality of environmental reporting by Australian corporations in 2002 and 2006, Clarkson et al. (2011) discovered that companies with a greater tendency to pollute revealed more environmental information in both years. Therefore, there is a negative association between EP and environmental information disclosure under the context of legitimacy theory.

Proponents of the legitimacy theory argue that disclosure will not reflect or affect corporate EP, or if it does affect corporate EP, it will have a negative effect. Beyond this, Cowan and Deegan (2011) argued that carbon emissions disclosures are a way of bridging the legitimacy gap and are thus unlikely to reflect genuine

GHG emission and environmental performance. As Patten (2015) suggested that if environmental disclosure mitigates the negative impact of EP on business reputation and reporting is more effective than action (Cho et al., 2012), then it will decrease firms' incentives to participate in environmental practises and increase performance.

Increasing numbers of voluntary social and environmental information releases are viewed as "green cleaning" suspects (Gray, 2006; Lyon & Maxwell, 2011). Milne et al. (2009) claimed that reports are just written assertions that businesses engage in sustainable conduct. When businesses say in their disclosures that "sustainable is a journey," they may easily conceal their mostly economic-centric business practices, which starkly contrast with social realities (Milne et al., 2006). Similar remarks were made by Tregidga and Milne (2006) on corporate management centered on resource efficiency and utilizing disclosure to position firms as leaders in sustainable action. Focusing exclusively on whether corporations publish environmental information, ignoring their real effect, encourages the business practice of making environmental disclosure a corporate strategy and raises questions about the sustainability of companies' actions (Mitchell et al., 2012). Phillips (2013) claimed that eco-entrepreneurs should use narrative disclosure reporting to establish a unified sense of self-identity that may resolve the underlying conflict between the enterprise (values) and the environment (values). Therefore, according to the legality theory, the disclosure of environmental information, including carbon emissions, will not have a real or negative impact on a company's actual EP.

2.8.1.2 Signal theory perspective

In order to avoid the issue of adverse selection, the theory of signaling implies that a firm with high carbon performance has the incentive to separate itself from its counterparts with lower performance. Good environmental performers can deploy sophisticated environmental management systems and make capital

investments in process upgrades or low-carbon technology to decrease their environmental risks and GHG emissions. Companies then notify the public about their improved carbon status by publishing more reliable, objective emissions data that cannot be easily replicated by businesses that have not taken mitigation measures (Clarkson et al., 2008). Consequently, firms with strong environmental performance are more likely to provide environmental information. As several studies have revealed, environmental disclosure reporting may be employed as a signaling strategy, suggesting a favorable association between GHG disclosure and GHG performance (GHGP) (Al-Tuwaijri et al., 2004; Clarkson et al., 2008; Dawkins & Fraas, 2011).

In addition to indicating a favorable association between environmental disclosure and EP, signaling theory suggests that it can also enhance the sustainability performance of corporations from the outside in (Schalteger & Wagner, 2006). Externally, communication with stakeholders may assist businesses in evaluating expectations, determining performance metrics, and determining accounting techniques (Schalteger & Wagner, 2006). From the standpoint of internal corporate management, appropriate disclosure that satisfies stakeholder and public demands enables organizations to develop their measurement and management operations, hence driving improvements in corporate sustainability performance (Burritt & Schaltegger, 2010).

The outside-in approach considers environmental disclosure as a means for managers to communicate the need to enhance business performance within the firm (Burritt & Schaltegger, 2010). Thus, the environmental disclosure process can facilitate the “penetrating” of stakeholder norms and expectations into firms to promote change and performance improvement (Boons & Strannegrd, 2000). For instance, Salo’s (2008) quantitative examination of corporate governance and EP revealed that when corporations release non-FP information, managers may place a greater emphasis on the performance domains that handle those

disclosures (Burritt & Schaltegger, 2010; Clarkson et al., 2008).

Different findings have been obtained on the influence of GHG disclosure on EP based on signaling theory and legitimacy theory. While corporations may first undertake disclosure in reaction to public pressure and information needs, environmental disclosure and sustainability reporting may create opportunities, influence managers' decisions, and give improved performance incentives, according to research (Burritt & Schaltegger, 2010). Bewley & Li, 2000; Clarkson et al., 2008; Li et al., 1997) have discovered that higher-performing businesses may have more "positive news" to reveal, whereas lower-performing companies may have difficulties copying their performance, that is, imitation is difficult and competitive advantage can be ensured. This indicated that disclosure could be a source of motivation for firms to create momentum in organizations, improve social and environmental performance (Branco & Rodrigues, 2006), create value and benefits (including an enhanced image and reputation) (Hoogiemstra, 2000), differentiate themselves from the global competition (Hasseldine et al., 2005), and influence the valuation of the firm (Clarkson et al., 2015). In this context, pressure to increase the quality and scope of environmental disclosures may motivate organizations' dedication to sustainability and enhanced EP practices (Clarkson et al., 2008).

2.8.1.3 An integrated framework for the relationship between GHG disclosure and EP

The theoretical framework of the relationship between GHG information disclosure and EP is mainly based on the legitimacy theory and signal theory. According to the logic of legitimacy and associated critical perspectives, changes in the disclosure may have little or no effect on carbon emission performance. Despite the fact that quantitative research so far has concentrated on the 'horizontal' study of carbon disclosure and performance across a certain period, the theoretical foundations and assumptions employed in earlier studies have

important consequences. Along this line of thought, more transparency is viewed as a means to create a sustainable image (Milne et al., 2006; 2009) or repair a poor image to earn or maintain legitimacy (O'Donovan, 2002; Patten, 2015). In such a scenario, better performance will not be reached, particularly among superior performers, as they would have little motivation to develop further.

Nevertheless, based on the signaling theory, environmental information disclosure may be turned from the outside to the inside into pressure and motivation to encourage businesses to improve their EP. As carbon emissions have lately acquired considerable attention, associated challenges have steadily permeated company management concepts and practices. In several nations, carbon emissions are already monetized and transparent to certain entities (Vesty et al., 2015). As stated by Topping (2012), given the increased demand for carbon information both inside and outside the purview of company operations, the carbon information disclosure process may and should result in changes in the behavior and performance of corporate carbon management. With the mandated sharing of information, it is anticipated that the measurement content will also be monitored. Therefore, disclosing carbon emissions and EP data may result in beneficial and productive shifts in strategic thinking, allowing businesses to convert data into action (Schalteger & Wagner, 2006; Topping, 2012).

2.9 Influence of institutional environment

2.9.1 Main theoretical perspectives

Concerning the influence of the institutional environment on corporate behavior, two groups have been distinguished: the institutional economics branch, represented by North (1994), and the organizational sociology branch, represented by Scott (1995). This section will classify institutional theories from institutional economics and organizational sociology viewpoints and give a framework for assessing the effectiveness of the institutional environment on the link between corporate GHG disclosure, corporate FP, and corporate EP.

2.9.1.1 Institutional theory from an economic perspective

Institutions, according to the institutional economists represented by North (1994), are limitations on organizational behavior and associated game rules. Institutions include formal institutions (such as political and judicial rules, economic law, and contracts), informal institutions (such as sanctions, traditions, and standards of conduct), and institutional implementation.

North (1994) believed that the institutional environment is the determining factor in the efficiency differences between economic organizations. He noted that transaction costs represent the complexity of the whole system (both formal and informal) that constitutes an economy or a larger society, and that this entire structure describes transaction costs at the level of individual contracts. North (1994) regarded institutions as the determining element of economic performance, compared transaction costs from the perspective of institutions, and analyzed the institutional causes for the variations in economic performance between the third world and industrialized nations. He thought that the institutional structure is the foundation for the formation and execution of an efficient market, and that the absence of an institutional structure in the third world is a typical cause of insufficient market development. Therefore, the third world countries have greater transaction costs each transaction, and occasionally exchanges cannot occur due to these expenses.

From the perspective of institutional economics, institutional theory research focuses primarily on external institutional environment restrictions and operational costs, as well as the cost of adjusting to and overcoming the role of market uncertainty in various institutional contexts.

2.9.1.2 Institutional theory from an organizational sociology perspective

From the perspective of organizational sociology, the institutional theory is

widely used in studying corporate strategic issues, and it overcomes the inherent limitations of the rational choice model. Unlike the institutional theory from the perspective of economics, the institutional theory from the perspective of organizational sociology believes that institutions refer to social rules and norms that conform to legitimate behavior (Dimaggio & Powell, 1983). In order to obtain legitimacy, organizations comply with the mainstream social value system, to enhance the ability of enterprises to obtain resources and support from the external society. Even in some cases, enterprises must sacrifice corporate efficiency to obtain legitimacy (Zhou, 2003). Consequently, institutional theories of organizational sociology are frequently integrated with efficiency-based theories of the firm to explain organizational behavior and strategies of businesses (Eisenhardt, 1989).

Presently, organizational sociology is the primary source of the institutional theory that experts in the study of strategic business management refer to. On the one hand, organizational sociologists have a broader definition of institutions than institutional economists like North (1994). Institutions comprise not just laws, regulations, processes, conventions, traditions, and customs, but also "symbolic systems that give a framework of meaning for human activity, cognitive models, and moral templates" (Scott, 1995). On the other hand, Scott's three-system theoretical model of institutions clearly defines the boundaries of institutions and proposes operable and measurable constructs, which provide a basis for future theoretical research and encourage the application of institutional theory in quantitative research (Zhou, 2003). Following is a thorough overview of institutional theory from the standpoint of organizational sociology and the three-system institutional theoretical paradigm.

Prior to the 1960s, organization research was predicated on Weber's rational organization paradigm (Zhou, 2003). In the rational organization model, the organization has rigorous organizational goals, acts rationally, connects its

operations using efficiency mechanisms, and arranges its production according to the maximizing principle. This is also the neoclassical economics viewpoint. However, the rational organization model cannot explain why the firm spends so much money on activities that have little to do with its production efficiency. Numerous huge corporations, for instance, actively participate in social welfare initiatives, which cost money and energy, have little to do with their internal production operations, and cannot boost firm efficiency. Early institutional education posed a challenge to the Weber-style rational organization concept.

Selznick (2000) is exemplary of early institutional education. In 1949, he emphasized that an organization is an institutionalized entity and not a closed system that is influenced by its environment. Instead of being the outcome of human design, the development of an organization is a natural process that arises via continual adaptation to the surrounding environment. In his book "Administrative Leaders," Selznick (2000) elaborated on the idea of institutionalization as the process through which value judgments that surpass the organization's specified goal or technical demands permeate the organization. In other words, institutionalization occurs when external values and idea systems continually impact an organization, and this influence surpasses the organization's technical requirements. The early institutional school abandoned Weber's (1981) rational organizational framework and no longer equates the organization with a mere efficiency machine; instead, it views the organization as a living organism influenced by its social surroundings and history. The institutional school offers an innovative viewpoint and theory to organizational study.

The neo-institutional school was particularly popular in the 1980s. The 1977 publication of Meyer and Rowan's "Institutional Organization: Formal Structure as Myth and Ritual" marked the beginning of a new institutionalism in organizational sociology (Feng & Wang, 2010). Meyer and Rowan claimed that

businesses encounter two distinct environments: institutional and technical environments. The technical environment requires that the organization be efficient and arrange production based on the maximizing principle. However, organizations are often products of institutional circumstances in addition to technological requirements—the institutional setting forces groups to be subject to "legitimation" mechanisms. Legitimacy encompasses the effect of cultural systems, conceptual systems, social norms, and other institutional settings on organizational behavior. The fundamental premise of the legitimacy mechanism is that a society's legal system, cultural expectations, and concept system become generally acknowledged social realities that exert a powerful binding effect on the conduct of individuals. Zhou (2003) defines legitimacy mechanisms as the conceptual factors that persuade or compel companies to adopt legitimate organizational structures and conduct. The New Institutional School investigates and comprehends diverse organizational behaviors and analyses organizational phenomena within the context of the organizational environment. Numerous businesses participate in social welfare initiatives. Although these activities have nothing to do with production, their objective is not to increase productivity, but rather to enhance the social standing and social recognition of businesses, fostering a robust institutional framework for company growth.

Dimaggio and Powell, who in 1983 published "Revisiting the Iron Prison: Institutional Convergence and Collective Rationality in the Field of Organizations" in the American Sociological Review, made a significant theoretical contribution to the New Institutional School. Ingeniously, they proposed three processes through which the institutional environment has an effect on the organization: the coercive mechanism, the imitation mechanism, and the social norm mechanism. They then dug further into the impact mechanism of the institutional environment on the organization.

The first mechanism is coercive. Other organizations and societal standards exert

both official and informal influences on organizations. The legal system is coercive, and corporations are required to comply with government-created rules and regulations or face punishment. In some instances, companies may undergo a transformation owing to government regulations. To comply with environmental restrictions, for instance, industries adopt new eco-friendly technology; to comply with tax laws, organizations create accounts and employ accountants. In addition, professional organizations have an influence on several facets of society, and organizations within society must be adapted expeditiously to meet these institutionalized normative criteria.

The second mechanism is mimetic. Each firm imitates the habits and methods of successful organizations in the same industry due to the imitation process. This occurrence is mostly attributable to unknown sources. In the event of uncertainty, the enterprise's aims are vague, there is no right or incorrect judgment standard in the pursuit of profit maximization, and a number of internal and external elements, including the environment, technology, and its own organizational structure, are obscure. Emulating prosperous businesses' actions provides an appropriate model for minimizing uncertainty and managing risk. Newly formed firms tend to copy existing organizational structures and activities, and their managers actively seek organizations that might serve as models. In particular, there are two types of imitation mechanisms: institutional imitation and competitive imitation. Competitive imitation occurs when firms in the same area replicate the superior experience of rivals, such as replicating their products and services, organizational design, which are imitations developed in response to competitive pressure. Institutional imitation is another process, which refers to the existence of a generally recognized organizational structure or behavior in a particular sector. If businesses do not embrace this institutionalized form or practice, they will face pressure from their competitors.

The third mechanism is the social normative mechanism. Social norms are the

rules and expectations of behaviour that all members of a society adhere to. Norms can be absorbed into one's mind and adhered to even in the absence of outward incentives. The norm is the embodiment of a value or an ideal; it is more clear and detailed than the latter and relates to real conduct (North, 1994). In contrast to the impact of laws or formal rules on corporate conduct, social institutional laws, norms, etc. are regarded as the key components of institutional theory (Dimaggio & Powell, 1983; Scott, 1987). If a corporation breaks these institutional standards, it may be penalized through the loss of social resources including social networks, discrimination by industry members, or danger to future economic returns (Ellickson & Whistler, 1991; Ingram & Silverman, 2002). In addition to economic and legal sanctions, social institutional norms can constrain the conduct of businesses by restricting the relationship and economic linkages between businesses and society in order to suit society's requirements.

As mentioned previously, the organizational sociology school's institutional theory is broader than that of the institutional economics school. However, such a broad definition has limitations as well. The system's border becomes hazy, which is not favourable to the creation of appropriate research variables for quantitative study (Liu et al., 2012). On the basis of a synthesis of previous definitions of the system, the theoretical model of the three systems is proposed. Three types of isomorphism - coercive, normative, and mimetic - are utilized in the suggested regulatory, normative, and cognitive institutions to provide legitimacy to organizations. These three institutions constitute a continuous transition from conscious to unconscious, the legal compulsion to granted (Hoffman, 1999).

The regulatory dimension consists of laws, policies, regulations, etc., with legal power, as well as different norms established by organizations with authority comparable to legal authority (such as countries and governments). It is coercive because the regulatory dimension regulates behavior by rewarding or punishing it.

Specialized enforcement authorities, including the police and courts, carry out regulatory activities. However, occasionally control takes the shape of praise, admonishment, or other informal forms. The core concept of the control system is that the authority and reward and punishment system that the organization has entrenched in its political environment, regulations, and power structures have a significant effect on the company's long-term development. Consequently, organizations have an incentive to align with the coercive force of laws and regulations, government opinions, or unquestioned rules (Qian & Burritt, 2008) in order to maintain links with government mandates, behavioral dependence, government funding, and other quasi-political influences. An area or nation with a robust regulatory system is characterized as "having a decent political system, an authoritative court system, and regulations with a continuous order of authority" (Chang & Wang, 2010).

The normative dimension belongs to the category of social obligations. In addition, the normative dimension includes several elements, including rules, regulations, guidelines, and standards of behavior. It lacks the regulatory dimension's obligatory characteristics. The normative dimension is mainly based on shared values and social standards, with a high "moral" authority. Regulatory pressure is considerably more substantial in industries or organizations with high ethical standards, such as medical care, legal services, accounting and auditing, finance. Companies operating in the same institutional setting can become more comparable by promoting and disseminating norms through artificial processes such as certificates and certifications. Specifically, organizations are vulnerable to peer pressure, as well as pressure from industry norms and industry groups. Through mutual network interactions, firms replicate the conduct of successful corporations in their own industries in order to decrease uncertainty and obtain legitimacy and recognition from other industry participants. In most cases, the characteristics of industry growth determine institutionalized imitation. Mature industries have more possibilities for enterprises to emulate, thus, new entrants to

the market have more opportunities to learn from and imitate current industry leaders.

The cognitive component is the individual's or group's knowledge and comprehension of the external world, as well as the "self-evident" acceptance in the heart of concepts and concept systems based on this information and comprehension. Cognition is a deliberate mental activity that cannot be demonstrated without evidence and the actor's mental representation of the external environment. Establishing a cognitive system primarily depends on learning and imitation, which manifests as recognizing a particular notion, doctrine, sermon, consciousness, myth, or symbol. According to the fundamental premise of the legitimacy mechanism, cultural expectations, concept systems, and other commonly acknowledged social realities exert a powerful binding effect on public and organizational behavior. Factors such as cognition, perceptions, may stress organizational behavior since they are not individual traits but psychological programs that many individuals share with the same social experience and education. Different groups, individuals in distinct nations or areas, have different ways of thinking due to the fact that they have always had different education, belong to different cultures, and have different occupations. When an organization experiences cultural changes, it must comprehend and adapt to the local culture in accordance with local realities in order to achieve legitimacy from the local society. Different cognitive backgrounds will limit and alter organizational behavior and produce distinct outcomes for the same conduct.

2.9.2 An integrated framework for the relationship between mandatory disclosure regulation and GHG disclosure

Institutional theory is the theoretical basis for studying the disclosure of GHG information emissions by mandatory disclosure policy. This study mainly discusses the institutional theory from the perspective of organizational

sociology and legitimacy, and then provides a theoretical framework for the impact of the 2018 regulations on corporate environmental information disclosure.

The institutional theory of organizational sociology highlights the significance of the legitimacy mechanism in organizational structure and behavior. This theory acknowledges organizational behavior and analyses organizational phenomena based on the effect of the institutional environment, which is considerably different from Weber-style rational organization. Individual choice is the basis for the creation of organizations, according to Weber's rational organization theory. Organizations are the consequence of rational choice, a kind of organization that emerges when people play games for their own interests. While the institutional school argues that organizations' shape depends on the reaction to the external institutional environment, the functional school argues that the form of organizations is determined by internal factors.

In contrast to the efficiency mechanism, institutional theory interprets and explains organizational behavior and phenomena from another entirely different perspective: legitimacy. It is proposed that the objective of the study of organizational phenomena should not be to explain organizational phenomena from within the organization but rather from the external environment's perspective. It transcends the rational model framework, proposes new theoretical reasoning and explanatory logic, and advances the academic growth of organizational sociology. Moreover, the proposed three-system theoretical model of institutions clearly defines the boundaries of institutions and proposes operable and measurable constructs, which serve as an application basis for future theoretical research and encourage the application of institutional theory in quantitative research.

2.9.3 Research progress of institutional environment affecting corporate GHG disclosure

Prior research on corporate information disclosure mainly concentrated on environmental information disclosure, particularly the connection between GHG disclosure and corporate FP. While significant progress has been made, the institution's operating environment has been disregarded as the most crucial and fundamental aspect of the connection between the two parties. It must be emphasized that businesses are constantly embedded in a particular institutional framework and that their conduct tends to seek benefits, avoid disadvantages, and adapt to the surroundings. Therefore, the enterprise's behavioral performance and the outcome of its behavior are highly dependent on the institutional framework in which it operates. Understanding how the institutional context affects the interplay between these two components is helpful in getting to the heart of the topic. In recent years, the research on corporate GHG information disclosure has increasingly progressed to the level of examining the link between the institutional environment and corporate information disclosure due to the accumulation of research and a deeper understanding.

In terms of theoretical research, Aguilera et al. (2007) provided a cross-country comparative theoretical model for understanding CSR behavior based on institutional contrasts between the American model and continental Europe. Using the regulated environment as an example, scholars such as Aguilera et al. (2007) asserted that the government's efforts to foster social cohesiveness, build a competitive mechanism, and support collective responsibility would favor boosting CSR activity. However, diverse institutional settings will result in heterogeneous CSR behavior. According to these researchers, continental European governments are aggressively pushing CSR policies, including GHG disclosure, throughout the country and actively encouraging local enterprises to report environmental information and assume responsibility for emission reductions. Some governments, such as the Chinese government, combine

obligatory and optional disclosure regulations. Some nations have not implemented disclosure-related institutional reforms.

On the basis of the social isomorphism model, Marquis et al. (2007) highlighted the significance of legitimacy in the interaction between organizations and the regulatory environment. They utilized the geographical location of businesses as a source of institutional pressure to explain the disparities in the kind and amount of GHG disclosure across businesses in various regions. Similarly, Marquis et al. (2007) highlighted a number of characteristics that influence the extent of corporate information disclosure and the isomorphism of organizational behavior throughout the community. These aspects primarily consist of cultural cognitive characteristics at the community level, the degree of closeness between businesses and local non-profit organizations, political and legal concerns, and the consistency of information disclosure by businesses to local communities.

According to Kolk and Perego (2010) and Chen and Bouvatai (2009), a country's institutional framework and its environmental concerns provisions might influence businesses' reporting tactics. Many researchers have conducted a significant number of quantitative studies on the influence of the institutional environment on corporate environmental information disclosure, continuing the previous research ideas. In their study, Esty and Porter (2005) showed that stringent environmental rules might foster firms' continual innovation, raise related transparency, and thereby boost economic competitiveness. Similar findings indicate that the more evolved an environmental regulatory system is, the greater the number of legal, economic, and social aspects a business must promote. These firms will become more environmentally conscious as a result (Huber, 2000). However, the evaluation of corporate technical innovation and EP by external stakeholders must continue to rely on the substance of corporate self-reports. Therefore, developing a dependable reporting system might have an impact on the reporting activities of companies.

Moreover, business responses to climate change depend on public attitudes and social norms, which are impacted by the institutional environment and culture. Maignan and Ferrell (2000) discovered, based on a cross-cultural comparison between France, Germany, and the US, that consumers in French and German appear more willing than American consumers to actively support environmentally conscious companies that consistently implement environmental practices. The perspectives of customers in these three nations on CSR may be interpreted from two viewpoints. On the one hand, consumers in these three countries accept and agree with CSR practices to a certain extent, which is connected to the level of economic development and the similar democratic traditions of the three countries. On the other hand, different national ideologies and cultural norms may account for the current cognitive disparities.

The research of luo and Luo (2008) similarly proposed that the difference in institutional pressure is the key to the difference in the EP of firms. Organizations may function differently in the long run, depending on how urgently they feel the need to preserve, maintain, or restore organizational legitimacy in the face of institutional pressure. In the research of Wang and Juslin (2009), they emphasized social environmental pressures (such as public aspirations and media attention), political and legal environmental pressures (such as laws and related policies promulgated by the government), natural environment pressures, and market pressures (such as industry norms and guidelines upstream and downstream of the supply chain) and stakeholder pressure (including social interest groups, trade unions). However, as mentioned above, the study is limited to the cause-driven mechanism of the institutional environment for firms' environmental disclosure. It ignores the impact of the institutional environment on the behavioral outcomes of enterprises. In fact, diverse institutional contexts will have a different effect on corporate conduct, resulting in variations in the behavior of corporations operating under various systems. Simultaneously, the

same business action will yield different outcomes under various systems.

Corporate social responsibility actions, such as GHG information disclosure, are behavioral decisions made by businesses in a social context. Therefore they will undoubtedly be influenced by the institutional framework. Because businesses are constantly situated in a particular institutional framework, their conduct tends to seek benefits, avoid disadvantages, and adapt to the surrounding conditions. Therefore, the motivations and outcomes of an enterprise's activity are heavily influenced by the institutional framework in which it operates. Understanding the influence of the institutional context on corporate information disclosure will assist in explaining the effect of the obligatory disclosure system on company GHG emissions, as well as the motivation, outcomes, and consequences of corporate GHG disclosure. However, current research continues to focus on the antecedent driving mechanism of the institutional environment on corporate information disclosure while disregarding the influence of the institutional environment on the corporate behavior process and outcomes.

Deeply digging into the impact of the institutional environment on enterprises will not only help clarify the complex relationship between institutions and corporate behavior but will also aid in systematically and comprehensively comprehending the impact of the mandatory disclosure system on the quality of corporate GHG information disclosure. Different institutional contexts will influence corporate behavior, resulting in variations in corporate behavior across systems. Similarly, the same business activity will have distinct outcomes under various systems. Consequently, this part offers a theoretical foundation for the link between mandatory regulations and the quality of GHG declaration by corporations.

In addition, this part provides a brief examination of how institutional theory impacts firms in theoretical research and which areas will be affected.

Institutional theory plays a significant role in this study since the mandatory disclosure system will influence not only its interaction with corporate GHG information disclosure but also the company's overall FP and EP. Consequently, this part provides additional observational context and theoretical importance for a deeper understanding of the effect of corporate GHG disclosure on business performance.

2.10 Hypothetical development

2.10.1 The impact of the 2018 regulations on corporate GHG information disclosure

Based on the previous research on institutional theory and the established theoretical framework, it lays a theoretical foundation for the hypothetical development of the relationship between mandatory disclosure institutions and the quality of corporate GHG information disclosure.

From the organizational social perspective of institutional theory, the capacity of businesses to successfully navigate the external social and political environment is primarily contingent on two elements. One is the perspective of the firm's position in society by top management (Miles, 1986). Companies with higher CSR believe they should accept more social obligations, exhibit greater cooperation with regulation, and are more susceptible to external systems. While companies with a poor level of CSR, on the other hand, have a tendency to prioritize their own interests, neglect their social duties, and take an individualistic or aggressive approach while engaging in the regulatory process. Consequently, the collaboration will be reduced and less vulnerable to the impact of linked institutions (Brenner, 1988).

Before the government intervenes more to enforce restrictions, businesses will be keen to demonstrate their efforts by boosting social information disclosure (Watts & Zimmerman, 1986). Active disclosure of social information may also be

advantageous for businesses. By disclosing valuable information, companies may stabilize prices in regulated industries, and companies may benefit from applicable tax or subsidy schemes (Inchausti, 1997).

The other is the firm's involvement with external affairs, environmental pressures, departmental structures, and process coordination (Miles, 1986). According to Preston and Post (1975), when a social issue is raised, it is thoroughly evaluated in the field of public policy and categorized as a legal solution or restriction based on its significance. Threats to corporate legitimacy, according to the theory of corporate legitimacy, do force businesses to provide increasingly extensive social responsibility information and content in associated reports. For instance, Patten (1992) conducted an empirical study of social responsibility information disclosure. Beginning with the Exxon Valdez oil spill in 1992, he discovered that companies do increase the disclosure of non-public social information in their annual reports due to increased threats to corporate legitimacy.

If the external public is unsatisfied with the organization's performance, the firm will be subject to external pressure. It will need to modify its behavior to fulfill the expectations of the external public. Alternatively, the external environment may exacerbate the problem and transform it into a legal system that impacts and requires the organization. Therefore, businesses are not only influenced by the mature legal environment during operation, but must also adjust to the effect on the creation of public policy and the legal process. Social disclosure is one of the techniques firms employ to influence corporate policy processes, according to this theory. This strategy directly meets the expectations of the outside world to acquire information about the business and the procedure for implementing applicable regulations and indirectly assists the organization in establishing an image as a socially conscious firm. Consequently, social legitimacy may be viewed as a consequence of the process of implementing public policy. When

public policy increases the cost of firms in the transition process, organizations will be required to respond to this process through social disclosure.

At the same time, external measures (such as reporting instructions) assist in aligning management and shareholder interests (Chithambo & Tauringana, 2014). If the corporation senses adverse opinions from external stakeholders or if it does not match the standards of the implicit contract made with the community, it might attempt to sway public opinion using relevant paper media such as annual reports, strategy reports, or newspapers (Dyegan et al., 2000).

Under the influence of institutional theory, the environmental information disclosure content of enterprises is relatively low in the case of insufficient legislative requirements and ecological responsibility, and each environmental milestone process is followed by a progressive increase in the amount of environmental information presented in the annual report. The 1992 Earth Summit in Rio de Janeiro, for instance, not only increased worldwide firms' awareness of environmental preservation, but also had a substantial effect on their environmental information sharing. Llena et al. (2007) examined the changes in the disclosures of 51 significant Spanish enterprises before and following the 2002 implementation of environmental accounting standards. By collecting relevant reports from companies and studying the characteristics and content of the released environmental information, it can be found that in the first year of the promulgation of environmental accounting standards, the proportion of relevant environmental information disclosures in the annual notes is very high. In addition, the disclosed items, the form, and the quantity of the disclosure are pretty different from the previous disclosures.

The external market and laws influence the disclosure of accounting information (Inchausti, 1997). According to a study conducted with a sample of Spanish firms, the application of accounting standards prior to their introduction will have

an effect on the company's disclosure of associated information. Rankin et al. (2011) discovered that enterprises impacted by the EU ETS are more likely to build systems for measuring and reporting GHG information across the enterprise, which in turn will report more environment-related data on relevant platforms. Similarly, they discovered that the Australian GHG Reporting Standard "ISO 14064-1" had a considerable influence on the quality and substance of GHG reports from associated firms. Lubis et al. (2020) determined that the introduction of The Indonesia Public Information Disclosure Act is essential for enterprise resource management, as well as for enhancing the transparency and accountability of information disclosure while decreasing information asymmetry. Nonetheless, there are studies indicating that in the dynamic development of cities, the economic and EP, and the regulatory processes are constantly improving, and the process and impact of government and public participation in corporate environmental information disclosure need to be discussed in greater detail (Li et al., 2021).

Consequently, this thesis hypothesizes a positive association between the new mandatory carbon disclosure requirement—the 2018 standards—and corporations' GHG disclosures in the UK, and proposes hypothesis 1:

Other things being equal, there is a positive relationship between the publication of the 2018 regulations and the quality of corporate GHG-related information disclosure.

2.10.2 GHG information disclosure and FP

Based on an integrated theoretical framework of agency theory, stakeholder theory, and voluntary disclosure theory, as well as previous research, the study lays the theoretical foundation for the development of hypotheses about the relationship between disclosure quality and firm FP. When examining the effect of corporate GHG disclosure on corporate FP, academics generally hold two distinct perspectives. One is that firms are required to engage in the form of

CSR for GHG information disclosure, which is expensive and has essentially no financial rewards. Companies with environmental responsibilities are at a competitive disadvantage compared to those without such expenditures. In addition to raising the direct cost of the firm (Barnett & Salomon, 2006; Ullmann, 1985), the methods for enterprises to adopt environmental information disclosure may also produce agency costs owing to the proxy problem (Wang et al., 2008b). Ultimately, these actions lower the enterprise's operational profit and undermine the objective of increasing shareholder value. In the study by Griffin et al. (2017), firms are primarily for profit, and the GHG emissions disclosed to CDP may be negative information to stakeholders, resulting in a fall in the equity value of the company. Clearly, this viewpoint was shaped by the thinking logic of neoclassical economics, which seeks to maximize shareholder interests through an efficiency mechanism. This perspective views the company as a "black box" of input-output transformation, ignoring the limits imposed on organizational behavior by its institutional context.

Nevertheless, based on the principal-agent theory, there are a variety of perspectives. According to Hardiyansah et al. (2021), environmental disclosure is the company's reaction to external stakeholders' expectations. Relevant information disclosure can lessen the information asymmetry between a corporation and the outside world, hence lowering proxy-agent costs. Although an organization bears certain costs after environmental information disclosure, the advantages given by the enhancement of FP far surpass the expenses in reality (Borghei et al., 2018).

The neo-institutionalist school's questioning and criticism of neoclassical economics indirectly give a theoretical justification for businesses to disclose environmental information as part of their social responsibility. To some degree, all organizations are immersed in relational and institutionalized settings, and their existence and growth depend on the institutional environment's recognition

of their legitimacy. The institutional theory views the institutional environment as a normative composition of many stakeholders, including customers, investors, governments, suppliers, and environmental groups. External stakeholders will have specific expectations for organizational activities, and organizational actions must match societal and stakeholder standards in order to be legitimate in the view of stakeholders. When a business disregards the limits of its institutional environment, its legitimacy will be threatened, and it will be penalized by the institution.

The institutional theory begins with the link between organizations and society, based on the legality mechanism of businesses, and indirectly provides firms with the theoretical basis for disclosing relevant environmental information. The stakeholder theory, which relies on the contractual link between businesses and stakeholders to support the disclosure of corporate GHG information, has become the most significant theoretical foundation in CSR research. In recent years, regular exposure to corporate environmental issues has prompted people to consider the role and responsibilities of businesses in society. Nowadays, reasonable management practices have fought against the mindless pursuit of maximizing efficiency and interests. Particularly when the requirement that the global temperature rise must be limited to 1.5 degrees Celsius was placed on the agenda, public attention, legal standards, media reporting, customer demands, and pressure from peers in the sector compelled corporate executives to prioritize GHG emission reductions.

In actuality, the stance opposing corporate participation in linked information disclosure only assesses the cost of engagement from the standpoint of the explicit contract between the firm and its shareholders, ignoring the influence of implicit contracts, which is insufficient. In addition to formal contracts with shareholders, the value of a company also rests on implicit relationships with other stakeholders (McGuire et al., 1988). The stakeholder theory focuses on the

contract theory's fundamental premise that the company is viewed as "the connection of a series of contracts" and posits that the enterprise has signed a series of multilateral contracts with all relevant stakeholders (Freeman & Evan, 1990). Various explicit and implicit contracts define their responsibilities and obligations to stakeholders. These contract topics include not only owners, but also managers, suppliers, customers, consumers, and communities, as well as other players. Each contract member makes a specific investment in the organization and assumes a risk, and their activities can influence the ultimate achievement of the enterprise's objectives.

In the process of executing the contract, to maintain the contract's continuity and stability, each party is obliged to protect the interests of the other party. On the one hand, the fulfillment of a contract is facilitated by the deterrent of the law and the court's enforcement mechanism. On the other hand, factors such as the market's game strength, basic moral norms, and credit and reputation appeals will compel the parties to decrease opportunistic conduct and hence automatically execute the contract. When a business breaches the implicit agreement with its stakeholders, it must incur the associated costs. Therefore, it is insufficient for opponents of corporate information disclosure to examine simply the growing cost of CSR using explicit cost analysis. They disregard the hidden expenses that businesses incur when they violate stakeholder expectations. In addition, high-quality information disclosure (measured by nature and type) may effectively restrict and minimize the implicit agency cost of listed businesses (Juan & Dan, 2012), lower the company's agency cost (Zhou et al., 2018), and enhance the company's FP (Plumlee et al., 2015).

If organizations examine this issue from a longer-term and larger vantage point, they will discover that CSR may provide the company benefits (Barnett, 2007). The stakeholder theory highlights the need for corporate governance to balance the interests of all stakeholders thoroughly. In contrast to the conventional

shareholder primacy, this theory asserts that the growth of any organization is inextricably linked to the input or involvement of diverse stakeholders. The enterprise should promote the overall interests of stakeholders when carrying out social activities (Freemann, 2010; Clarkson, 1995). From this perspective, businesses are responsible for fulfilling their social duties. By actively fulfilling their social duties toward product and investment markets, businesses obtain a competitive edge that impresses customers and investors. As the degree of information asymmetry diminishes, the favorable response of product and investment markets to corporate information transparency makes it simpler for businesses to improve their performance (Wang et al., 2020).

Moreover, according to the voluntary disclosure hypothesis, firms' discretionary disclosures should be value-added (Diamond & Verrecchia, 1991; Verrecchia, 1983). The difference between environmental information disclosure and financial information disclosure is that environmental information disclosure is to meet the expectations of stakeholders, while financial information disclosure is to cater to investors' valuations (Griffin & Sun, 2013). In addition, Blacconiere and Northcutt (1997) found that when environmental regulation is tightened, companies that reveal more EP information exhibit less unfavorable stock price responses than other firms in the same industry. Plumlee et al. (2015) discovered that future cash flow is favorably correlated with voluntary disclosure, but the stock cost is negatively correlated. Moreover, companies with objective or comprehensive environmental disclosures are more likely to have reduced financing costs (Aerts et al., 2007).

Some further study demonstrates that extensive disclosure minimizes information asymmetry (Mensah et al., 2003) and boosts the value of a company (Toly, 2019). Toly (2019) stated that GHG emissions transparency and ESG have a favorable effect on business value. Similarly, Anggraeni (2015) found that the impact of GHG disclosure on company value is positive, despite the fact that the

moderating influence of EP is not readily apparent. According to Clarkson et al. (2013), environmental disclosures have a favorable effect on business value and future cash flows as evaluated by ROA. Weber (2014) asserted that Chinese enterprises that engage in environmental, social, and governance reporting have greater FP. Ganda (2018) further believed that carbon emissions disclosure is favorably connected with ROA, a measure of company FP, in the majority of situations.

Based on all the theories proposed above, including institutional theory, stakeholder theory, and voluntary disclosure theory, as well as previous research, this research puts forward the following hypotheses:
Under the influence of the mandatory disclosure regulation, there is a positive relationship between the company's GHG disclosure and their FP.

2.10.3 GHG information disclosure and EP

Based on an integrated theoretical framework of legitimacy theory and signaling theory, as well as previous research, the study provides a theoretical basis for the development of hypotheses about the relationship between disclosure quality and firm EP. Initially, the focus of the research was on the relationship between corporate environmental performance and environmental information disclosure, and there were several instances of horizontal comparison. In the early 1990s, for example, environmental information disclosure was grossly inadequate, as demonstrated by three investigations by Freedman and Jaggi (2004, 2005, 2009). Meanwhile, EU corporations disclose less than their counterparts in Japan and Canada (Freedman & Jaggi, 2009). Hughes et al. (2001) surveyed the disclosures of 51 US industrial enterprises within the same period. They discovered that firms with varying EP use varying disclosure techniques, with those with weak EP typically disclosing more environmental information. Sutantoputra et al. (2012) examined the relationship between ecological disclosure and performance using data from 53 Australian enterprises. Contrary to the majority of other

investigations, they found no correlation between exposure and EP. According to Luo and Tang (2014), the higher the carbon emission level, the better the EP.

So far, there is little quantitative data about the influence of changes in company disclosures on EP improvement. According to the legality and signaling theories mentioned above, the revelation of information disclosure on GHG emissions has two separate effects on the EP, including GHG emissions.

Previous research based on legitimacy theory and signaling theory has produced contradictory results about the relationship between environmental disclosure and EP, providing some background information for the current investigation. According to the legality theory, changes in the exposure may have minimal or no effect on carbon performance. Although quantitative research so far has concentrated on the "horizontal" study of carbon disclosure and performance across a specific period, the theoretical foundations and assumptions employed in earlier studies have significant implications. In this sense, increasing transparency is viewed as a mean to create a sustainable image (Milne et al., 2006; 2009) or repair a negative image in order to obtain or retain legitimacy (O'Donovan, 2002; Patten, 2015). In such a scenario, actual performance will not be reached, particularly for organizations that are already performing well, because they have little motivation to develop further. Disclosure can be used to provide incentives or pressures inside a company as part of a management strategy based on signal theory. External programme disclosure is applied internally to aid managers in decision-making and performance enhancement (Burritt & Schaltegger, 2010).

This study does not examine whether high or low polluters are more likely to share carbon information or if these disclosures represent actual environmental conditions, unlike previous research. Instead, the study examined if a company's carbon performance improved as its disclosure strategies improved, a less

researched topic. This field has been stated that environmental disclosure research is insufficient and that there are significant gaps, including a lack of knowledge of fundamental changes and impacts on environmental and social situations (Gray & Milne, 2015). In addition, more research is required to determine whether particular firms will alter their disclosure tactics over time and, if so, what effects this will have on their environmental or carbon performance. These challenges appear to have significant practical relevance for policy-setting regulators and disclosure-decision-making company management.

Institutional theory asserts that a country's institutional framework and its arrangements with regard to environmental concerns impact the reporting tactics of businesses (Kolk & Perego, 2010; Chen & Bouvain, 2009). In addition, the pressure on businesses to address climate change challenges is contingent on public opinions and stakeholder investment, as well as institutional context and culture (Luo et al., 2012). Reid and Toffel (2009) contend that regulatory risks significantly influence corporations adopting practices that are congruent with broader social movement objectives. Consequently, the link between carbon disclosure and carbon performance may be influenced by the institutional frameworks of businesses. In the context of this study, corporate information disclosure laws have shifted from voluntary to mandatory, indicating that corporate environmental disclosures are subject to more stringent supervision and requirements, which will have an effect on the content and quality of corporate environmental disclosures. Based on institutional theory and signal theory mentioned above, this study proposes the following hypotheses:
Under the influence of the mandatory disclosure regulation, there is a positive relationship between the company's GHG disclosure and their EP.

2.11 Summary

The research in this chapter adopts a multi-theoretical framework consisting of socio-political theory, signaling theory, institutional theory, agency theory and

voluntary disclosure theory as the basis for understanding and explaining corporate environmental information disclosure behavior. From this, it can be concluded that the motivation of enterprises to disclose GHG information and the impact of information disclosure on enterprises.

Following years of research, researchers have not yet agreed on the link between corporate GHG disclosure and corporate FP and EP. Systematically and completely examining the link between corporate GHG disclosure and FP from the viewpoints of cost theory, stakeholder theory, and voluntary disclosure theory is beneficial. Similarly, an examination from the perspectives of signaling theory, legitimacy theory, and institutional theory will aid research in gaining a deeper understanding of the link between corporate GHG disclosures and EP. In addition, merging institutional theory provides a theoretical study foundation for the effect of the mandatory disclosure system on the disclosure of environmental information by corporations. Through an in-depth examination of various theoretical views and obligatory disclosure rules, the interaction between GHG disclosure, corporate FP, and EP has become even clearer.

This study examines, from the perspective of institutional differences, the internal mechanism that influences the relationship between corporate GHG disclosure and corporate FP, which has important theoretical implications for the verification of the relationship between GHG disclosure and corporate FP. Analyses and integration of theory provide a greater understanding of the link between corporate GHG declarations and FP. The research integrates institutional theory and stakeholder theory to thoroughly evaluate the underlying mechanism of the link between GHG disclosure and corporate FP under the influence of institutional variables when examining the impact of institutions on GHG disclosure.

This study aims to fill the gap in related research and offer quantitative evidence

for the link between the research elements, including GHG information disclosure, corporate FP and EP. This chapter undertakes a thorough analysis and literature evaluation of relevant theories. Finally, three hypotheses that must be investigated in this study are provided, laying a sound theoretical groundwork for the following chapter.

Chapter 3: Methodology chapter

3.1 introduction

There is no single ‘right’ way of tackling a research problem in social science. The central hypothesis of this thesis is that “all organizational theories are based on scientific philosophy and social theory” (Burrell & Morgan, 1979). When conducting quantitative research, it is necessary to choose between various research paradigms. The more important thing is to choose the scientific philosophy and scientific methods that are most suitable for the research objectives. The primary purpose of this chapter is to develop a methodological framework to study the impact of mandatory carbon disclosure on companies listed on the main UK markets.

At the beginning of research design, it is necessary to carefully consider the relative advantages and disadvantages of each method and decide whether each method is suitable for achieving the goals of the relevant research. Therefore, the methodological steps of this study are outlined below.

This chapter is divided into five parts. The first section mainly introduces the research paradigm, mainly combining the research background and research purpose, laying the foundation for the subsequent research methods, and also affecting the research design. Section 2 explains sample selection criteria and identify research samples to clarify the research objectives of this research. Section 3 outlines the discussion about alternative scientific research methods and choose the most appropriate method. At the same time, it explains how the research was conducted, with a particular focus on the data collection techniques used, including documentary data collection, review of company (climate change) materials, and content analysis phases. This part selected relevant datasets, specific indicators through content analysis methods, and proposed quantitative detection models. Section 4 concludes.

3.2 Research paradigm

The word “paradigm” is derived from the Greek word “paradeigma”, which was first used by Kuhn in 1962 to denote a conceptual framework. According to Bogdan and Biklen (1998), “paradigm” is a collection of logical assumptions, concepts that guide thinking and research, or researcher’s intentions and motivations to study a problem (Cohen & Manion, 1994). A model is constructed from this collection to help researchers embody scientific ideas, values, assumptions, and frameworks in the research process.

The choice of research paradigm guides researchers from a philosophical standpoint to think about their research process from three aspects: ontology, epistemology and methodology. When researchers consider research questions, they first need to confirm the research paradigm. The choice of paradigm determines the intention, motivation, and expectations of subsequent research. At the same time, research paradigms also help researchers consider whether research is “effective” (Antwi & Hamza, 2015), and which research methods are appropriate for theory building and method use in one's own research (Sobh & Perry, 2005). Thus, specifying an established paradigm at the outset can provide a good foundation for subsequent research in terms of methodology, literature, or study design (Mackenzie & Knipe, 2006).

Bell and Bryman (2007) divided research paradigms into two distinct types: positivism and interpretivism. After that, classical positivism has further developed into logical positivism, post-positivism, critical realism and so on. The orientation of this research is to use the positivist-hermeneutic dichotomy at the epistemological and methodological levels. Methodologies that match positivist epistemology and interpretivist epistemology share names with their epistemology, namely positivist methodology and interpretivist methodology (Han, 2016).

Interpretive researchers are concerned with understanding "the world of human experience" (Cohen & Manion, 1994). They need to incorporate their own background and experience in their research by interviewing a sample of people, documenting their views, conducting case studies, observing participate, and analyzing texts in research subjects to explore facts and interesting phenomena (Creswell, 2003).

The interpretivist paradigm is characterized by a qualitative approach to the exploration of reality, and thus serves as the basis for qualitative methodology. Qualitative methods are a means of collecting data, and interpretivism is a research paradigm established, articulated, and adapted for qualitative research. Explanatory research is more subjective than objective. Willis (2007) argued that the goal of interpretivism is to value subjectivity, and "interpretivists eschew the idea of an objective study of human behavior". In contrast to statistics, researchers using interpretivist paradigms and qualitative methods typically seek personal experience, understanding, and perception to obtain data that reveal reality.

In contrast, positivism is sometimes referred to as 'scientific method' or 'science research', which is "based on the rationalistic, empiricist philosophy that originated with Aristotle, Francis Bacon, John Locke, August Comte, and Emmanuel Kant" (Mertens, 2005). After World War II, positivism was replaced by post-positivism (Mertens, 2005), whose ontological foundation was critical realism. Popper (1968), one of the representatives, believed that research is a process of "falsification" of imprecise representations through a series of rigorous methods and constantly approaching objective facts. At the same time, researchers must continue to conjecture and refute to get closer to the truth.

Bell and Bryman (2007) argued that quantitative research is the process of

verifying factual information by collecting data and testing generalizable hypotheses. The quantitative research paradigm is the foundation of quantitative methodology. Positivism assumes that some problems in society can provide explanations of a causal nature (Creswell, 2003), in which measured variables and test hypotheses are associated with general causal explanations (Sarantakos, 2005; Marczyk et al., 2005). Data collection techniques focus on collecting and gathering hard data in digital form in order to observe changes and present evidence in quantitative form (Zhang, 2020).

In general, the research process includes three dimensions: ontology, epistemology and methodology (Terre & Durrheim, 1999). The research paradigm is a complex system that closely integrates these three dimensions, including the thought process and the practice process of investigation. Thus, ontology (the way the researcher defines reality or truth), epistemology (the process by which the researcher understands truth and reality), and methodology (the survey methods used by the research) provide a framework for a scientific research investigation (Antwi & Hamza, 2015), which guides researchers through the entire research process, including strategic methods and analytical processes.

3.2.1 Ontology and Epistemology

Ontology is a branch of philosophy that is primarily concerned with the nature and structure of the world (Wand & Weber, 1993). At the same time, ontology helps researchers reflect on the form and nature of reality and how to recognize the nature of reality (Antwi & Hamza, 2015; Bryman & Bell, 2011). It is divided into two distinct branches: objectiveism and constructionism. Objectivism believes that realism exists independently of the researcher, while constructivism believes that reality is a product of social processes.

On the ontological level, constructivism and interpretivism have a lot in common.

In general, interpretivism is a constructivist approach that focuses on the experience and meaning of the researcher and the researched. Constructivist researchers stress that reality is socially constructed - based on people's experience of the external world. There is no theory of right and wrong in the minds of interpretive researchers (Walsham, 1993), and there is no single right and specific way to acquire relevant knowledge (Willis, 1995). In other words, knowledge is generated by the researcher's in-depth study of the phenomenon of interest, interacting personal experience with the environment. Interpretive paradigms explore knowledge through the subjective experience of individuals, reinforced by observation and interpretation, where observation is the gathering of information about an event, and interpretation is the translation of information through diagrammatic reasoning or judging the match between the information and some abstract shape (Aikenhead, 1997).

Positivist researchers, on the other hand, assume that reality is objectively given and independent of the researcher. The philosophical thought of the French philosopher Comte provided a philosophical basis for positivist researchers to explore social reality (Harris, 1923). He believed that knowledge can be obtained through observation and experimentation, which is a way of rationally understanding social behavior. In other words, knowledge is objective and can be measured and quantified experimentally using tools. Therefore, positivist researchers usually choose scientific methods to systematize the knowledge generation process with the help of quantitative tools to improve the accuracy of parameter description and the relationship between parameters (Antwi & Hamza, 2015). Positivism is concerned with uncovering truth and expressing it in a positive way. According to Walsham (1995), the positivist position holds that scientific knowledge consists of facts, while its ontology holds that reality is independent of social construction. If the research is done against a stable reality, then the researcher takes a realist ontology - an objective view of the world - an epistemological position based on the true and false of opinions and statements,

and obtains the relevant reality through control and verification.

Epistemology, which refers to the philosophy of the researcher's relationship to what is known, expresses "the nature of human knowledge and understanding that can be obtained through different types of inquiry and alternative methods of inquiry" (Hirschheim et al., 1995). In other words, epistemology refers to the researcher's relationship to what is known and the way in which that knowledge is presented. There are still two aspects to broad epistemological positions: interpretivism or constructivism and positivism.

The perspective of interpretivist or constructivist is the theoretical framework for most qualitative research, which defines the world as people construct, interpret, and experience in their interactions with each other and in wider social systems (Bogdan & Biklen, 1992). According to this paradigm, the nature of inquiry is explanatory, and the purpose of inquiry is to understand a particular phenomenon rather than generalize it to the totality. Researchers in the interpretivist paradigm tend to engage with participants over a period of time, insight into phenomena experienced by participants and detailed descriptions add richness and depth to the data, and develop a deep understanding of research questions in unique contexts (Ulin, 2004). Qualitative methods are thus inductive, usually in-depth understanding of research problems in a specific context (Ulin, 2004), focuses on the process of research and is not very general.

Positivism evolved mainly from 19th-century philosophical methods. For positivists, the essence of social reality is that quantitative facts exist outside individual opinions and thoughts, and they are governed by the law of causality (Crotty, 1998). Positivism refers to the social sciences that treat social reality as stable, through an organized approach that combines logical deduction with precise quantitative observation of individual behavior to discover probabilistic causal laws that can predict general patterns of human activity, the knowledge

and interpretation of this process is additive (Neuman, 2003). In this paradigm, researchers aim to obtain the closest approximation to the truth by developing the most objective method possible. Therefore, researchers usually develop some variables in experimental studies, and then test the relationship between the variables to explain how they interact with each other and how to lead to related results. Multivariate analysis and statistical forecasting techniques are one of the classic contributions of this type of research. Under this framework, researchers generally believe that reliable knowledge is based on the direct observation or manipulation of natural phenomena through experimental scientific means (Lincoln & Guba, 2000; Neuman, 2003).

Both quantitative and explanatory researchers believe that human behavior may be patterned and regularized. However, positivist researchers typically view human behavior in terms of causal laws, while interpretiveists typically view behavior as evolving as people continue to interact in society (Neuman, 2003). Therefore, on the one hand, interpretive researchers typically use interviews, focus group discussions, and naturalistic observations to collect data to conduct qualitative research methods. quantitative researchers, on the other hand, emphasize the use of measurable data to explain behavior through the use of highly standardized tools, such as questionnaires, psychological tests with precisely worded questions. Unlike the criteria of the interpretivist paradigm, which emphasize validity and credibility, validity, reliability, and objectivity are the criteria for quantitative testing. According to Spratt et al. (2004), positivists use validity, reliability, objectivity, precision, and generality to judge the rigor of quantitative research because they intend to describe, predict, and verify quantitative relationships in a relatively controlled environment.

In general, objectivism is concerned with the fact that knowledge exists objectively and can be obtained by revealing the truth through quantitative means (Henning et al., 2004). Based on the objectivist ontology and positivist

epistemology, this study constructs some models to examine the relationship between the promulgation of the 2018 regulations in the UK and the quality of GHG emission and energy consumption information disclosure of affected listed companies, as well as the link between listed companies' GHG IDQ and those company's FP and EP. This is because corporate actions (eg, making relevant disclosures) are influenced by many external factors (including stakeholders, laws and regulations, company characteristics). According to previous theoretical research and literature review, corporate sustainability and GHG information disclosure are affected by various factors. Based on the literature review in the previous chapter and the research background, it is believed that information disclosure is a way to solve institutional pressure (Bansal & Roth, 2000). It can be found that to a certain extent, the laws and regulations will restrict the behavior of enterprises to a certain extent. Enterprises will disclose relevant information to achieve legitimacy, but they may also choose green cleaning or concealment for fear that the disclosed content will have a bad impact on them. This process needs to be verified by scientific methods, and the research purpose can be achieved by selecting measurable data to conduct objective and rigorous quantitative research on this process.

At the same time, in the research on the relationship between corporate GHG information disclosure and FP and EP, previous research did not draw a consistent conclusion. Therefore, as a researcher independent of social phenomena, this study hope to regard the actual impact of information disclosure on enterprises as an objective phenomenon. This study selects objective financial data and EP indicators to represent the actual FP and EP of enterprises, and finds out whether it exists and what kind of causal relationship exists through independent and objective data and quantitative research.

3.2.2 Methodological Issues in Research

Methodology refers to the use of ontological and epistemological foundations as

guidelines for how researchers conduct research (Sarantakos, 2005), as well as the principles, procedures, and practices for conducting research.

In methodological research, constructivists and interpretivists do not believe in experimental or quasi-experimental research designs. Constructivists believe that reality is multifaceted and cannot be segmented or studied in the laboratory, but only as a unified whole in its natural environment (Wert-Gray et al., 1991). Qualitative methodology is based on constructivist ontology and interpretivist epistemology. It embeds a hypothetical meaning into the participant's experience, and this meaning is mediated by the researcher's own perception (Newman & Ridenour, 1998). Researchers using qualitative methods immerse themselves in culture by observing people and their interactions in the culture, frequently participating in activities, interviewing key people, obtaining life histories, constructing case studies, and analyzing existing documents or other cultural artifacts. The goal of a qualitative researcher is to obtain an insider's view of the population under study.

In contrast, the empirical research paradigm is the foundation of quantitative methodology. The realist or objectivist ontology and empiricist epistemology contained within the positivist paradigm requires an objective or independent approach to research in which the focus is on measuring variables and testing hypotheses related to general causal explanations (Sarantakos, 2005; Marczyk et al., 2005). Empirical studies use experimental designs to measure effects, especially through group change. Data collection techniques focus on collecting hard data in digital form so that evidence can be presented in quantitative form (Neuman, 2003; Sarantakos, 2005). In terms of methodology, the authenticity of empirical research is achieved by validating and replicating observable results (Lincoln & Guba, 2005), manipulating variables on research subjects (Trochim, 2000), and applying statistical analysis (Bryman, 1998). Therefore, positivists emphasize the use of valid and reliable methods to describe and explain events.

For a study related to financial, accounting and business content, knowledge may come from a collection of four aspects: (1) intuitive knowledge (helping users choose research areas); (2) authoritarian knowledge (helping researchers organize literature reviews); (3) logical knowledge (to help researchers analyze and organize research data); (4) empirical knowledge (to help researchers draw research conclusions). Among them, positivists and interpreters will have different trade-offs when arranging and analyzing research data. Interpretivists prefer to use qualitative data because it is often associated with a high level of validity, as the data in such studies tend to be credible and honest (such as data from interviews and surveys). Qualitative data provides higher quality information and insights that actually reflect reality and the dynamics of human organization. However, in contrast to quantitative data (which is mostly secondary), qualitative data is often influenced by human behavior, such as experiences, values, and beliefs. Therefore, the reliability of qualitative data is also undermined to a certain extent.

Positivists tend to use quantitative data because quantitative data provide objective information that researchers can use to make scientific hypotheses (Pham, 2018). In other words, quantitative research is methodologically more "scientific" than qualitative research, and therefore more trustworthy. Furthermore, one quantitative researcher argues that there is a set of laws and regulations to follow, so it is crucial to avoid mistakes. However, everything has two sides. An inflexible approach can avoid mistakes, but it may not be a satisfactory way to explain reality or phenomena. Positivists tend to ignore unexplained phenomena. Furthermore, quantitative researchers often ignore individual emotions, which can influence human behavior. In contrast, interpreters can use qualitative data to detail participants' feelings, opinions, and experiences, and to explain the implications of their actions.

For the background and purpose of this research, the research process will be designed following an quantitative paradigm. Quantitative data obtained through content analysis determines the quality of GHG disclosures, quantitative financial data is used to represent FP, and GHG emissions are used to represent GHGP. An objective and detailed study of the relationship between mandatory disclosure laws and disclosure quality, FP, and EP.

3.3 Research design

Research design is defined as "a general plan specifying the methods and procedures for collecting and analyzing the required information" (Zikmund et al., 2013), and is an emphasis on collecting correct and relevant information through an economical and orderly systematic approach. It tries to blend research-relevant purpose with economics and procedure (Akhtar, 2016). Manheim (1977) showed that research design not only predicts and prescribes the seemingly countless decisions related to data collection, processing, and analysis, but also provides a logical basis for those decisions. Therefore, it is necessary to carry out research design or planning before data collection and analysis of research projects, it can ensure the smooth conduct of the research, and also can produce more professional research with minimal effort, time and money expenditure.

Pre-planning of the methods used to collect the relevant data and the techniques used in the analysis was required during the design of this study. At the same time, the purpose of the study and the feasibility of the sample, time and funding need to be considered in advance. If the designed research project does not meet the research objectives, the sample size is too small to represent the main body of the research, or the sample size cannot be completed within a certain period of time, it may lead to the failure of the research work. Research design also helps researchers organize ideas so that errors and deficiencies in the procedure can also be identified. Therefore, an efficient and appropriate design must be

prepared before starting the research process.

The research process consists of six stages: (1) specifying the question/topic to be studied; (2) framing the research design; (3) planning the sample (probabilistic or non-probabilistic or a combination of both); (4) collecting data; (5) analyzing data (editing, coding, processing, tracking); (6) prepare reports (Akhtar, 2016). There are four characteristics that need to be met to conduct a study design: flexibility, appropriateness, efficiency, and economy (Akhtar, 2016). This is primarily based on the fact that the research process is implementable and repeatable, with a balance between redundancy and a tendency to overdesign, while also reflecting the theory being studied and incorporating specific expectations and assumptions into the design.

The purpose of this study is to explore what impact the implementation of the further mandatory carbon and energy information disclosure regulation will have on the disclosure content of companies, as well as what substantial impact will the company's disclosure of GHG and energy information bring to the company, which is reflected in EP on the one hand and FP on the other. For research purposes, it is necessary to select the most appropriate sample source. Based on a systematic literature analysis, the study sample selection for GHG information disclosure mainly considered the UK. The reason is that the UK government, as the earliest and most proactive entity in history to promote corporate carbon reporting, can serve as an ideal environment to explore the changes of related companies from voluntary disclosure to different mandatory disclosure stages. At the same time, in response to changes in the GHG information disclosure regulation, in addition to voluntary disclosure, relevant companies are also faced with multiple obligatory reporting obligations. Since the government required listed companies to conduct mandatory carbon reporting in 2013, the implementation of the update in 2016, and the 2018 regulations have continued to expand the subjects that need to be reported and the content that needs to be

reported has been continuously refined.

In order to identify the sample companies for research, it is first necessary to determine the target groups that the implementation of the mandatory disclosure regime will affect. According to the latest mandatory disclosure system promulgated in 2018, the scope of influence has expanded from listed companies to listed companies and limited liability companies, and the disclosure requirements have also increased the disclosure of energy consumption. Therefore, this study hopes to explore the impact of the latest the 2018 regulations on the disclosure content of companies on the basis of the mandatory disclosure system that has been implemented. According to the feasibility of the research design (Akhtar, 2016), the research needs to obtain all relevant documents for the disclosure of the sample companies to the law. Since limited liability company annual reports and independent reports are difficult to obtain from public websites, and the responses received by contacting some departments are incomplete, UK-listed companies are an ideal sample to study changes and effort made by companies in response to institutional changes (CDP, 2013).

The research first needs to explore how the implementation of mandatory carbon and energy disclosure regimes will affect the disclosure content of UK-listed companies. When investigating the extent of social and environmental reporting (voluntary or mandatory), the annual reports of organizations listed on stock exchanges often serve as a source of raw data (Buniamin, 2010). Apart from availability reasons, the annual report is used because it is the main document prepared by the company (Gray & Bebbington, 2000). Companies use annual reports as their primary communication tool for disseminating information, including environmental information (Gray et al, 1995a). Annual reports provide information about the management of a business and are a way for organizations to build their image through voluntary reporting (Hines, 1989). At the same time

they are widely used by previous researchers to determine the extent and nature of reporting practices.

Using the relevant disclosures in the annual report (including both content and form) to compare the disclosure contents after the implementation of the 2018 regulations with the contents before the implementation, which can help accomplish the first goal of the study. That is to explain from a scientific point of view the impact of the 2018 regulations on corporate GHG emission and energy consumption disclosures and which specific aspects of disclosures are affected by tracing back the context in which companies disclose information. According to Cowan and Gadenne (2005), companies are required to comply with mandatory regulations during the reporting period and provide their users with information on their specific performance during the reporting period. Therefore, the quality of corporate information disclosure and the relationship with the 2018 regulations can be reflected through the number of companies' disclosure of relevant content.

In addition to this, research document sources include specific social and environmental disclosures, such as CSR reports and equivalent documents, websites, blogs or online reports from other companies. Many companies voluntarily report emissions-related data in their CSR and corresponding reports. Even after the introduction of mandatory carbon reporting, these companies continued to report this data in separate documents and online reports that complement their annual reports. For example, Aguiar (2009) used stand-alone reports and annual reports from 2000-2004 when investigating the impact of the UK ETS on global climate change disclosures. In practice, the independent documents and websites of some companies provide more in-depth and detailed information than annual reports. Therefore, stand-alone reports other than annual reports are also studied as original materials in this study.

Secondly, in order to better achieve the purpose of research, and to clearly reflect the changes in the disclosure content of enterprises in annual reports and a large number of independent reports, it is necessary to convert qualitative literature data into quantitative data. And based on these data to make quantitative analysis of the literature content, and then make judgments and inferences about the facts. Therefore, the research needs to choose the most suitable method to analyze the relevant materials. This method can analyze the results in a more detailed and programmed manner according to the factors that make up the literature, so that the scientific understanding of the facts can finally be realized through quantitative analysis and descriptive statistics. Descriptive statistics allow conclusions to be drawn about changes in corporate disclosures of GHG emissions and energy consumption.

Thirdly, in order to accomplish the second goal of the study, that is, what impact do changes in companies' GHG emissions and energy information disclosure have on their actual operations, this study needs to conduct an experimental design based on sample companies. According to the literature review in chapter 2, under the background of theoretical support, the hypothesis is put forward that there is a causal relationship between corporate environmental information disclosure and the actual operational FP and EP of the company. In order to verify relevant hypotheses and give more convincing and scientific evidence, it is necessary to design relevant experiments to obtain final results. On the one hand, the research needs to verify the hypothesis on the correlation between the company's environmental disclosure and actual FP; on the other hand, the research needs to verify the correlation between the company's environmental disclosure and the company's actual GHG emissions. In order to ensure the flexibility and appropriateness of the study design, it is necessary to minimize the bias of the data collection and analysis, to generate the maximum amount of information, and to ensure the accuracy of the performance. Research needs to transform the qualitative content of the relevant causal relationship into

measurable indicators, and at the same time select the most representative indicators to scientifically verify the correlation.

Finally, in the process of experimental design, in order to ensure the accuracy and reliability of the research results, it is also necessary to control irrelevant but potentially influential factors. In addition to the two variables with causal relationship, factors that may affect their relationship or certain factors also need to be controlled using representative indicators, so that more representative conclusions can be obtained. In addition, it is also possible to compare the impact of relevant factors among different types of British companies in the selected sample, and then explore the different effects of mandatory disclosure policies as driving factors on reporting practices and actual performance in different industries.

3.4 Content analysis

3.4.1 Content analysis research method

Content analysis is more suitable for qualitative content analysis, and is a qualitative analysis method that categorizes most texts into fewer content categories for compilation (Vaismoradi et al. 2013). In practice, content analysis can classify qualitative textual data, grouping words, phrases or other texts with similar meanings together, so it is more suitable for classifying relevant information disclosed by enterprises on the environment. In the research on quantitative content analysis, after classifying and analyzing the text content, the method of converting it into counting is beneficial to the subsequent quantitative analysis research.

Through the study of previous literature, it is found that content analysis is usually used as the main tool for analyzing public information, and is also used in some studies on corporate annual reports, social responsibility reports, and sustainability reports. In research on environmental information and GHG

disclosures, content analysis topics include: the differences between voluntary and mandatory corporate social disclosures (Gray et al., 1995a), organizational responses to regulatory changes (Buhr, 1998), the quality of reporting on GHG and circular economy issues (Janik et. al., 2020), the quality of environmental reporting (Alrazi et al., 2010), the quality of CSR disclosures (Dyduch & Krasodomska, 2017), the quality of sustainability reporting (Al-Shaer, 2020), the extent of sustainability disclosure (Papoutsi & Sodhi, 2020) and the impact of external pressures on CSR (Neu et al., 1998).

Although previous research has covered a variety of topics, most studies have examined corporate disclosures of different types/categories of environmental and social data. These categories vary according to the size of the organization (Gray et al., 1995a), profitability (Neu et al., 1998), industry type (Dyduch & Krasodomska, 2017; Gnanaweera & Kunori, 2018; Al-Shaer, 2020), and geographic location (Alrazi et al., 2010; Janik et. al., 2020). The prerequisites for conducting content analysis include the sources of information disclosed by the business, a definition of the content to be analyzed, and a specification of how the data will be obtained (measurement of the manner of disclosure or the amount of disclosure). All three of these requirements will be discussed in this chapter.

In terms of documentation sources for measuring corporate environmental disclosures, the annual report has historically been used as the primary analytical source of disclosure because it is a statutory document and is produced on a regular basis (Gray et al., 1995a). In addition to being a legitimate means, annual reports can also be viewed as strategic documents, selectively presenting an impression of the company's activities (Buhr, 1998). For example, Kraft (2018) mainly selected annual reports as the source of information when conducting content analysis on the materiality of climate disclosures. Similarly, when Nor et al. (2016) analyzed the quality of corporate environmental information disclosure

in Malaysia, they also chose annual reports as the main source of information. However, Zegal and Ahmed (1990) also pointed out that an analysis of a single annual report containing a company's environmental information may not adequately represent a company's or industry's disclosure activities. In addition, the annual report may only include a portion of the company's GHG disclosures. For example, Alrazi et al. (2010) considered sustainability issues reported in the corporate website and stand-alone reports in addition to annual reports in their content analysis of the quality of environmental reports. Therefore, in addition to the analysis of the company's annual report, environmental/sustainability/social responsibility reports and website content are also considered as sources of supplemental GHG disclosure and energy consumption information (Unerman, 2000).

One of the limitations of research on corporate content disclosure is the difficulty in measuring the extent of voluntary disclosure (Healy and Palepu, 2001). Core (2001) also points to the need to develop improved measures of disclosure quality. To date, two main methods of measuring disclosure have been used. The first method is to use subjective analyst disclosure quality rankings. This approach is not practical now is is that the Association of Investment Management and Research stopped ranking the relevant reports after the fiscal year 1995. Also impractical for researchers is that the UK and other countries do not have similar rankings (Beattie, et al., 2004). Another approach is for researchers to construct a disclosure index, in which the number of disclosures is used as a proxy for disclosure quality (Botosan, 1997). Analyst ratings are a more subjective way, and the construction of a disclosure index is a semi-objective way. In semi-objective methods, researchers usually pre-specify a list of items and check for the existence of the text, ignoring parts of the text that are not relevant to the list, belonging to the type of content analysis targeting text content. It is a relatively objective, form-oriented content analysis method (Beattie et, al. 2004). Although Marston and Shrives (1991) pointed out that index scores "may

measure the degree of disclosure, but not necessarily the quality of disclosure", they ultimately conclude that the construction of a disclosure index inevitably involves subjective judgment. At the same time, it has proven to be a valuable research tool that will continue to be used as long as corporate disclosure is the focus of research. For the research and use of the disclosure index in the company's annual report and other textual content, it is wise to choose a more objective construction of the disclosure index in this study.

3.4.2 Content analysis process

In the process of content analysis of corporate environmental information disclosure, in addition to the analysis of the content of sentences, paragraphs and non-narrative disclosures (such as images) included in relevant reports on GHG information and energy consumption, it is also necessary to classify relevant content. A framework needs to be created to classify different content, find indicators according to the classification criteria of each category, and then create an index based on the existence of specific disclosure indicators of sample companies. In this way, it is not only possible to comprehensively classify and count the disclosures of different forms (quantitative and qualitative), but also to clearly and effectively observe and analyze the disclosures of different categories of each enterprise and the disclosures of the same category of different enterprises.

First, the study summarizes the most relevant studies on quantitative content analysis of corporate reports in the past 12 years. The detailed content is shown in table 3.1. It can be seen that the existing literature adopts a variety of classification standards to analyze the narratives in corporate annual reports and social responsibility reports, which also provides direction, ideas and reference for the classification and measurement of this research.

Table 3.1 Overview of quantitative content analysis classification and measurement

Author	Assessment Subject	Types of Reports	sample	quantitative content analysis classification	measurement
Janik et. al. (2020)	the existence, quality , and specificity of reporting GHG and circular economy(CE) issues	sustainability reports	61 organizations from the energy sector in the EU	quality of reporting GHG issues/Quality of reporting CE issues/Clarity of reports/Comparability	Quantitative evaluation index (experts score indicators) and aggregation of indicators）
Gnanaweera et. al. (2018)	corporate sustainability disclosure guidelines determination (CSDF rate)	CSR and annual—integrated reports and corporate websites	85 Japanese companies listed on Tokyo Stock Exchange in the First Section, from 2008 to 2014.	Essential information indicators and category/ Quality assessment variables	Scoring of disclosure items and disclosure Index
Alrazi et al. (2010)	Environmental reporting quality	Corporate website, annual reports and a stand-alone report on sustainability issues	51 electric utilities from 19 countries (Australia, Brazil, Canada, Chile, Czech Republic, France, Germany, Italy, Japan, Korea, Hong Kong, Malaysia, New Zealand, Portugal, Russia, Spain, Thailand, UK, USA)	Strategy and Analysis/Organizational profile/Report Parameters/Governance, Commitments and Engagement/Environmental Initiatives/Performance Indicators	The scoring system allocates scores using a scale and 41 overall environmental information disclosure indices and 25 CO_2 emissions disclosure indices
Al-Shaer (2020)	Quality of sustainability reporting	Any types of reports	350 UK companies(10 different industrial sectors, including energy and utilities)	Establish a board-level sustainability committee/Provide external assurance of independent	The scoring system allocates scores using a scale based on five thresholds

				sustainability reporting/Link between executive compensation and sustainability goals	
Amran et al. (2014)	Credibility of sustainability reports	Sustainability reports and annual reports	113 Asia-Pacific region companies from 12 countries (Australia, New Zealand, China, India, Indonesia, Korea,Malaysia, Philippines,Singapore, Taiwan, Thailand, Japan)	Categories related to research objectives include ten indicators	The scoring system allocates scores using a scale based on ten thresholds
Nor et al. (2016)	Extent of carbon information reporting	Annual reports, stand-alone sustainability reports and corporate websites	90 Asian electricity generating companies (44 Indian, 26 Chinese, 20 Japanese)	Categories related to research objectives include twenty indicators	Scoring of dsclosure items
Bonsón & Bednárová (2015)	Extent to which Eurozone companies report on CSR indicators	Annual reports or separated sustainability reports	306 Eurozone companies from 12 countries(19 different subsectors, including utilities)	Environmental indicators /Social indicators /Corporate governance indicators	Integrated scorecard taxonomy scoreboard(each specific indicator is assigned a score and summed up)
Dyduch & Krasodomska	Quality of CSR disclosures	CSR disclosures in annual reports and integrated reports	60 Polish non-financial companies (different sectors, including 6 companies representing energy industry)	Business model, policies, risks related to CSR issues/Environmental matters/Social and employee	The scoring system allocates scores using a scale based on three thresholds and disclosure weighted index

(2017)				related matters/Ethical matters	
Fernandez-Feijoo et al. (2014)	Transparency of the sustainability reports	Sustainability reports from the GRI database	1047 companies from 10 countries(38 different sectors, including energy and energy utilities)	Frequency of CSR reporting/Level of application/Declaration of the level/Assurance of Sustainability reports	the percentage of occurrences of the metric to the total
Hąbek (2017)	Quality of CSR reports	CSR reports—GRI-based and non-GRI	44 companies from Visegrad Group (Czech Republic, Hungary, Poland, Slovakia)(different sectors, including energy and energy utilities)	Relevance of information indicator/ credibility of information indicator.	The scoring system allocates scores using a scale based on five thresholds
Kraft (2018)	Substantiveness of climate disclosures	Annual reports	45 electric utilities companies operating in the USA	Substantive/ semi-substantive/ symbolic categories	Scoring of disclosure items
Loza Adaui (2020)	Quality of sustainability reporting	Sustainability reports or annual reports containing sustainability disclosures	27 Peruvian companies(different sectors, including 10 companies from energy, electricity and oil sector)	Credibility/content/communication	the percentage of occurrences of the metric to the total
Matuszak & Różańska (2017)	Extent and quality of CSR reporting quantify the CSR-disclosure practices,	CSR disclosure data in annual reports, CSR reports and the websites	150 Polish companies(26 different sectors, including 6 energy companies)	Environment/Labour Practices/Human Rights/Community/Involvement/ Anti-Corruption	The scoring system allocates scores using a scale based on five thresholds
Michelo	Quality of CSR	CSR or	112 UK companies(different	Environmental items/Social	the percentage of occurrences

n et al. (2015)	disclosures	sustainability reports—GRI based and non-GRI	sectors, including utility industries)	items/Accuracy/Managerial orientation	of the metric to the total
Moseñe et al. (2013)	Comparison of the levels of compliance with GRI indicators of environmental sustainability	Sustainability reports	7 Spanish companies (wind energy sector)	Materials/Energy/Water/Emissions, Effluents and Waste/Compliance/Transport	The scoring system allocates scores using a scale based on three thresholds
Papoutsi & Sodhi (2020)	Extent to which sustainability reports indicate corporate sustainability performance	Sustainability reports obtained from the Sustainability Disclosure Database	331 companies: 117 American or Canadian and 214 European.(18 different sectors, including 35 energy and utilities companies)	Environmental sustainability indicators/Social sustainability indicators	The scoring system allocates scores using a scale based on four thresholds
Rankin et al. (2011)	Extent and credibility of GHG disclosure	Annual reports and stand-alone environment or sustainability reports	187 Australian companies (different sectors, including 61 energy and mining companies)	Description of GHG inventory/other issues to be considered	The scoring system allocates scores using a scale based on five thresholds

Source: Author compiled.

The selection of relevant indicators and measurement methods in the research on content analysis have a guiding role in this research. According to table 3.1, it can be seen that in most of the studies on quantitative content analysis, after classifying the text content, it is divided according to each category in detail, and the most relevant indicators are found for quantitative calculation.

In the process of classifying content, some studies consider the aspects most relevant to the purpose of the study and the content. For example, in the study of substantiveness of climate disclosures, Kraft (2018) divided the content of annual reports into three categories: substantive, semi-substantive and symbolic categories, and and then subdivided them into different indicators to conduct statistical analysis on the relevant indicators of sample companies. Some studies considered potential disclosure quality factors. In a study by Fernandez-Feijoo et al. (2014) of transparency of the sustainability reports, standards of disclosure quality were taken into account. They considered the number of report disclosures, the level of report disclosure and whether third-party assurance was provided, and selected relevant indicators for analysis from these aspects.

Other studies considered two aspects in the classification process. In a content analysis of the existence, quality, and specificity of reporting GHG and circular economy issues, Janik et. al. (2020) categorized the content of sustainability reports from 61 organizations from the energy sector in the EU. In addition to considering quality of reporting GHG issues, quality of reporting circular economy issues, it also includes clarity of reports and comparability. Collectively, Gnanaweera et. al. (2018) designed the determination of the 85 Japanese company sustainability reporting guidelines, including not only the relevant indicators of essential information indicators and category, but also the relevant indicators of quality assessment variables. Considering from different aspects, the indicators can be classified in more detail, and the statistical content can be more practical and meaningful.

There are two ways to measure the relevant indicators. One is to count the frequency of related content appearing in pages or sentences. The other is to use the information disclosure index for statistics. Table 3.1 lists the quantitative content analysis methods used in the relevant studies. By providing the GHG disclosure index as a mechanism to eliminate and bridge the gaps in the dimensional imbalance of previous studies that limit environmental and social disclosures to purely descriptive narratives without any quantitative information. Combined with the content of this study, the information on GHG emissions and energy consumption includes quantitative information and qualitative information, which need to be classified in detail. Using the information disclosure index can conduct quantitative analysis on the disclosure of each individual indicator, and is also conducive to subsequent quantitative research.

3.4.2 Content analysis design

3.4.2.1 Sample selection criteria design

After the research method has been determined, certain screening of samples and criteria that are critical to the research is required. From 2016 to 2021, the population of the UK business community increased from 5.5 million in 2016 to 6 million in 2020 and then decreased to 5.6 million in 2021 (Department for Business Innovation and Skills, 2016; 2020; 2021). This number includes a range of companies that differ in size (e.g., small to multinational), ownership (e.g., private, public, or public), and industry (e.g., banking, beverage, retail). Each company and department has its own unique perspective (i.e., organizational culture and behaviour) on contemporary issues (such as climate change). Therefore, the selection of the sample range needs to meet the following aspects:

(1) it can reflect the different perceptions of climate change by different types of companies;

(2) It can generate practical, analyzable and quantifiable data that is helpful to the research results, which in turn helps to generate the analytical results and draw

objective conclusions;

(3) It can provide verifiable specific reports and financial data in line with the actual performance of the company for careful analysis and further research.

In order to help obtain the required sample companies, it is necessary to find relevant academic literature and study relevant methods to determine the number of samples that meet the requirements. According to research, companies listed on the FTSE 350 stock index meet the expected criteria. The FTSE 350 Index is a market capitalization-weighted stock market index that includes the largest 350 companies by capitalization listed on the London Stock Exchange. The selected companies not only represent a wide range of industry sectors, but will also provide a variety of representative examples of environmental initiatives and legal norms, and it is composed of large companies that may lead the pace of GHG reporting. The FTSE 350 is the largest UK index included in CDP each year, providing a wide range of reasons and explanations for companies' actions in response to environmental changes. At the same time, FTSE 350 companies are more representative and strategic in meeting emission reduction targets and disclosing GHG emissions information for the controversial small and medium-sized enterprises in the UK. In addition, some private companies in the UK were also investigated at the data collection stage and not all companies involved provided detailed reports and reported data. Therefore, although it is also affected by regulations, the lack of relevant data does not satisfy relevant research.

In order to study the changes in this process in more detail and accuracy, better verify the hypothesis and meet the research objectives, the study selected all companies listed on the FTSE 350 in the UK for the past six years, that is, from 2016 to 2021. Due to the implementation of the mandatory disclosure system in 2013, the GHG information of listed companies in the UK has undergone major changes in the disclosure of information in relevant reports due to changes in the

regulation.

Therefore, when the disclosure information of enterprises in 2016 is basically stable, choosing to include the first three years and the last two years released by the 2018 regulations can more clearly judge the impact of the latest system. At the same time, because the public awareness was relatively weak at the beginning, and the implementation of relevant policies was not too strict, the relevant impact may not be clear. Following the adoption of the Paris Agreement in December 2015, countries have begun to promote GHG reduction through advocacy, policy development, and action. The time period selected for this study is a period of higher-level policy debate, the birth of clear policies, the rapid increase of public awareness, and the continuous clarification of external stakeholder needs, so it is more suitable to study the impact of the latest regulation.

The purpose of the research phase described above is to ensure that sufficient and valid data are collected to answer the research question and achieve the purpose of the research. In the first phase of data collection, FTSE 350 company annual reports, board reports, sustainability reports, and company websites were explored to investigate all avenues for companies to report on GHG information before and after the introduction of the 2018 regulations. The next step is to collect, analyze and categorize GHG-specific disclosures in all reports. The data collection and analysis at this stage mainly helps to test the first hypothesis, that with the introduction of the 2018 regulations, there will be a positive impact on the content of corporate disclosures about GHG information. By analyzing the relevant reports of FTSE 350 companies from 2016 to 2021 on the content of GHG information, it is judged whether the number of disclosed content has increased.

3.4.2.2 Content analysis indicators

In the process of selecting research indicators, the following four aspects are mainly considered: (1) Indicators need to include voluntary disclosure content and disclosure content required by mandatory regulations. In this way, the research purpose of the impact of the 2018 regulations on the content of corporate disclosure can be met. (2) The indicators are comprehensive and need to be closely related to the research content and standards. The selected indicators should include all the company's information on GHG emissions and energy consumption, including quantitative and qualitative content, as well as corresponding standards, which can better reflect the actual performance of different companies. (3) The indicators are practical and can be used for content analysis and evaluation of various types of enterprise reports. (4) The selection of indicators needs to consider some room for improvement. This will involve relatively high-demand metrics, including whether the company is taking steps to reduce warm GHG emissions and whether it identifies risks and opportunities related to managing environmental changes, and whether it refers to the use of the latest guidelines for mandatory disclosure.

Based on the above criteria, as the first global sustainability reporting standard, GRI enables all organizations to publicly report on their economic, environmental and social impacts and demonstrate how they contribute to sustainable development. Taking the GRI standard as the basic pillar of the research process, and combining with the relevant mandatory disclosure policies and guidelines (DEFRA 2006, DEFRA 2013, and SECR 2018) adopted by the UK for listed companies in chapter 2, the most appropriate set of indicators is designed for corporate disclosure content. In order to better collect the GHG emissions and energy use disclosures of UK listed companies, it is necessary to ensure the correlation between the selection criteria and indicators.The detailed process of the three stages of this research index is as follows:

In the first stage, the research topic was considered related to the disclosure of

GHG emissions and energy consumption in corporate reports, and it was mapped to the specific standard disclosure of GRI (2016). Seven indicators related to GHG emissions are mainly selected as the basic indicators. Mainly include:
(1) Direct (Scope 1) GHG emissions, (2) Indirect (Scope 2) GHG emissions, (3) GHG emission intensity ratio, (4) Other indirect (Scope 3) GHG emission, (5) Reduction of GHG emission, (6) Emission of ozone-depleting substances, (7) Emission of Nitrogen oxides, Sulfur oxides, and other significant air emissions.

In the second stage, with reference to the requirements of the British government, the mandatory disclosure policy was promulgated in 2013 and the latest regulation "the 2018 regulations" in 2018, as well as the guidelines DEFRA 2006, DEFRA 2013, SECR 2018 issued in combination with the law. On the basis of the first seven indicators, the relevant content that is mandatory to be disclosed is selected to expand the disclosure indicators. Qualitative plus quantitative includes a total of 26 indicators, and the specific results are listed in table 3.2 below.

In the third stage, by collecting relevant literature on corporate GHG emissions, carbon emissions and sustainability report disclosure in the past ten years, the research summarizes the key GHG disclosure content indicators proposed by different researchers for listed companies. Considering the impact of the latest mandatory GHG and energy information disclosure regulation on the content of corporate disclosures, this study divides the indicators into three categories according to time periods. The first category is what companies need to disclose in relevant reports after the implementation of the original mandatory disclosure policy in 2013. The second category is the content that companies need to add on the previous basis after the announcement of the latest the 2018 regulations. These two types of indicators need to be combined with the indicators selected in the first two stages, taking into account the mandatory disclosure regulations in 2013 and the relevant requirements of the 2018 regulations. The third category is

Table 3.2 GHG emission and energy consumption disclosure indicators

Qualitative Indicators	Quantitative indicators
State the reason of exclusion emission	Excluded emission (estimation)
description of the methodology used to calculate GHG emission	Global energy use
Reporting period covered	Energy consumption and GHG emission in UK
Energy efficiency actions	Disclosure of GHG emission by source (coal, electricity, etc.)
GHG management team/ person responsible	Historical base year selected and base-year GHG inventory
Organizational boundary	Gross emission
External assurance/ Third party assurance statement	Carbon offsetting
State and specify each scope	Green tariff
GHG emission reduction strategies/ details/ action	Base year emission data
Specification of GHG emission reduction target level and target year	Base intensity ratio as benchmark
State the reason for intensity measurement indicators choice	Environmental fine
State the reason for any significant changes in intensity measurement from the previous year	
State the conversion tools/ emission factors used	
State the reason for restated emission	
State the reason for reduction emission	

Source: mandatory disclosure regulations and policy guidelines (DEFRA 2006, DEFRA 2013, SECR 2018).

the content that can be disclosed voluntarily. The relevant legal system for the disclosure of indicators in this part is not clearly stipulated, and the disclosure is selective according to the company's own situation and voluntary degree. The selection of relevant indicators is not only based on the regulatory guidelines for GHG disclosure, but also some Scopus-searched and peer-reviewed literature (Gnanaweera et. al., 2018). By filtering out similar indicators, 48 disclosure indicators were finally identified based on the analysis and are listed in table 3.3 below.

Table 3.3 Summary of GHG emissions and energy consumption disclosure indicators in different guidelines and related literature

Category	Indicator	Selected references
Disclosure required after implementation of MCR and before the 2018 regulations	1.Direct(Scope1) GHG emissions	GRI (2016), DEFRA (2009), DEFRA (2013), SECR (2018), Alrazi et al. (2010), Nor et al. (2016), Dyduch & Krasodomska (2017), Rankin et al. (2011), Roca & Searcy (2012), Janik (2020)
	2.Indirect(Scope2) GHG emissions	GRI (2016), DEFRA (2009), DEFRA (2013),SECR (2018), Alrazi et al. (2010), Nor et al. (2016), Dyduch & Krasodomska (2017), Roca & Searcy (2012), Janik (2020)
	3.Excluded emission(estimation)	DEFRA (2009), DEFRA (2013), SECR (2018)
	4.State the reason of exclusion emission	DEFRA (2009), DEFRA (2013), SECR (2018)
	5.GHG emission intensity ratio	GRI (2016), DEFRA (2009), DEFRA (2013), SECR (2018), Nor et al. (2016), Roca & Searcy (2012), Janik (2020),
	6.description of the methodology used to calculate GHG emission	DEFRA (2009), DEFRA (2013), SECR (2018), Alrazi et al. (2010), Nor et al. (2016), Talbot & Boiral (2013)
	7.Comparative emission data from previous reporting	Rankin et al. (2011), Nor et al. (2016), Janik (2020), SECR (2018)
	8.Reporting period covered	DEFRA (2009), DEFRA (2013), SECR (2018), Rankin et al. (2011)
Disclosure required after the implementation of the 2018 regulations	1.Global energy use	SECR (2018)
	2.Energy efficiency actions	SECR (2018)
	3.Energy consumption and GHG emission in UK	SECR (2018)
Voluntary Disclosure	1.Sustainability committee	Zhu et al. (2018), Al-Shaer (2020)

	2.GHG policy statement	Zhu et al. (2018), Alrazi et al. (2010)
	3.Commitment to external initiatives	Alrazi et al. (2010), Amran et al. (2014), Al-Shaer (2020)
	4.stakeholders engagement activities	Alrazi et al. (2010)
	5.GHG management team/person responsible	DEFRA (2009), DEFRA (2013), SECR (2018), Zhu et al. (2018), Nor et al. (2016), Rankin et al. (2011)
	6.Identification regulatory risk to climate change	Mansley & Dlugolecki (2001)
	7.reporting guideline used in GHG reporting	Tauringana & Chithambo (2014), Sidaway & De (2011)
	8.Organizational boundry	DEFRA (2009), DEFRA (2013)
	9.Regular internal calculation of GHG emissions	Zhu et al. (2018)
	10.Regular external audits of GHG emissions	Zhu et al. (2018), Nor et al. (2016)
	11.External assurance/Third party assurance statement	DEFRA (2009), DEFRA (2013), SECR (2018), Zhu et al. (2018), Alrazi et al. (2010)
	12.Existence external verification of quantity of GHG emission	Nor et al. (2016)
	13.Disclosure of GHG emission by source(eg. coal, electricity, ets)	DEFRA (2009), DEFRA (2013), SECR (2018), Roca & Searcy, (2012), Nor et al. (2016)
	14.Disclosure of GHG emission based on market or location	Nor et al. (2016)
	15.Hisrorical base year selected and base-year GHG inventory	DEFRA (2009), DEFRA (2013), SECR (2018), Rankin et al. (2011)

	16.Other indirect (Scope 3) GHG emission	GRI (2016), DEFRA (2009), DEFRA (2013), SECR (2018), Alrazi et al. (2010), Nor et al., (2016), Dyduch & Krasodomska (2017), Roca & Searcy (2012), Janik (2020)
	17.Total gross memission	DEFRA (2009), DEFRA (2013), SECR (2018)
	18.Reduction of GHG emission	GRI (2016), Nor et al. (2016), Khan (2019), Janik et al. (2020)
	19.Emission of ozone-depleting substances	GRI (2016), Alrazi et al. (2010)
	20.Emission of Nitrogen oxides, sulfur oxides, and other significant air emissions	GRI (2016), Alrazi et al. (2010), Roca & Searcy, (2012)
	21.Carbon offsetting	DEFRA (2009), DEFRA (2013), SECR (2018)
	22.Green tariff	DEFRA (2009), DEFRA (2013), SECR (2018)
	23.Base year emission data	DEFRA (2009), DEFRA (2013), SECR (2018)
	24.Base intensity ratio for bunchmarking	DEFRA (2009), DEFRA (2013), SECR (2018)
	25.Environmental fine	DEFRA (2009), DEFRA (2013), SECR (2018)
	26.State and specify each scope	DEFRA (2009), DEFRA (2013), SECR (2018)
	27.Initiatives to reduce GHG emission	Alrazi et al. (2010)
	28. CEO and /or chairman statement	Zhu et al. (2018), Alrazi et al. (2010), Kraft (2018)
	29.Vision and /or value and /or mission statement	Alrazi et al. (2010), Zhu et al. (2018)
	30.GHG emission reduction strategies/details/action	DEFRA (2009), DEFRA (2013), SECR (2018), Nor et al. (2016)
	31.Specification of GHG emission reduction target level and target year	DEFRA (2009), DEFRA (2013), SECR (2018), Zhu et al. (2018), Nor et al. (2016), Hąbek (2017), Michelon et al. (2015)

	32.State the reason for intensity measurement indicators choice	DEFRA (2009), DEFRA (2013), SECR (2018)
	33.State the reason for any significant changes in intensity measurement from the previous year	DEFRA (2009), DEFRA (2013), SECR (2018)
	34.State the conversion tools/emission factors used	DEFRA (2009), DEFRA (2013), SECR (2018)
	35.State the reason for restated emission	DEFRA (2009), DEFRA (2013), SECR (2018)
	36.State the reason for reduction emission	DEFRA (2009), DEFRA (2013), SECR (2018)
	37.The use of SECR guidance	Reports

Note: compiled by the author

3.5 Quantitative Research

The topic of this research is to determine the specific impact of the latest mandatory disclosure law, the 2018 regulations, through changes in disclosure content, and the causal relationship between changes in GHG IDQ and corporate financial and the relationship between GHG IDQ and corporate EP. First of all, it is necessary to calculate the GHG and energy information disclosure index of the full sample enterprises during 2016 to 2021 year according to the content analysis. Then, put it together with the company's FP, EP, and control variables for statistical analysis to test the impact of changes in the content disclosure of listed companies on financial and EP.

According to the research models and assumptions put forward by previous scholars, research belongs to the category of multivariate analysis, and regression analysis is the most commonly used and relatively mature method for multivariate analysis. For example, Luo (2019) used a lead-lag method to examine the impact of carbon emission performance on carbon disclosure levels of sample companies over an 8-year period. The model is based on the Ordinary Least Squares (OLS) regression model and selects measurable numerical indicators to represent some financial indices. Similarly, in the study of Li et al. (2017), OLS regression model was applied to test the proposed hypothesis that corporate environmental disclosure has a positive impact on FP. The analysis of the data by building a model finally concluded that environmental information disclosure does not contribute to FP.

Therefore, based on the more mature measurement methods in the existing literature, multiple regression analysis is mainly used to test the relationship among variables. Before the regression analysis of the data, the multicollinearity of the independent variables and the residual value of the variables are tested to ensure that the requirements of normal distribution, error independence, linear relationship, and equal variance are met. The research adopts the method of

establishing regression model to test the hypothesis, and all calculations and statistics use Excel and Stata statistical software.

3.6 Data validation

Two aspects need to be considered when conducting content analysis, namely reliability and validity. Reliability is based on the stability of index selection, repeatability and accuracy of results (Milne & Adler, 1999). Stability means that the results of the content classification should remain stable over time (Milne & Adler, 1999). In the process of selecting relevant indicators, verification by independent personnel (verifiers not directly related to the study) should not change the results. In addition, the classification used in the analysis process should be standard or normative, which can further ensure that the classification selected for the study measures to the greatest extent what the author really wants to measure or explore. Therefore, the reliability process ensures that content analysis is a reasonable approach to analyzing qualitative databases by creating quantitative indicators (Weber, 1990).

Milne and Adler (1999) recommend the use of stability and repeatability tests in corporate disclosure studies. These two types of reliability are commonly referred to as internal reliability and external reliability, respectively. In other words, internal reliability can be tested by researchers screening reports for multiple metrics over a specified time period. Internal reliability was confirmed if each index classification presented the same results. External reliability, which measures whether different researchers use the same decision rules to screen the same text for indicators that produce the same results.

The research is mainly to verify the content analysis of sample companies in the UK. The purpose of the data validation process is to assess whether the data were appropriately collected for the study, and whether the findings were repeatable and stable. The result of verifiers' data validation process is as follows:

(1) Most of the data collected by the validator is similar to the original data collected for the research.
(2) The data collected for UK listed companies' GHG emissions and energy consumption disclosure practices are similar to validators and original data.
(3) However, validators found less disclosure of energy use information in UK company annual reports compared to the original data. In particular, these data relate to disclosures under the mandatory disclosure policy the 2018 regulations, which are not encoded by validators but are encoded in the original data. The conclusion is that the original data is more comprehensive and should be retained.

To add reliability to the data, the study collected various reports from companies at the source. The company's annual report, sustainability report, and environmental Disclosure report are derived from audit reports available on the company's official website, rather than audit reports found elsewhere online. And the study double-checked that each report was the correct one provided directly by the company.

In addition to this, the study conducted additional checks to verify that all corporate disclosures related to GHG and energy information were included in the analysis. This step is mainly used to search for keywords in the report (including emissions, trading, GHG, climate, global, warming, carbon dioxide, energy) after downloading all reports. This process applies to all electronic reports for all samples.

After the reliability and validity analysis of the content analysis process, the research also needs to test the robustness of the quantitative research results, which is also an essential part of verifying whether the quantitative research results are reliable. The robustness test examines the robustness of the explanatory power of the evaluation methods and indicators, that is, whether the

evaluation methods and indicators still maintain a relatively consistent and stable interpretation of the evaluation results when some parameters are changed. When the research changes some conditions or assumes that the conclusions obtained remain unchanged, then the conclusions of the quantitative research are robust; otherwise, the conclusions obtained are open to question, and the research needs to find out the reasons for the changes in the conclusions and explain them.

3.7 Summary

This chapter designs the whole research process according to the research purpose and research hypothesis. Starting from the philosophical basis of ontology, epistemology and methodology, it is judged that this research adopts the ontology of objectivism, epistemology of positivism. This study uses an quantitative study on the grounds that the research method contributes to a better understanding of the impact of mandatory disclosure regulation and the relationship between corporate environmental disclosure and financial and EP. Quantitative research is especially useful for research that tests theories and tests hypotheses. Based on previous studies and theories, under the guidance of positivist epistemology, sample materials are used to test hypotheses, and statistical inference based on probability theory, namely quantitative research, is used as the research method.

Overall, this study selected a representative sample of the top 350 UK-listed companies in the FTSE Index. Public companies are chosen because of their obligation to provide annual reports to the public. At the same time, FTSE 350 companies are more representative and strategic than controversial SMEs in meeting emission reduction targets and disclosing information on GHG emissions. They represent a broad range of industry sectors, provide a broad range of representative environmental initiatives and legal norms, and have the potential to lead the way in GHG reporting.

Research uses quantitative methods as a means of collecting data and as a basis for obtaining research results. In the process of index construction, the content analysis method was adopted to quantitatively analyze the IDQ of the company's GHG emissions and energy consumption, which was not easy to quantify. The index set corresponds to the content in the report, and the total number is quantitatively analyzed, which can provide further evidence for the improvement of the theory and the verification of the correlation.

The set of indicators of disclosure content was collected based on a research framework after analysis of the literature in the field. Under the framework of this research, the indicators collected include quantitative data such as the amount of emissions and energy consumption, and qualitative data such as reasons for reducing emissions and measures to reduce emissions. Using corporate reports from 2016 to 2021 as a data source, the disclosures are divided into three categories: the contents disclosed by enterprises after the promulgation of the 2018 regulations, the contents disclosed before the promulgation of the 2018 regulations, and the contents disclosed by enterprises voluntarily all the time. The purpose of collecting these data is to analyze disclosure trends and to test the hypothesis that there is a positive correlation between disclosure content and the 2018 regulations.

The limitations of previous studies and inconsistencies in the interpretation of correlations are fully recognized. For example, it relies on a sample of firms from different countries in the study, and thus lacks the ability to test the theory from the findings. However, the analysis of companies in the UK in the leading development of the environmental disclosure regulations can provide valuable conclusion evidence through quantitative research, supporting the establishment of some scientific models to verify and analyze the impact of changes in the mandatory disclosure system on the quality of corporate environmental information disclosure and the correlation between environmental disclosure

quality and corporate FP and EP in the entire process.

Finally, by establishing a regression model, the whole research process is tested quantitatively and robustly. The study design provides the basis for the analysis and conclusions in the next chapter.

Chapter 4: Statistical analysis chapter

4.1 Introduction

This chapter introduces the detailed process of statistical analysis as part of the quantitative research, mainly based on the research method of the previous chapter to screen the sample data for the research question, establish the economic model and conduct a descriptive analysis of the preliminary results. According to the sources and standards for selecting company samples and GHG disclosure indicators determined in chapter 3, subsection 4.2 determines the selection of annual reports, sustainability reports of UK-listed companies, and GHG disclosure-related information disclosed on official websites as the data source of content analysis methods. At the same time, since this research hopes to judge the impact of the 2018 regulations on the content of corporate GHG information disclosure, the GHG disclosure content indicators are divided into three categories. In addition, the indicators for the study are selected, including FP, environmental, and control variables. Subsection 4.3 defines the construction of the model. Subsection 4.4 provides a detailed descriptive analysis of environmental disclosure results, FP, EP, and the correlation between independent and dependent variables.

4.2 Data collection

4.2.1 Selection of research sample

Based on the selection criteria and background analysis of the sample companies in chapter 3, to verify the research hypotheses and meet the research objectives, the target sample of the research includes companies listed on the FTSE 350 Index from 2016 to 2021.

Companies listed on the FTSE 350 were chosen because they represent a wide range of industry sectors, provide a variety of representative examples of environmental initiatives and legal norms, and consist of the largest 350 listed

companies in the UK by market capitalization likely to lead the pace of GHG reporting. These companies are not only representative in achieving emission reduction targets and disclosing carbon emission information but also have broader disclosures, which can comprehensively examine the reasonableness of disclosures and results by large companies in different industries.

The data from 2016 to 2021 were selected for the study because this study explores and judges the impact of the mandatory disclosure regulation - the 2018 regulations- on the quality of corporate GHG emissions and energy consumption information disclosure. Therefore, the year of the selected sample data includes three years before the release of the 2018 regulations and two years after that. After 2021, many companies did not publish relevant annual reports, so data after 2021 was not included in the research period. The six-year data can also create enough panel data for quantitative research related to environmental information disclosure and policy impact, which also helps to further improve the accuracy of the research conclusions. Researchers can only draw analytical results and objective conclusions for research purposes by obtaining valuable, analyzable, quantifiable, and relevant data. Therefore, the study conducted a further screening process for the sample data.

First, based on the ICB version 4.0, FTSE 350 contains eleven industries. However, according to previous studies on corporate environmental information and social disclosure (Qiu et al., 2016; Tauringana & Chithambo, 2015), companies related to the financial sector are excluded. Companies related to the financial sector include banks, insurance companies, investment trusts, unit trusts and real estate companies. There are two main reasons: on the one hand, because the financial sector complies with different disclosure and statutory requirements (Guest, 2009), this may affect its accounting policies, disclosure decisions and corporate governance structures (Mangena & Tauringana, 2007). The disclosure content and decision-making of companies in related industries may be quite

different from those of companies in other industries, leading to certain deviations in the research conclusions of the overall industry. On the other hand, financial organisations function differently from other businesses, and as a result, the FP of enterprises varies. Therefore, 142 companies related to the financial sector need to be excluded.

Second, to ensure the results' validity and comparability, subsidiaries of other companies also need to be excluded if the sample companies have subsidiaries of other companies throughout the study period. Also, studies need to exclude samples with no published annual reports and/or missing annual reports (due to post-merger deletions).

Third, when using cross-sectional data for research, the number of samples should not be less than 10 (Tian et al., 2014). This study categorizes industries according to ICB. The specific samples are shown in table 4.1.

Table 4.1 Sample selection

Industry classification	Total number of sample companies	After excluding firms related to the financial sector	Number of original reports	After missing samples are removed
Industrials	56	56	336	330
Consumer Discretionary	56	56	336	270
Consumer Staples	20	20	120	96
Health Care	12	12	72	66
Technology	17	17	102	54
Telecommunications	6	6	36	30
Basic Materials	21	21	126	84
Utilities	9	9	54	36
Energy	12	12	72	60
Financials	117	-	-	-
Real Estate	25	-	-	-
total	351	209	1254	1026

Source: Industry classifications come from ICB.

The implementation time of the 2018 regulations in the study is that the fiscal year of listed companies starts on or after April 1, 2019. Therefore, in the process of selecting annual reports, it is also necessary to classify reports at different times according to time nodes. Table 4.2 presents the ranges for the fiscal year-end dates in the annual reports of different companies. In the study, reports of different years were selected as the main sample source for content analysis, and the 2019 annual report and the 2020 annual report were carefully analyzed and classified. That is, the annual report for the fiscal year beginning before April 1, 2019 is classified as the 2019 annual report, and the annual report for the fiscal year beginning after April 1, 2019 is classified as the 2020 annual report. The timelines of other reports follow this standard.

Table 4.2 Time range of fiscal year end dates for annual reports of different companies

Fiscal year end date	Company number
1.1-1.31	2
2.1-2.29	4
3.1-3.31	31
4.1-4.30	5
5.1-5.31	1
6.1-6.30	9
7.1-7.31	4
8.1-8.31	2
9.1-9.30	12
10.1-10.31	2
11.1-11.30	2
12.1-12.31	97

Note: Data collection comes from corporate annual reports.

According to the content analysis in chapter 3, in order to obtain the GHG and energy disclosure information of a sample of relevant listed companies, it is necessary to analysis their annual reports, sustainability reports and website content. Reports are downloaded from public sources, such as the organization's web pages and company registration websites. If the report is not found in the public domain, a report request is made to the organization. A total of 1026

annual reports were collected, which lasted for six years. Some companies only have independent reports and sustainability reports, while others may have only started to report separately in recent years, with a total of 725 reports. Some companies also collect related information disclosed directly on the website. The distribution of samples in different years and industries is shown in table 4.3. It can be seen that the 1026 sample companies involve a total of six years and nine industries, most of which are distributed in the industry. The number of samples divided by year for a single industry is at least 30, which exceeds the minimum number of samples of 10. Therefore, it is feasible to do regression analysis by year and by industry.

Table 4.3 Sample selection of annual reports

Industry classification	2016	2017	2018	2019	2020	2021	Total
Industrials	54	54	55	61	56	55	330
Consumer Discretionary	45	40	42	46	52	45	270
Consumer Staples	16	16	18	17	19	10	96
Health Care	11	11	11	11	11	11	66
Technology	6	8	7	8	12	13	54
Telecommunications	5	5	5	5	5	5	30
Basic Materials	13	14	15	15	12	15	84
Utilities	5	6	6	7	6	6	36
Energy	8	8	12	12	11	9	60
total	163	162	171	176	188	166	1026

Note: Compiled by the author. Industry classifications come from ICB.

4.2.2 Selection of GHG information disclosure indicators

After identifying the sample companies, collecting all company reports and determining the relevant standards, this research needs to sort out different indicators disclosed at different stages according to the companies' reports. This process requires a content analysis of what the company discloses in the report, matching it with the indicators.

The use of content analysis techniques in research to develop disclosure indexes

has been used in some early environmental accounting studies (Freedman & Wasley, 1990; Wiseman, 1982) as well as in quantitative firm annual reports and independent environmental/ sustainability reports (Hossain et al., 1994; Mangena & Tauringana, 2007). Through content analysis technology, the information related to GHG emissions and energy consumption in corporate reports is analyzed in detail, and the disclosure quality of each sample is quantified by combining the indicators extracted from the mandatory disclosure regulations and voluntary disclosure content. In the selection process of indicators, the research pay more attention to the content of matching disclosure rather than calculating the number of words disclosed, the number of lines and the proportion of the whole report, which is not only more accurate and objective but also more targeted. Based on classification techniques used in earlier environmental research, disclosure indices are either associated with general environmental disclosures (Wiseman, 1982) or regulatory-specific disclosures (Patten, 2002), as was the case in this study.

Chapter 3 provides a framework for GHG reporting content, indicators, and standards. In order to further quantify the quality of corporate environmental disclosures, this study combines disclosure frameworks, disclosure reports, and a series of crucial GHG disclosure indicators proposed by related research in the past decade to develop 48 indicators covering three categories. In order to improve the validity of the research indicators and make the applicability of the indicators more comprehensive, the indicators collected in the research include qualitative and quantitative data. The specific classification of indicators is described below.

Category 1 - Disclosure content after the implementation of the mandatory carbon reporting (MCR) and before the implementation of the 2018 regulations

According to the detailed introduction of chapter 2 of the MCR regulations, after the implementation of the mandatory disclosure regulations in 2013, the law

requires companies to disclose some emissions in detail, mainly including quantitative indicators (such as scope1 and scope 2) and qualitative indicators (such as excluded emissions and causes, the method used to calculate emissions information, at least one ratio, previous year emissions and reporting period). Therefore, these six items are used as the indicator selection content for category 1. The source of the corresponding indicators in the company's annual report, the coding method selected, and the detailed matching example are shown in appendix 1.

Category 2 - Disclosure content after the implementation of the 2018 regulations

The second category of indicators mainly includes the contents newly added by the 2018 regulations that need to be disclosed by companies. With the implementation of the 2018 regulations, in addition to the 2013 law requiring companies to disclose some contents, three additional metrics have been added, including global energy use, energy efficiency actions and UK energy consumption and emissions. Therefore, the indicators that need to be disclosed after the implementation of the 2018 regulations include three items in the second category. The contents of each indicator that need to be disclosed in the corporate report are coded in appendix 1.

Category 3 - Content that has always been voluntary disclosure

In addition to mandatory disclosure of emissions, the law also gives companies a great deal of discretion. Along with the promulgation of the corporate disclosure law, the government has also issued corresponding guidelines to help guide corporate disclosure. Therefore, this study mainly refers to the disclosure guidelines and related literature of UK companies, and summarizes 37 voluntary disclosure indicators, which include qualitative indicators (such as listed companies' governance and participation in GHG emissions, relevant guidelines followed, GHG management commitments, relevant active measures taken, reasons for emission reduction) and also quantitative indicators (such as other

indirect (scope 3) GHG emissions, ozone-depleting substances emissions, environmental fines). The main purpose of choosing voluntary disclosure indicators is to judge whether companies comply with relevant policies and regulations when making disclosures, whether they attach importance to emission reduction and energy conservation, whether they are concerned about climate change, and whether they are committed to continuous improvement. The disclosures for each indicator in corporate reports are content-coded in appendix 1.

4.2.3 Measurement of the disclosure index

Previous literature studies have shown that disclosure can be quantified on a weighted or unweighted basis (Freedman & Jaggi, 2005). Freedman and Jaggi (2005) used a weighted disclosure index alongside an estimated disclosure value based on the authors' perceived importance of the information in assessing a firm's global warming performance. Meanwhile, Prado-Lorenzo et al. (2009) took a binary variable (1 or 0, depending on whether the item is revealed) and claimed that subjectivity is a significant difficulty. Their research showed that the process of evaluating Internet coverage and website information is more suitable for choosing a binary variable technique for analysis. At the same time, the weighted quantization technology is also divided into equal weight and unequal weight. The basic principle of using the unequal weight index is that the information provided by different components has the same correlation. Research by Gray et al. (1995b) revealed that weighted or unweighted methods had no substantial effect on the findings.

This study focuses on the impact of specific regulations, namely the 2018 regulations, on the content of corporate GHG disclosures, so the number of indicators for the selected disclosure categories is limited. It mainly includes two dimensions to capture the disclosure of GHG information: one is the collection of qualitative information, and the other is the disclosure of quantitative data.

Due to some subjectivity issues in weighting, this study assigns equal weights to all indicators and adopts an unweighted method that does not weight any specific user group or element (Cooke, 1989). Therefore, laws and regulations have the same weigh on the mandatory disclosure index of the company's disclosure content and the index of the company's voluntary disclosure content. If an index is disclosed, the company will get 1 point; if it is not disclosed, the company will get 0 points. However, if this item does not apply, there will be no penalty. The total disclosure index score for each sample company was then calculated as the ratio of the total disclosure score divided by the maximum information the company could disclose and finally expressed as a percentage.

4.2.4 Selection of FP indicators and control variables

4.2.4.1 Selection of FP indicators

Given the wide-ranging impacts of corporate activities on the environment, companies are increasingly required to disclose environmental information. The relationship between environmental information disclosure and corporate FP is controversial, and there is insufficient research on how environmental information disclosure affects FP. In the process of testing hypothesis 2 - there is a positive relationship between GHG disclosures and the FP of listed companies affected by the UK mandatory disclosure requirements. In addition to selecting disclosure content indicators, selecting appropriate financial indicators as factors variable is also necessary.

The disclosure of GHG in the process of sustainable corporate development is to reduce environmental pollution and simultaneously strive to maximise market value. With the continuous development of the institutional environment, the awareness of containing environmental degradation and the impact of GHG emissions has been continuously enhanced. The evaluation of corporate FP also needs to be improved. While measuring FP is considered a more straightforward task, it also has its specific complexities, mainly due to a lack of agreement on

which measurement tools to use when measuring FP.

In the financial literature, there are many measures of a company's FP. However, the most commonly used measures in research can be divided into two broad categories: (a) short-term measures related to accounting value ratios and profitability coefficients (Waddock & Graves, 1997; Cochran & Wood, 1984); (b) long-term indicators related to market value factors (Alexander & Buchholz, 1978), also known as asset growth factors. There are also some researchers who use both methods (McGuire et al., 1988). These categories of metrics represent different perspectives on how to assess a company's FP, have different theoretical implications (Hillman & Keim, 2001), and each have specific biases (McGuire et al., 1986). Using different measures can complicate the comparison of results from different studies.

Accounting measures reflect only historical aspects of firm performance (McGuire et al., 1986). In addition, they are subject to managerial manipulation and differences in accounting procedures (Branch & Branch, 1983). Market indicators are forward-looking and focus on market performance. They are less susceptible to different accounting procedures and represent investors' assessments of a company's ability to generate future economic returns (McGuire et al., 1988). Nevertheless, stock market-based performance measures also pose obstacles (McGuire et al., 1986). For example, according to Ullmann (1985), the use of market measures suggests that investors' assessment of firm performance is an appropriate performance measure (McGuire et al., 1988).

As accounting-based measures, the most commonly used variables are ROA and ROE (Buallay, 2019; Conway, 2019; Villalonga et al., 2019). In addition, ROA and ROE are also widely used to measure FP in research related to CSR and environmental information disclosure (Wang et al., 2016). To calculate these two indices, simply use the available net profit (before or after tax) (Tian & Estrin,

2008). ROA and ROE are useful metrics for assessing current corporate FP because they reflect the level of profitability a company has achieved in past accounting periods. In market-based measures, Marris and Tobin's Q is a ratio commonly used as a market reaction (Buallay, 2019; Conway, 2019). They can be good tools for assessing long-term FP and future market value because they reflect the market's assessment of the underlying profitability expressed by stock market prices.

In view of the relatively short period of influence of the regulations in 2018 in this study and the consideration of the time interval selected for the study, this study uses ROA as the measures of FP of the companies in the sample. This analysis estimates ROA as the ratio of net income/total assets (Villalonga et al., 2019). ROA is used to measure a company's FP. Financial data for all companies and years was collected through Refinitiv-Eikon database. Similar to the independent variable, the dependent variable was retrieved over a 6-year period (2016-2021).

4.2.4.2 Selection of GHGP indicator

Since the threats to companies from climate change are primarily centered on corporate emissions of CO_2 into the atmosphere, carbon emission levels appear to be an appropriate and objective measure of carbon performance. This study measures carbon performance based on GHG emission intensity. Higher values of carbon intensity indicate that a company is inefficiently using its resources, especially energy, and therefore under-performing (Porter & Van, 2000). GHG emissions intensity is calculated as the natural logarithm of the ratio of total Scope 1 and Scope 2 GHG emissions to the company's total sales, reflecting the efficiency of a company's production process.

The reasons for choosing GHG emission intensity as a corporate GHGP indicator are mainly based on the following considerations. First, compared to

the absolute emissions (scope 1 and scope 2 emissions) of the company, the GHG emission intensity represents the carbon emission level of a company's business activities of selling products and providing services in a certain fiscal year. The value has observable and quantifiable characteristics. It is often reported as an indicator for internal and external analysis and is therefore comparable across companies (Hoffmann & Busch, 2008). Second, based on previous research on environmental metrics, CO_2 emissions per pound of sales are an appropriate proxy for measuring company-level carbon performance (Clarkson et al., 2011a). Scope 1 and 2 GHG emissions are derived from CDP and corporate annual reports, where CDP is the only database that publishes years of self-reported emissions data from thousands of the world's largest companies according to a standardized methodology (Hoffmann & Busch, 2008). The relevant values of the missing enterprises are then supplemented according to the annual reports of the enterprises. Therefore, data that complement each other are not only comparable, but also representative. Finally, representative carbon performance indicators can help stakeholders make key decisions (Luo, 2019). Decision makers can evaluate the current environmental situation according to the carbon emission intensity indicators reported by enterprises, and then evaluate the current environmental policies and provide references for the formulation of future environmental policies. At the same time, GHG emission intensity is the best way to measure the effect of GHG emission reduction (Hoffmann & Busch, 2008). Enterprise managers and external investors can evaluate the company's emission reduction strategy, the efforts and effects made to curb emissions based on the company's emission indicators.

4.2.4.3 Selection of control variables indicators

In order to control for firm characteristics that may drive research on GHG disclosures and corporate FP relationships, the study chose to characterize firm size (Size), concentration of ownership (OC), firm growth capability (GC), financial risk (FR), current financial liquidity risk (CR), financial leverage (FL)

and asset liquidity (AT) as control variables. The specific measurements and data sources of FP indicators and control variables are shown in table 4.4.

First, firm size has often been used as a control variable in previous environmental disclosure studies (Patten, 2002; Deegan & Gordon, 1996; Clarkson et al., 2011b). As companies grow in size, they become more visible and rely more on political or social support (Cho & Patten, 2007). They are more likely to disclose sustainability-related information and are of higher quality (Qian & Schaltegger, 2017). The study therefore uses size as a control variable, measured by the natural logarithm of a firm's total assets.

Second, this study uses ownership concentration as a control variable. Ownership concentration has a significant impact on firms' environmental behavior and FP (McConnell & Servaes, 1990; Shleifer & Vishny, 1997). Through its sharing ratio (more than 5%), the largest shareholder of an enterprise influences the real ownership structure effect of the organization (Yeh, 2005).

Third, it is necessary to control the growth capability of enterprises. Companies with high growth capabilities tend to disclose more environmental information to meet stakeholder needs and gain public legitimacy. At the same time, faster-growing firms are more likely to reinvest in long-term and future-oriented strategies, such as environmental and sustainability strategies (Clarkson et al., 2011a). Following McGuire et al. (1988), a firm's ability to grow is measured by the firm's operating income growth rate.

Fourth, firms with high debt or low liquidity are less likely to invest in environmental improvement and disclosure (Clarkson et al., 2008). Debt asset ratio (total liabilities to total assets) measures firms' financial risk, while current ratio (total current assets to total current liabilities) measures financial liquidity. Therefore, financial risk and liquidity are also selected as control variables.

Table 4.4 Specific measurements and data sources of FP indicator, GHGP indicator and control variables

Variable type	Variable symbol	Full name	Measurement	Data sources
Independent variable	REG	The 2018 regulations	a score of 0 for 2016, 2017, 2018 and 2019, and a score of 1 for 2020 and 2021	Annual report
Independent/ dependent variable	IDQ	GHG information disclosure index	the ratio of the total disclosure score to the greatest amount of information that might be disclosed	Content analysis
Dependent variables	ROA	Return on assets	Net Income/Average Total Assets	Refinitiv-Eikon
	GHGP	GHG performance	Natural logarithm of the ratio of total Scope 1 and Scope 2 GHG emissions to total company sales	CDP and annual report
Control variables	SIZE	Company size	Natural logarithm of total assets	Refinitiv-Eikon
	OC	Shareholder concentration	Proportion of ownership by shareholders with 5% or more	Refinitiv-Eikon
	GC	Company growth capability	Operating income growth rate	Refinitiv-Eikon
	FR	Financial risk	Total liability/Total asset	Refinitiv-Eikon
	CR	Current financial liquidity risk	Current assets/Current liability	Refinitiv-Eikon
	FL	Financial leverage	Total debt/Total asset	Refinitiv-Eikon
	AT	Asset Turnover	Net Sales/Average total assets	Refinitiv-Eikon

Fourth, research finds that firms with high debt or low liquidity are less likely to invest in environmental improvement and disclosure (Clarkson et al., 2008). A company's debt asset ratio (total liabilities to total assets) measures its financial risk, while its current ratio (total current assets to total current liabilities) measures financial liquidity. Therefore, financial risk and financial liquidity are also selected as control variables.

Fifth, financial leverage is a sign of corporate financial risk, and it also affects decisions affecting important stakeholders (Xu et al., 2016). Companies are vulnerable to financial burdens. Companies with high financial leverage are more likely to lose market share, which may reduce profitability, FP, and market value (Buallay, 2019; Wang et al., 2020). The ratio of total debt to total assets is often used to measure a firm's financial leverage (Buallay, 2019). Therefore, in this research analysis, financial leverage needs to be used as a control variable that affects FP.

Sixth, total asset turnover was used as a control variable in the study, defined as the ratio of net sales to average total assets (Alsaifi, 2019). The total asset turnover ratio will have an impact on the operating conditions of a company and at the same time affect FP (Alsaifi, 2019), so it is necessary to use the total asset turnover ratio as a control factor affecting FP.

4.3 Measurement model setting

Due to the time-series nature of the panel data, the study employed fixed-effects modeling techniques to help capture variation across different subjects in space and over time (Baltagi, 1995; Inchausti, 1997). More importantly, this technique enables researchers to account for ignored or unobserved variables and control for unobserved heterogeneity between firms. The static model for panel data is as follows:

$$Y_{i,t} = \beta_0 + \beta_1 \cdot X_{i,t} + \delta_{i,t}$$

Among them: $Y_{i,t}$ are endogenous variables; $X_{i,t}$ are exogenous variables; β is a set of vector parameters; $\delta_{i,t}$is a random variable.

From the basic panel-fixed model, many estimates can be derived. A model similar to the ordinary least squares dummy variable model is the fixed effects model, estimated as:

$$Y_{i,t} = \beta_0 + \beta_1 \cdot X_{i,t} + \mu_i + \delta_{i,t}$$

where: μ_i represents the (fixed) individual or time effect.

This model provides time dummies. In the sample studied, all variables except "the Companies (Directors' Report) and Limited Liability Partnerships (Energy and Carbon Report) Regulations 2018 (REG)" (i.e. a score of 0 for 2016, 2017, 2018 and 2019, and a score of 1 for 2020 and 2021, whether before or after the 2018 regulations was enacted) were included in order to continue to study specific time effects. When the variable "REG" was included in the year, there was a large degree of multicollinearity, so it has been removed. When comparing the suitability of the two models, removing one original variable from a subsequent stepwise regression or other regression set does not affect the final result.

Therefore, models A1 and A2 are used to test hypothesis 1, that the mandatory GHG and energy disclosure policy the 2018 regulations has a positive impact on the quality of GHG disclosures by UK-listed companies. Model A1 represents a fixed individual, model A2 represents a fixed time, and the final model estimate is as follows:

Model A1:

$$IDQ_{i,t} = \beta_0 + \beta_1 \cdot REG_{i,t} + \beta_2 \cdot SIZE_{i,t} + \beta_3 \cdot OC_{i,t} + \beta_4 \cdot GC_{i,t} + \beta_5 \cdot FR_{i,t} + \beta_6 \cdot CR_{i,t} + \beta_7 \cdot FL_{i,t} + \beta_8 \cdot AT_{i,t} + \mu_i + \delta_{i,t}$$

Model A2:

$$IDQ_{i,t} = \beta_0 + \beta_1 \cdot SIZE_{i,t} + \beta_2 \cdot OC_{i,t} + \beta_3 \cdot GC_{i,t} + \beta_4 \cdot FR_{i,t} + \beta_5 \cdot CR_{i,t} + \beta_6 \cdot FL_{i,t} + \beta_7 \cdot AT_{i,t} + \beta_8 \sum_{t} (\text{year effect}) + \delta_{i,t}$$

where: i is 1,….1026; t is 1(2016), 2(2017), 3(2018), 4(2019), 5(2020), 6(2021) and is the cutoff of the distance variable for year-to-year variations, which captures differences between years, assuming that individual sample members are homogeneous;

μ_i indicates individual fixed effects;

(year effect) indicates time fixed effects;

All other variables are defined in table 4.4.

According to hypothesis 2 proposed in this study, that is, the impact of the quality of GHG information disclosure of UK listed companies on FP. Model A3 is designed to test this hypothesis. In the setting process of model A3, in addition to selecting GHG information disclosure index (IDQ) and the dummy variable REG as independent variables, the interaction variable of IDQ and REG is also selected as one of the independent variables. Since REG is a binary variable, that is, before 2020, the number is selected as 0, and after 2020 (including 2020), the number is selected as 1. Therefore, after adding the interaction item, β1 represents the increase in FP for each unit increase in IDQ before the implementation of the mandatory disclosure system. β1 + β3 represents the increase in FP for each unit increase in IDQ after the implementation of the mandatory disclosure system. Therefore, the addition of the interaction item can show the difference in the FP of the enterprise before and after the system disclosure when the IDQ level increases by one unit. Model A3 is proposed as follow.

$$ROA_{i,t} = \beta_0 + \beta_1 \cdot IDQ_{i,t} + \beta_2 \cdot REG_{i,t} + \beta_3 \cdot IDQ_{i,t} \cdot REG_{i,t} + \beta_4 \cdot SIZE_{i,t} + \beta_5 \cdot OC_{i,t} + \beta_6 \cdot GC_{i,t} + \beta_7 \cdot FR_{i,t} + \beta_8 \cdot CR_{i,t} + \beta_9 \cdot FL_{i,t} + \beta_{10} \cdot AT_{i,t} + \beta_{11} Industry_i + \beta_{12} Year_t + \delta_{i,t}$$

where: $IDQ_{i,t} \cdot REG_{i,t}$ represents interaction variable of IDQ and REG;

Industry indicates industry fixed effects;

All other variables are defined in table 4.4.

According to hypothesis 3 proposed in this study, that is, the impact of the quality of GHG information disclosure of UK listed companies on GHGP. Model A4 is designed to test this hypothesis. In the setting process of model A4, the interaction variable of IDQ and REG is also added as one of the independent variables. Since REG is a binary variable, that is, before 2020, the number is selected as 0, and after 2020 (including 2020), the number is selected as 1. Therefore, after adding the interaction item, β1 represents the increase in GHGP for each unit increase in IDQ before the implementation of the mandatory disclosure system. β1 + β3 represents the increase in GHGP for every unit increase in IDQ after the implementation of the 2018 regulations. Therefore, the addition of the interaction item can show the difference between the GHGP of the enterprise before and after the implement of the 2018 regulations when the IDQ level increases by one unit. Referring to model A3, model A4 is proposed.

$$GHGP_{i,t} = \beta_0 + \beta_1 \cdot IDQ_{i,t} + + \beta_2 \cdot REG_{i,t} + \beta_3 \cdot IDQ_{i,t} \cdot REG_{i,t} + \beta_4 \cdot SIZE_{i,t} + \beta_5 \cdot OC_{i,t} + \beta_6 \cdot GC_{i,t} + \beta_7 \cdot FR_{i,t} + \beta_8 \cdot CR_{i,t} + \beta_9 \cdot FL_{i,t} + \beta_{10} \cdot AT_{i,t} + \beta_{11} Industry_i + \beta_{12} Year_t + \delta_{i,t}$$

where: $IDQ_{i,t} \cdot REG_{i,t}$ represents interaction variable of IDQ and REG;

Industry indicates industry fixed effects;

All other variables are defined in table 4.4.

4.4 Descriptive Analysis

4.4.1. GHG information disclosure

Descriptive statistics of trends in GHG disclosure levels from 2016 to 2021 are shown in table 4.4. These figures show that the average disclosure rate in 2016 was 24%, with a low of 0% and a high of 85%, indicating that the amount of GHG disclosed by companies varies widely. In 2017 and 2018, disclosures were

27% and 32%, respectively, a modest increase. There was a substantial increase in disclosures from 2019 to 2020, from 40% to 53%, likely because companies saw the 2018 regulations as a signal that the government intends to mandate GHG disclosures, and companies increased relevant disclosures in order to comply with the regulations. Between 2020 and 2021, there has been a small increase in GHG disclosures, from an average of 53% to 55%.

Descriptive statistics for 2019 show a minimum disclosure rate of 1% and a maximum disclosure rate of 93%. Part of the increase in disclosures in 2019 may be due to the mandatory GHG and energy disclosure regulation issued by the government in 2018. This recommendation is supported by the fact that in 2019, about 6% of the sampled companies disclosed that they used the SECR guidelines in compiling and reporting their information, and by 2020, about 40% of the sampled companies disclosed the use of SECR guidelines in compiling and reporting their information.

While the trend in GHG disclosures continues to rise, the average increase in GHG disclosures between 2020 and 2021 (from 53% to 55%) is lower than between 2018 and 2019 (from 33% to 40%). Between 2019 and 2020, GHG disclosures increased from an average of 40% to one of 55%, which may be due to the fact that although the mandatory disclosure regime was implemented from April 1, 2019, the 2018 enactment released some signals of intention to issue implications for GHG disclosure guidelines. This is in line with Ascui and Lovell (2011), who noted that although convergence of various stakeholder pressures (eg. from governments, non-governmental organizations and professionals) has influenced changes in corporate behaviour in favour of climate change, but expectations of future regulation are themselves a major driver.

The small increase two years after its introduction could be explained by some companies catching up with reporting trends. Based on aggregated data

(2016-2021), the results show that companies have GHG scores ranging from 0% to 95%, but overall, the four-year average disclosure rate was 39%, indicating the degree of GHG disclosures of FTSE 350 companies remain still low.

Table 4.5 Descriptive statistics of GHG information disclosure during 2016-2021

Year	Mean	Std dev.	Min.	Max.	Skewness	Kurtosis
2016	0.24	0.23	0.00	0.85	1.273	0.767
2017	0.27	0.23	0.00	0.84	1.046	0.261
2018	0.32	0.24	0.02	0.91	0.884	-0.065
2019	0.40	0.24	0.02	0.93	0.476	-0.596
2020	0.53	0.26	0.02	0.95	-0.137	-0.866
2021	0.55	0.26	0.02	0.95	-0.276	-0.775
2016-2021	0.39	0.27	0.01	0.95	0.454	-0.928

Note: This table consolidates the descriptive statistics of the 2016-2021 disclosure scores of all sample companies from the software Stata 16.

Table 4.6 and 4.7 provide further insight into disclosures. A review of disclosures showed that, overall, listed companies made more disclosures under the disclosure required after implementation of MCR and before the 2018 regulations than had always been voluntary disclosures and those required after the 2018 regulations. For example, in 2016, companies disclosed 52% of what they disclosed after mandatory disclosure requirements were implemented and before the 2018 regulations, compared to 20% and 11% for the other two periods (see table 4.7). However, throughout the study period, companies have gradually increased the level of disclosures required to disclose and voluntary disclosures following the implementation of the 2018 regulations. The level of disclosure required after the implementation of the 2018 regulations will reach 30% in 2019 and even 73% in 2021. Meanwhile, the level of voluntary disclosures reported on 36% of projects in 2019 reached 49% in 2020.

Three quantitative data were most frequently reported after companies disclosed mandatory disclosure requirements and prior to the 2018 regulations, including emission for scope 1, scope 2 and related emission intensity. In 2020, almost 93% of companies reported these figures (see table 4.6, category 1, items 1, 2, 6).

These show that as the largest source of GHG emissions and the most practical impact on climate change, most companies are aware of the importance of these numbers. Therefore, after the introduction of the mandatory disclosure requirements, most companies have followed the relevant regulations seriously. In terms of the items disclosed after the implementation of mandatory disclosure requirements and before the implementation of the 2018 regulations, the item with the least disclosure is excluded emission (estimation). This may be due to the fact that some companies did not exclude emissions from scope 1 and scope 2, ignoring relevant statements on the interpretation of these values and information (see table 4.6, category 1, item 3).

Table 4.6 GHG information disclosure scores for all industries during 2016-2021

Category	Indicator	2016		2017		2018		2019		2020		2021	
		Absolute frequency.	Relative (%)	Absolute frequency.	Relative (%)	Absolute frequency.	Relative (%)	Absolute frequency.	Relative (%)	Absolute frequency.	Relative (%)	Absolute frequency.	Relative (%)
Disclosure required post-implementation of MCR and pre-the 2018 regulations	1.Direct(Scope1) GHG emissions	124	73%	129	75%	137	80%	144	84%	158	92%	161	94%
	2.Indirect(Scope 2) GHG emissions	126	74%	130	76%	135	79%	145	85%	159	93%	162	95%
	3.Excluded emission(estimation)	10	6%	9	5%	21	12%	24	14%	25	15%	26	15%
	4. State the reason of exclusion emission	38	22%	43	25%	51	30%	58	34%	64	37%	64	37%
	5.GHG emission intensity	145	85%	142	83%	148	87%	153	89%	160	94%	159	93%
	6.description of the methodology used to calculate GHG emission	68	40%	76	44%	85	50%	97	57%	118	69%	118	69%
	7.Comparative emission data from previous reporting	139	81%	144	84%	156	91%	159	93%	162	95%	159	93%
	8.Reporting period covered	68	40%	74	43%	82	48%	87	51%	95	56%	94	55%
Disclosure required after the implementation of the 2018 regulations	1.Global energy use	14	8%	16	9%	23	13%	55	32%	112	65%	123	72%
	2.Energy consumption	29	17%	34	20%	37	22%	52	30%	122	71%	130	76%
	3.GHG emission and energy related to UK	6	4%	6	4%	13	8%	25	15%	98	57%	103	60%
Voluntary Disclosure	1.Sustainability committee	11	6%	11	6%	24	14%	33	19%	57	33%	63	37%
	2.GHG policy statement	20	12%	28	16%	47	27%	63	37%	73	43%	77	45%
	3.Commitment to external initiatives	29	17%	34	20%	44	26%	71	42%	116	68%	115	67%
	4.stakeholders engagement activities	26	15%	31	18%	38	22%	58	34%	101	59%	103	60%
	5.GHG management team/person responsible	8	5%	12	7%	19	11%	38	22%	60	35%	60	35%
	6.Identification regulatory risk to climate change	38	22%	53	31%	70	41%	105	61%	141	82%	146	85%

	7.reporting guideline used in GHG reporting	119	70%	126	74%	135	79%	142	83%	154	90%	150	88%
	8.Organizational boundry	56	33%	63	37%	74	43%	86	50%	99	58%	102	60%
	9.Regular internal calculation of GHG emissions	31	18%	36	21%	41	24%	60	35%	71	42%	75	44%
	10.Regular external audits of GHG emissions	21	12%	29	17%	32	19%	46	27%	56	33%	58	34%
	11.External assurance/Third party assurance statement	54	32%	65	38%	73	43%	87	51%	105	61%	108	63%
	12.Existence external verification of quantity of GHG emission	42	25%	44	26%	50	29%	64	37%	78	46%	83	49%
	13.Disclosure of GHG emission by source(eg. coal, electricity, ets)	30	18%	38	22%	45	26%	58	34%	76	44%	88	51%
	14.Disclosure of GHG emission by facility or segment level	17	10%	22	13%	37	22%	52	30%	71	42%	81	47%
	15.Hisrorical base year selected and base-year GHG inventory	42	25%	47	27%	61	36%	70	41%	89	52%	97	57%
	16.Other indirect (Scope 3) GHG emission	42	25%	46	27%	56	33%	63	37%	97	57%	109	64%
	17.Total gross memission	128	75%	130	76%	132	77%	137	80%	145	85%	146	85%
	18.Reduction of GHG emission	68	40%	84	49%	104	61%	115	67%	135	79%	133	78%
	19.Emission of ozone-depleting substances	1	1%	1	1%	3	2%	2	1%	2	1%	3	2%
	20.Nitrogen oxides, sulfur oxides, and other significant air emissions	6	4%	7	4%	10	6%	12	7%	21	12%	21	12%
	21.Carbon offsetting	4	2%	4	2%	13	8%	19	11%	28	16%	30	18%
	22.Green tariff	1	1%	2	1%	4	2%	10	6%	13	8%	14	8%
	23.Base year emission data	25	15%	29	17%	37	22%	49	29%	61	36%	64	37%
	24.Base intensity ratio for bunchmarking	20	12%	23	13%	27	16%	38	22%	52	30%	56	33%
	25.Environmental fine	6	4%	7	4%	12	7%	12	7%	17	10%	18	11%
	26.State and specify each scope	33	19%	36	21%	36	21%	46	27%	78	46%	85	50%
	27.Initiatives to reduce GHG emission	52	30%	65	38%	80	47%	116	68%	143	84%	141	82%
	28. CEO and /or chairman statement	15	9%	21	12%	28	16%	47	27%	89	52%	93	54%
	29.Vision and /or value and /or mission statement	35	20%	41	24%	56	33%	82	48%	124	73%	126	74%

30.GHG emission reduction strategies/details/action	74	43%	87	51%	106	62%	130	76%	154	90%	155	91%
31.Specification of GHG emission reduction target level and target year	50	29%	55	32%	63	37%	88	51%	123	72%	138	81%
32.State the reason for intensity measurement indicators choice	38	22%	41	24%	48	28%	52	30%	63	37%	64	37%
33.State the reason for any significant changes in intensity measurement from the previous year	1	1%	1	1%	7	4%	7	4%	15	9%	14	8%
34. State the conversion tools/emission factors used	96	56%	99	58%	113	66%	120	70%	134	78%	134	78%
35. State the reason for restated emission	21	12%	27	16%	39	23%	50	29%	73	43%	77	45%
36. State the reason for reduction emission	34	20%	42	25%	52	30%	69	40%	96	56%	99	58%
37.SECR guidance	0	0%	0	0%	1	1%	11	6%	69	40%	83	49%

Note: The 48 indicators are derived from table 3.3 in Chapter 3. The indicator score is determined by summing the number of disclosures of each indicator for all organizations using content analysis method each year.

Table 4.7 Summary GHG disclosure scores

Type of disclosure	**2016**			**2017**			**2018**			**2019**			**2020**			**2021**		
	all firms score	Max. poss. score	% of score	all firms score	Max. poss. score	% of score	all firms score	Max. poss. score	% of score	all firms score	Max. poss. score	% of score	all firms score	Max. poss. score	% of score	all firms score	Max. poss. score	% of score
Disclosure required post-implementation of MCR and pre-the 2018 regulations	718	1368	0.52	747	1368	0.55	815	1368	0.60	867	1368	0.63	941	1368	0.69	943	1368	0.69
Disclosure required after the implementation of the 2018 regulations	57	513	0.11	74	513	0.14	92	513	0.18	152	513	0.30	374	513	0.73	388	513	0.76
Voluntary Disclosure	1294	6327	0.20	1487	6327	0.24	1817	6327	0.29	2308	6327	0.36	3079	6327	0.49	3209	6327	0.51
Total GHG disclosure score	2069	8208	0.25	2308	8208	0.28	2724	8208	0.33	3327	8208	0.41	4394	8208	0.54	4540	8208	0.55

Source: The final data is mainly calculated based on content analysis and table 4.6..

The three groups of indicators are categorised based on the selection of information disclosure indicators. The indicator scores are derived by summing all indicators depending on the number of disclosures in each of the three categories. In terms of the disclosure items of disclosure required after the implementation of the 2018 regulations, the three items increased slightly from 2016 to 2018. Global energy use, energy consumption, GHG emission and energy related to UK increased from 8%, 17% and 4% in 2016 to 13%, 22% and 8% (see table 4.6, category 2, 1, 2, 3 item). And from 2019 to 2021, there has been a great improvement, from 32%, 30% and 15% in 2019 to 72%, 76% and 60% in 2021 (see table 4.6, category 2, 1 , 2, 3 items). It shows that under the mandatory disclosure of the 2018 regulations, the impact on enterprises is very significant. More businesses are complying with legal requirements, with new mandatory disclosures.

Among the disclosure items that have always been part of the voluntary disclosure, in addition to the total emissions amount, 70% of the companies reported report 90% of companies reporting reference to relevant guidelines for GHG reporting in 2019. This shows that the impact of relevant guidelines on companies is also very important for the introduction of the 2018 regulations, and it can provide guidance for companies to make relevant disclosures.

4.4.2 Dependent variables and control variables

Table 4.6 and table 4.7 have listed the descriptive statistics about GHG information disclosure, and table 4.8 listed the descriptive statistics about the company's FP variable, GHGP variable and control variables.

Table 4.8 Descriptive statistics for dependent and control variables

variables	meaning	unit	minimum	maximum	mean	standard deviation	skewness	kurtosis
ROA	Return On Assets	ratio	-0.253	1.090	0.101	0.111	2.501	17.375
IDQ	the total disclosure score to the greatest amount of information that might be disclosed	ratio	0.000	0.950	0.403	0.154	0.097	2.304
GHGP	GHG emission density	ratio	-4.779	1.940	-0.358	0.848	-1.425	7.544
SIZE	Natural logarithm of total assets	number	7.707	11.610	9.525	0.677	0.351	3.242
OC	Shareholder concentration	%	0.019	0.750	0.139	0.123	2.634	10.243
GC	Company growth capability	ratio	-0.731	2.716	0.085	0.253	3.773	36.196
FR	Financial risk	ratio	0.039	1.786	0.577	0.209	0.621	4.714
CR	Financial liquidity	ratio	0.144	10.345	1.622	1.123	2.620	14.308
FL	Financial leverage	ratio	0.000	0.916	0.248	0.150	0.849	4.771
AT	Asset Turnover	ratio	0.008	6.958	0.897	0.727	3.287	21.646

Note: There are 1026 firm-year sample observations. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2020. IDQ is the disclosure quality indicator. ROA stands for FP Indicator. GHGP is the GHG emission density indicator. SIZE, OC, GC, FR, CR, FL, AT represent the size, equity concentration, growth capability, financial risk, financial liquidity, financial leverage and total asset turnover of the enterprise respectively.

Table 4.8 presents the results of a descriptive analysis of the 1026 firm-year observations. The results show that the mean of enterprise's return on assets is 0.1013, ranging from -0.2528 to 1.0904. The average GHGP for full sample is -0.3581 (the minimum is -4.7795, with the maximum of 1.9398). The size of the firms in the sample (measured by total assets) is wider and varies widely from year to year. For example, total assets ranged from £7.7070 million to £11.6097 million, with a mean of £9.5246 million and a standard deviation of £0.6773 million. The largest shareholder holds the least 1.85% of the company's shares, and the largest is 74.99%, and the shareholding concentration is moderate (13.90% on average during the six-year period). Most of the companies sampled had low growth capability (measured by operating income growth rate) (average of 0.0848).

Financial risk (measured as a ratio of total liabilities to total assets) varied widely, with financial risk ranging from 0.0392 to 1.7855 with a standard deviation of 0.2089. It is worth noting that ROA, shareholder concentration, growth capacity, financial liquidity and asset liquidity have high kurtosis. However, Tabachnick et al. (2007) argued that in large samples, the effects of normality's skewness and kurtosis values are suppressed. Therefore, in this case, the effect of non-normal distribution in the independent variables is unlikely to affect the final result.

4.4.3 Correlation between dependent and independent variables

This subsection focuses on the correlation between the dependent and independent variables, and the results are presented in table 4.9. Table 4.9 presents the results of the correlation among dependent, independent, and control variables, including the mandatory GHG and energy disclosure policies, the quality of GHG disclosures, FP, and GHGP, over a six-year period (2016-2021). The coefficient indicates a significant positive correlation between mandatory

GHG and energy disclosure policies and the quality of GHG disclosures. Furthermore, carbon disclosure increased with company size (correlation coefficient = 0.194, $p < 0.01$), suggesting that large companies generally tend to disclose more comprehensive and detailed information related to carbon emissions. This evidence is consistent with previous research that large companies are more likely to legitimize their operations or enhance their reputation through voluntary disclosure. Likewise, when $p<0.01$, the relationship between financial risk and total asset turnover and carbon disclosure was positively and statistically significantly correlated.

The coefficient is a significant positive coefficient between the quality of GHG information disclosure and the companies' FP. When $p<0.01$, firm size (correlation coefficient = -0.204), growth capability (correlation coefficient = 0.115), financial risk (correlation coefficient = -0.089), financial liquidity (correlation coefficient = 0.152) and total asset turnover (correlation coefficient = 0.219) and FP are statistically correlated.

At the same time, the coefficient between the quality of GHG information disclosure and the company's GHGP is significantly negative. The results showed that the correlations among the respective variables were not high. Field (2013) believes that the correlation coefficient of independent variables greater than 0.8 is worthy of attention. However, according to Myers (1990), even if the correlation coefficients are not very large, a certain degree of multicollinearity can still exist. Therefore, this study also examined the variance inflation factors in the model to further test for multicollinearity. Table 4.10 listed the values of the variance inflation factors for all independent variables in the different models.

Table 4.9 Correlation matrix among dependent and independent variables

	REG	IDQ	ROA	GHGP	SIZE	OC	GC	FR	CR	FL	AT
REG	1										
IDQ	0.657***	1									
ROA	0.115***	0.027***	1								
GHGP	-0.073**	-0.028***	0.004	1							
SIZE	0.093***	0.194***	-0.204***	0.034	1						
OC	-0.000	-0.080**	0.051	0.098***	-0.020	1					
GC	0.153***	-0.002	0.115***	-0.067**	-0.060*	0.005	1				
FR	0.045	0.082***	-0.089***	0.038	0.257***	-0.037	-0.066**	1			
CR	0.035	0.025	0.152***	0.052*	-0.211***	0.084***	0.024	-0.507***	1		
FL	-0.030	-0.075**	-0.063**	0.162***	0.152***	0.031	-0.095***	0.320***	-0.171***	1	
AT	-0.107***	-0.142***	0.219***	-0.123***	-0.318***	-0.089***	-0.029	0.045	-0.070**	-0.159***	1

Note: The table presents Pearson's correlation matrix. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2020. IDQ is the disclosure quality indicator. ROA stands for FP Indicator. GHGP is the GHG emission density indicator. SIZE, OC, GC, FR, CR, FL, AT represent the size, equity concentration, growth capability, financial risk, financial liquidity, financial leverage and total asset turnover of the enterprise respectively. *, **, *** represent significance at the 0.1, 0.05 and 0.01 levels respectively.

Table 4.10 The values of the variance inflation factors

Model A1:Variable	variance inflation factors	Model A3&4:Variable	variance inflation factors
		IDQ	2.249
REG	1.04	REG	2.116
FR	1.54	FR	1.549
CR	1.39	CR	1.393
SIZE	1.23	SIZE	1.268
FL	1.18	FL	1.225
AT	1.18	AT	1.192
OC	1.03	OC	1.042
GC	1.03	GC	1.039
Mean VIF	1.20	Mean VIF	1.453

Note: This table shows values of the variance inflation factors. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2020. IDQ is the disclosure quality indicator. SIZE, OC, GC, FR, CR, FL, AT represent the size, equity concentration, growth capability, financial risk, financial liquidity, financial leverage and total asset turnover of the enterprise respectively.

When a serious collinearity problem occurs, the analysis results will be unstable, and the sign of the regression coefficient will be completely opposite to the actual situation. The larger the number of variance inflation factors, the more serious the multicollinearity. It is generally believed that when the variance inflation factors is greater than 10 (strictly 5), it means that the model has serious collinearity problems. According to the results in table 4.10, it can be seen that the number of all independent variables are between 1 and 2.5, indicating that there is no multicollinearity problem.

In the selection of model variables, random variables need to satisfy independent and identical distribution, that is, variables obey the same distribution and are independent of each other. This is one of the assumptions that OLS models need to satisfy. According to Berry and Feldman (1985), heteroskedasticity can be controlled by various methods, including variable transformation and the use of robust standard errors. In this study, firm size and GHGP were log-transformed,

again the test results are also tested for robustness using the robust option in Stata 16 (the data analysis software used in the study).

4.5 Summary

This chapter introduces the selection of sample companies, disclosure indicators, FP indicators, GHGP indicator and control variable indicators, and the establishment of models. According to the research purpose and relevant criteria, listed companies from different industries were selected from the FTSE 350 for research. There are 9 categories of these industries, including industry, customer discretionary, consumer staples, healthcare, technology, telecommunication, basic materials, utility and energy.

In the process of model building, the impact of the new regulations in 2018 on the quality of GHG information disclosure of sample companies is mainly determined by sample fixation and time fixation. In this way, it can be further seen that the impact on the quality of corporate GHG disclosure content is different after and before the implementation of mandatory disclosure. In addition, hypotheses 2 and 3 are tested using the interaction model of ordinary least squares regression. In the mode l, the interactive variables of the 2018 regulations and the quality of information disclosure and some control variables are added to judge the impact of the quality of information disclosure on the FP and GHGP of listed companies after the policy is implemented.

From the descriptive statistics of the disclosure items required to be disclosed after the implementation of the regulations in 2018, it can be seen that from 2016 to 2018, the information disclosure of the voluntary disclosure items and mandatory disclosure items all increased slightly. It not only affects the content of mandatory disclosure, but also has a binding effect on enterprises, and also has

a certain impact on voluntary disclosure projects. The 2018 regulations have a very significant impact on companies, and they also provide guidance for companies to make relevant disclosures. Besides, it can be seen that there is a correlation between information disclosure and corporate FP and GHGP in the sample companies.

This chapter mainly conducts descriptive analysis of samples and data from a statistical point of view. In the next chapter, different tests will be carried out on different models to further judge the correlation between the independent variable and the dependent variable and the degree of mutual influence. At the same time, the robustness test will also be carried out on the results.

Chapter 5: Statistical Study Results and Discussions

5.1 Introduction

This chapter includes the research hypotheses tests and provides quantitative findings and discussions. As shown in the previous chapter, the companies selected for the quantitative study represent the changes in GHG emissions and energy use disclosures made by UK-listed companies across different industries in response to the implementation of mandatory environmental policies. They are distributed in nine industries and are included in the FTSE 350. At the same time, these companies are part of the mandatory disclosure scope under the 2018 regulations. Therefore, these companies are selected as samples for research in this study.

From 2016 to 2021, the information disclosure of GHG emissions and energy use by sample companies has increased to a large extent. Especially after the 2018 regulations were disclosed, related companies have significantly increased the disclosure of relevant information. This chapter discusses the quantitative findings and summarizes how changes in disclosure quality across industries correlate with firms' financial and EP. The study presents some analyses based on quantitative findings. Section 5.3 then discusses the link between the quality of enterprises' disclosures about GHG emission and energy use and their economic and EP. Section 5.4 conducts robustness checks on the research model. The last section gives a summary.

5.2 Total sample regression results and analysis

5.2.1 Analysis of the regression test results of the impact of the 2018 regulations on GHG IDQ

Models A1 and A2 are used to test the impact of the 2018 regulations on GHG IDQ. The difference between model A1 and model A2 is the characteristics of

our time variable. In model A1, one dummy variable ("REG") was used to capture the time effect, while in model A2, there were six dummy variables to represent the time effect. The test results are shown in table 5.1.

Table 5.1: Multivariate results for models A1 and A2

GHG IDQ	'Model A1' coefficient	Robust std. err.	'Model A2' coefficient	Robust std. err.
REG	0.200***	(0.01)		
SIZE	0.050***	(0.02)	0.012*	(0.01)
OC	-0.117***	(0.05)	-0.064**	(0.03)
GC	-0.006	(0.01)	-0.005	(0.01)
FR	-0.002	(0.03)	0.009	(0.02)
CR	0.009**	(0.01)	-0.000	(0.00)
FL	0.027	(0.03)	0.001**	(0.02)
AT	-0.033***	(0.01)	-0.001**	(0.01)
2017.year			0.027***	(0.01)
2018.year			0.079***	(0.01)
2019.year			0.159***	(0.01)
2020.year			0.274***	(0.01)
2021.year			0.302***	(0.01)
R^2	0.685		0.825	
adj. R^2	0.619		0.804	
F	230.428		335.752	

Note: This table shows the correlation matrix for Impact of the 2018 regulations on GHG IDQ since 2020. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2020. ROA stands for FP Indicator. SIZE, OC, GC, FR, CR, FL, and AT respectively represent the company's scale, equity concentration, growth capability, financial risk, financial liquidity, financial leverage, and total asset turnover. *, **, *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

In the individual fixed effects model A1, R^2 is 0.619, indicating that the model is effective in explaining the independent variable the 2018 regulations and control variables such as company size and equity concentration on the quality of GHG information disclosure. The F value is 239.428, $p < 0.01$, which means that the test of model A1 is relatively valid. The results of model A1 show that the regression coefficient of the independent variable REG is positive, and it has passed the 1% significance test, indicating that the new mandatory disclosure

regulation has a significant positive impact on the quality of GHG disclosure. That is, after the promulgation of the new mandatory disclosure regulation, the number of GHG disclosure content of listed companies in the UK increased to a certain extent. In the first year of policy implementation in 2020, the quality of environmental information disclosure has increased by 27.4%, and in 2021, the figure has increased by 30.2%. Compared with 2.7% in 2017 and 2.9% in 2018, the overall quality of environmental information disclosure has been greatly improved (table 5.2 model A2). The model A1 explained 62% of the variation in GHG disclosures. Therefore, hypothesis 1 is supported.

The study's findings on the effects of the 2018 regulations are consistent with previous studies, such as Freedman and Jaggi (2005). They discovered that companies in Kyoto-compliant countries disclosed more information than their counterparts elsewhere. Likewise, Sidaway and De Lange (2011) found that the introduction of the National GHG and Energy Reporting Act in Australia also positively impacted companies not targeted by the Act, which were also encouraged to disclose more climate change information voluntarily. In addition, other research evidence suggests that firms tend to respond positively to government guidance or advice to meet regulatory needs (Inchausti, 1997; Llena et al., 2007).

Through content analysis, it can be seen that most companies report all the required elements, such as scope 1, scope 2 of GHG emission. According to the results of model testing, it can be deduced that as listed companies in the UK agree with and comply with the regulation, more GHG and energy-related information will be disclosed, thus showing compliance. They will also refer to the DEFRA and SECR guidelines derived from this legal system when designing the report, which will also point the way for future policies and legislation. The

research helps managers of UK-listed companies to justify GHG emissions and to report. The research helps managers of UK-listed companies to justify companies' disclosure and reporting of GHG emissions. Meanwhile, the Confederation of British Industry (CBI), an influential body in the UK, has been actively treating the launch of the DEFRA Guidelines, as it has long called for companies to make environmental reporting mandatory. Guidelines for environmental reporting disclosures provide guidance to relevant companies, play a significant role in promoting mandatory disclosures, and help companies achieve comparability and consistency in reporting (CBI, 2011). Research by De and Van (2011) also demonstrated that investors support government regulation and GHG reporting guidance.

Among the firm-specific control variables, ownership concentration related to governance, size related to the firm itself, and the firm's total asset turnover rate all have a significant impact on the quality of GHG disclosures. Among them, the enterprise scale, the largest shareholder's shareholding ratio and the total asset turnover rate are statistically significant at $p<0.01$, and the financial liquidity is statistically significant at $p<0.05$. Firm size is positively associated with disclosing more GHG information, which is consistent with previous studies on GHG disclosures such as Freedman and Jaggi (2005), Prado-Lorenzo et al. (2009), Rankin et al. (2011) and Berthelot and Robert (2012). This indicates that the larger the scale of the enterprise, the more external supervision it will receive, the more attention may be paid to the requirements of the relevant legal system, and the tendency to disclose more GHG and energy information (Cho & Patten, 2007).

Ownership concentration is significantly negatively correlated with GHG and energy disclosures, implying that directors and major shareholders have other

channels besides those surveyed here to collect information on companies' GHG emissions. Other research (Barker, 1998) found that the majority of fund managers (which formed the core of institutional investors and ownership concentration in the UK) considered meetings with senior managers to be their most important source of information. In terms of GHG emissions and energy consumption, it can be argued that institutional investors use or encourage other avenues (such as CDP disclosures). Therefore, they may not think it worthwhile to encourage managers to disclose GHG emissions and energy use information in annual reports or related websites.

The smaller the total asset turnover rate, the more information companies will disclose to GHG. While this result contradicts previous research on GHG disclosure (Freedman & Jaggi, 2005; Prado-Lorenzo et al., 2009; Rankin et al., 2011), it is consistent with Brammer and Pavelin (2008). There is a significant positive correlation between the company's asset current ratio and the company's disclosure of GHG information.

In the time fixed effect model A2, R^2 is 0.825, which indicates that the release of the system greatly affects the amount of GHG disclosures of listed companies over time. The results of model A2 explain 82.5% of the changes in the quality of GHG disclosures. The explanatory variable is the GHG IDQ of listed companies in the UK. The explanatory variable is the 2018 regulations. The regression coefficient is positive, and it has passed the 1% significance test, confirming that the importance of the time dummy variable (representing the effect of the 2018 regulations). On the basis of model A1, this model can clearly see the influence of time effect, and can further verify the effect of mandatory system. The time effect analysis showed that changes in GHG disclosures were most pronounced between 2019 and 2020, as indicated by changes in the correlation coefficient.

Therefore, H_1 cannot be rejected.

Among the control variables of model A2, the correlation coefficient of company size is positive, and it has passed the 10% significance test, which indicates that the increase of enterprise scale and the concentration of corporate equity will significantly affect the quality of its GHG information disclosure, that is, listed companies will increase the disclosure content of GHG information. This is consistent with previous studies (Cormier et al., 2004; Peters & Romi, 2014). Dalton et al. (1999) argued that larger firms tend to have more capabilities, experience, and a greater sense of social responsibility, allowing for greater oversight (in this case, on GHGs). The results show that the control variable ownership concentration has a significant negative correlation with GHG disclosure, which is consistent with the conclusion of model A1, which means that directors and major shareholders have other channels to collect company GHG emissions information. The correlation coefficient of financial leverage is positive and passes the 5% significance test, which indicates that an increase in the proportion of a company's total debt in its total assets will make companies disclose more GHG information. While this result contradicts previous research on GHG disclosures (Rankin et al., 2011), according to Xu et al. (2016), financial leverage is a proxy for corporate financial risk. A company's high financial leverage indicates an easy financial burden and an increased risk of losing market share, which can reduce corporate profitability, FP, and market value. Therefore, companies will mitigate adverse decisions made by important stakeholders by disclosing more GHG information.

According to the results of descriptive statistics and model testing, it can be concluded that from 2016 to 2021, relevant enterprises have increased their awareness of environmental protection and gradually increased the disclosure of

emission information in their relevant reports. In 2020 and 2021, there will be a greater improvement in the quality of disclosure, so it can be seen that the introduction of mandatory GHG and energy disclosure regulations will have a certain impact on it. This also confirms that in institutional theory, the more advanced the external environmental supervision system is, the more factors in the legal, economic and social aspects of the enterprise will promote it to become more environmentally friendly (Huber, 2000). At the same time, the evaluation of technological innovation and EP adopted by enterprises also needs to rely on the self-reporting of enterprises, so the establishment of mandatory disclosure system requirements will have an impact on the reporting activities of enterprises.

5.2.2 Analysis of the regression test results of GHG IDQ on FP and GHGP

According to the model setting, hypothesis 2, that the company's GHG disclosure quality has a positive impact on their FP, will be verified by model 3. The results are shown in table 5.2.

The results of model A3 show that the regression coefficient of the explanatory variable GHG IDQ is positive and has passed the 1% significance test. At the same time, the regression coefficient of the interaction term between the quality of GHG information disclosure and the 2018 regulations is also positive, passing the 10% significance test. Therefore, the quality of corporate environmental information disclosure is significantly positively correlated with FP, supporting H_2. After the implementation of the 2018 regulations, it has a positive effect on the positive correlation between the quality of GHG information disclosure and FP, which indicates that as British listed companies disclose more content on GHG emission information, from 2016 to 2021, companies will improve their FP as a whole.

Table 5.2 Multivariate results for models A3

	'Model A3' coefficient		**'Model A3' coefficient**	
	Independent variable ROA	Robust std. err.	Independent variable ROA	Robust std. err.
IDQ	0.119***	(0.03)	0.077***	(0.03)
IDQ*REG			0.104*	(0.06)
REG			-0.014	(0.01)
SIZE	-0.027***	(0.01)	-0.025***	(0.01)
OC	0.008	(0.03)	0.007	(0.03)
GC	0.043***	(0.02)	0.043***	(0.02)
FR	0.030	(0.03)	0.030	(0.03)
CR	0.020***	(0.00)	0.019***	(0.00)
FL	0.062*	(0.03)	0.062*	(0.03)
AT	0.034***	(0.01)	0.034***	(0.01)
cons	0.206***	(0.06)	0.207***	(0.06)
industry	Yes		Yes	
year	Yes		Yes	
R^2	0.250		0.252	
adj. R^2	0.231		0.233	
F	13.076		12.432	

Note: This table shows the correlation matrix for impact of GHG IDQ on ROA. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2020. IDQ is an indicator of disclosure quality. IDQ*REG represents the interaction term of disclosure quality and the 2018 regulations. ROA stands for FP Indicator. SIZE, OC, GC, FR, CR, FL, and AT respectively represent the company's scale, equity concentration, growth capability, financial risk, financial liquidity, financial leverage, and total asset turnover. Industry represents the industry fixed effect. Year represents a fixed time effect. *, **, *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

From the correlation coefficients of independent variables and interactive variables in table 5.2, it can be seen that the specific economic importance of the change of quality of GHG disclosure before and after the mandatory disclosure regulation on corporate FP. Before the implementation of the 2018 regulations, for every 1% increase in disclosure quality, the company's FP will increase by 11.9%. After the disclosure of the 2018 regulations, for every 1% increase in the quality of disclosure, the FP of the company will increase by 18.1%. This further verifies the hypothesis 2 of this study. Under the influence of the mandatory

disclosure regulations, the quality of corporate disclosure is positively correlated with corporate FP.

In model A3 with adjustment item IDQ*REG added, R^2 is 0.233. To a certain extent, the model can explain the influence of the independent variable corporate GHG disclosure quality and the control variable company size, growth capacity, etc. on the dependent variable ROA. The correlation coefficient of the explanatory variables is positive, and it has passed the 1% significance test, indicating that with the increase of companies' disclosure of GHG information, the overall FP of the company gradually improves, which is consistent with hypothesis 2. It is proved that as enterprises attach importance to environmental information disclosure, increasing the disclosure of relevant information has a certain positive impact on the FP of enterprises (Barnett, 2007). This also confirms that from a longer-term and broader perspective, CSR can bring benefits to companies (Barnett, 2007), while GHG emissions disclosure and EP have a positive impact on company value (Toly, 2019).

As is shown in table 5.2, firm-specific control variables, including firm size, operational-related growth capabilities, financial liquidity, asset turnover rate, and financial leverage have a significant impact on a firm's FP. Among them, enterprise size, enterprise growth ability, financial liquidity and asset turnover rate have statistical significance at $p<0.01$, and financial leverage has statistical significance at $p<0.1$. There is a positive correlation between growth ability and FP, and the correlation coefficient is 0.043, indicating that a 1% increase in a company's operating income will lead to a 4.3% increase in the company's FP. There is a positive correlation between financial liquidity and FP, with a correlation coefficient of 0.019, indicating that the more liquidity an enterprise has, the better its FP will be. There is a positive correlation between the asset

turnover rate and FP, and the correlation coefficient is 0.034, indicating that the faster the asset turnover of the enterprise, the better the FP will be. There is a positive correlation between financial leverage and FP, indicating that the greater the proportion of the company's total debt in total assets, the better the company's FP.

Interestingly, the regression coefficient of firm size is negative and passes the 1% significance test, which indicates that as firm size increases, firm FP continues to deteriorate. This may be related to the outbreak of COV-19 in 2020. In a changing market environment, smaller companies exhibit more green innovation strategies, tend to pursue change and visibility, and thus achieve better profitability than larger companies (Lin et al., 2019). At the same time, it is also possible that different industry environments may have different effects, and a detailed analysis will be carried out according to each industry in detail later. Other specific control variables (ownership concentration and financial risk) are not significantly associated with firm FP.

Similar to testing H_2， hypothesis 3, that the company's GHG disclosure quality has a negative impact on their GHGP, will be verified by model 4. The results are shown in table 5.3.

The results of model A4 show that the regression coefficient of the explanatory variable GHG IDQ is negative and has passed the 5% significance test. At the same time, the regression coefficient of the interaction item of GHG IDQ and the 2018 regulations is also negative, passing the 10% significance test. Therefore, the quality of corporate environmental information disclosure is significantly negatively correlated with GHGP, supporting H_3. After the implementation of the 2018 regulations, there is a strengthening effect on the negative relationship

between the quality of GHG information disclosure and GHGP. There is a significant negative relationship between the quality of GHG disclosure of listed companies and corporate GHGP, that is, as British listed companies disclose more GHG emission information, from 2016 to 2021, the overall GHG emission density of companies will gradually decrease, and their EP will become better.

Table 5.3 Multivariate results for models A4

	'Model A4' coefficient		**'Model A4' coefficient**	
	Independent variable GHGP	Robust std. err.	Independent variable GHGP	Robust std. err.
IDQ	-0.326***	(0.10)	-0.198**	(0.10)
IDQ_REG			-0.374**	(0.17)
REG			0.204**	(0.08)
SIZE	0.040**	(0.02)	0.039**	(0.02)
OC	-0.292***	(0.08)	-0.292***	(0.08)
GC	-0.046*	(0.02)	-0.043*	(0.02)
FR	-0.021	(0.07)	-0.019	(0.07)
CR	-0.027	(0.02)	-0.027	(0.02)
FL	-0.351***	(0.08)	-0.355***	(0.08)
AT	0.915***	(0.04)	0.915***	(0.04)
industry	Yes		Yes	
year	Yes		Yes	
R^2	0.660		0.660	
adj. R^2	0.652		0.652	
F	33.85		32.33	

Note: This table shows the correlation matrix for Impact of GHG IDQ on GHGP. Standard error in parentheses. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2020. IDQ is an indicator of disclosure quality. IDQ*REG represents the interaction term of disclosure quality and the 2018 regulations. GHGP stands for GHGP Indicator. SIZE, OC, GC, FR, CR, FL, and AT respectively represent the company's scale, equity concentration, growth capability, financial risk, financial liquidity, financial leverage, and total asset turnover. Industry represents the industry fixed effect. Year represents a fixed time effect. *, **, *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

From the correlation coefficients of independent variables and interactive variables in table 5.3, it can be seen that the specific impact of the change of

quality of GHG disclosure before and after the mandatory disclosure regulation on corporate EP. Before the implementation of the 2018 regulations, for every 1% increase in disclosure quality, the company's EP will decrease by 32.6%. After the disclosure of the 2018 regulations, for every 1% increase in the quality of disclosure, the EP of the company will decrease by 57%. This further verifies the hypothesis 3 of this study. Under the influence of the mandatory disclosure regulations, the quality of corporate disclosure is negatively correlated with corporate EP.

In model A4, R^2 is 0.652, which means that the test of model A4 is valid. To a certain extent, the model can explain the influence of the independent variable corporate GHG disclosure quality and control variables including company size and growth capacity on the dependent variable GHGP. Among them, the correlation coefficient of the explanatory variables is negative, and passed the 5% significance test, indicating that with the increase of corporate GHG information disclosure, the overall corporate EP will gradually improve, which is consistent with hypothesis 3. It proves that as companies pay more attention to environmental information disclosure, increasing the disclosure of relevant information will inhibit the company's GHG emission density. This also confirms that from a longer-term and broader perspective, CSR can not only bring FP benefits to companies, but also have a positive impact on EP.

From the results of model A4, it can be seen that firm-specific control variables, including corporate size, concentration of ownership, operational-related growth capabilities, asset turnover, and financial leverage, have a significant impact on firms' EP. Among them, concentration of ownership, financial leverage and asset turnover rate have statistical significance when $p<0.01$, corporate size have statistical significance when $p<0.05$, and growth capabilities has statistical

significance when $p<0.1$. There is a negative correlation between the growth capability of a company and its GHGP, with a correlation coefficient of -0.046, indicating that a 1% increase in a company's operating income will lead to a 4.6% decrease in its GHGP. There is a negative correlation between financial leverage and GHGP, and the correlation coefficient is -0.351, indicating that the greater the proportion of a company's total debt in total assets, the worse the company's GHGP. There is a significant negative correlation between ownership concentration and GHGP, and the correlation coefficient is -0.292, indicating that the more concentrated the ownership, the worse the company's GHGP. While there is a positive correlation between the firm size and FP, and the correlation coefficient is 0.039, indicating that the larger the enterprise, the less GHG emissions. There is a positive correlation between the asset turnover rate and FP, and the correlation coefficient is 0.915, indicating that the faster the asset turnover of the enterprise, the better the GHGP will be. Other specific control variables have no significant relationship with corporate EP.

5.3 Regression results and analysis by different industries

In this study, all samples included a total of nine industries, including industrials, customer discretionary, consumer staples, healthcare, technology, telecommunication, basic materials, utility and energy. Since the sample sizes of the telecommunications industry and the utility industry are 25 and 30, which are relatively small, and these two types of industries are not carbon emission-intensive industries, the samples of the two industries are combined for analysis.

In addition to verifying the correlation between independent variables and dependent variables among the overall samples regardless of industry type, this study also examines the impact of the 2018 regulations on the quality of GHG

disclosures by related companies. Since industry fixed effects are used in model A3 and model A4, controlling industry fixed effects means controlling factors that are relatively unchanged relative to a certain industry. Therefore, no further examination of different industries is required.

5.3.1 Analysis of the regression test results of the 2018 regulations on GHG IDQ by different industries

Results for the correlation of the 2018 regulations with the quality of GHG disclosures for the nine categories of companies in the study are presented in table 5.4. According to the results in table 5.3, it can be seen that in the individual fixed-effect model A1, the explanatory variable the 2018 regulations have positive regression coefficients on the quality of GHG information disclosure for all industries, and all have passed the 1% significance test. The results show that the new mandatory disclosure regulation has a significant positive impact on the quality of GHG disclosure in all industries. With the promulgation of the mandatory disclosure regulation, the amount of GHG disclosure content of all industries increased to a certain extent. This result is consistent with the results for the overall sample.

In model A1, the results in table 5.4 show that the correlation coefficients of the 2018 regulations in the industrial sector and the energy sector are relatively large, 0.205 and 0.247 respectively, indicating that with the emergence of the mandatory disclosure regulation, companies in the industrial and energy industries will disclose more information related to the environment. At the same time, companies in the industrial and energy industries are considered to be environmentally sensitive industries (Wang et al., 2020). The more environmentally sensitive the industry in which the company operates (the more attention an industry receives from environmental lobby groups), firms are more

motivated to disclose some form of positive environmental information (Deegan & Gordon, 1996). This may be to shift or change views on the environmental impact of the industry as a whole (industry legalization process), or to try to profitably differentiate the company from other companies in the industry (organizational legalization process). This argument is consistent with the findings of Patten (1992). Patten (1992) discovered that following the Exxon Valdez disaster in 1989, other oil companies in the US Fortune 500 significantly increased their environmental disclosure levels in their annual accounts.

Compared with the industrial and energy industries, the technology industry has the least impact on the changes in the amount of corporate environmental information disclosed by the 2018 regulations, with a regression coefficient of 0.154. Therefore, the research results show that although the legal system has a positive impact on the GHG and energy information disclosure of companies in different industries, it has a greater impact on companies in the industrial and energy industries, and related companies will disclose more relevant content.

As can be seen from the results in table 5.4, in the time fixed effect model A2, only the industrial industry passed the 1% significance test in 2017. In 2018, the regression coefficients for industrial, customer discretionary, consumer consumption, telecommunications industry and utility, and basic materials industry all passed the 1% significance test. In 2019, except for the information technology industry, which passed the 5% significance test, all others passed the 1% significance test. The regression coefficients for all industries in 2020 and 2021 passed the 1% significance test, indicating that the positive impact of the 2018 regulations on the quality of GHG disclosures by companies in different industries is clear. After the promulgation of the policy, enterprises have been paying more and more attention to GHG information disclosure, and then added

relevant information in the report. From 2017 to 2019, only all regression coefficients of industrial enterprises passed the 1% significance test, indicating that with regard to the disclosure of GHG information, the degree of disclosure and attention of industrial enterprises is significantly higher than that of enterprises in other industries. This may be closely related to the generally higher emissions of industrial enterprises.

In the industrial industry, the financial liquidity in the control variable of model A1 passed the 1% significance test, and the enterprise scale passed the 10% significance test, and the regression coefficients were all positive, indicating that the size of firms in the industry and the ratio of total current assets to total current liabilities both havea significant impact on the amount of GHG disclosures. The research results show that the larger the enterprise scale, the faster the enterprise asset liquidity, and the tendency to disclose more GHG and energy information (Cho & Patten, 2007).

Table 5.4 Regression test results on the 2018 regulations and GHG IDQ since 2020 for 9 different industries

	Industrials		Customer discretionary		Consumer staples		Healthcare		Technology		Telecommunication and Utility		Basic materials		Energy	
dependent variable:GHG IDQ	Model A1	Model A2	Model A1	Model A2	Model A1	Model A2	Model A1	Model A2	Model A1	Model A2	Model A1	Model A2	Model A1	Model A2	Model A1	Model A2
REG	0.205***		0.197***		0.190***		0.173***		0.154***		0.199***		0.188***		0.247***	
	(0.01)		(0.01)		(0.02)		(0.02)		(0.04)		(0.05)		(0.01)		(0.02)	
SIZE	0.073*	0.002	0.03	-0.001	0.094	0.060**	0.150***	0.058**	0.06	-0.058*	-0.289	0.016	0.127***	0.067***	-0.028	-0.022
	(0.04)	(0.02)	(0.04)	(0.02)	(0.08)	(0.02)	(0.05)	(0.02)	(0.06)	(0.03)	(0.59)	(0.02)	(0.04)	(0.02)	(0.04)	(0.02)
OC	-0.196	-0.105	-0.201**	-0.113*	-0.241	-0.276***	-0.061	0.041	-0.089	0.062	-0.171	-0.054	-0.095	-0.086	0.069	0.343**
	(0.12)	(0.08)	(0.08)	(0.06)	(0.15)	(0.09)	(0.15)	(0.09)	(0.21)	(0.12)	(0.97)	(0.08)	(0.08)	(0.06)	(0.21)	(0.15)
GC	0.02	0.01	0.015	0.011	-0.041	-0.04	0.009	-0.004	-0.11	-0.063	-0.017	0.042	-0.052	-0.027	-0.033**	-0.031**
	(0.02)	(0.01)	(0.02)	(0.02)	(0.04)	(0.03)	(0.07)	(0.04)	(0.11)	(0.09)	(0.43)	(0.12)	(0.04)	(0.04)	(0.02)	(0.01)
FR	0.002	0.077**	0.035	0.019	-0.324**	-0.140*	0.240*	0.04	-0.095	0.02	-0.175	0.037	-0.101	-0.044	-0.017	-0.096
	(0.06)	(0.04)	(0.07)	(0.05)	(0.16)	(0.08)	(0.14)	(0.07)	(0.21)	(0.09)	(0.21)	(0.05)	(0.11)	(0.08)	(0.08)	(0.06)
CR	0.057***	0.011	0.022*	0.01	-0.019	-0.029**	-0.002	0.004	-0.006	-0.008	0.05	-0.016	-0.011	-0.007	-0.018	-0.021**
	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)	(0.01)	(0.05)	(0.03)	(0.07)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
FL	-0.019	0.02	0.065	0.014	0.03	-0.003	0.199	0.012	0.014	0.073	-0.109	0.103*	-0.075	-0.081	0.229**	0.145*
	(0.06)	(0.04)	(0.07)	(0.05)	(0.1)	(0.06)	(0.17)	(0.09)	(0.15)	(0.09)	(0.22)	(0.06)	(0.09)	(0.07)	(0.1)	(0.08)
AT	-0.011	0.008	-0.033	-0.002	-0.048	-0.015	0.002	0.123*	-0.226	-0.113***	0.199	0.112**	-0.02	0	-0.03	0.034

	(0.02)	(0.01)	(0.02)	(0.01)	(0.04)	(0.02)	(0.14)	(0.07)	(0.16)	(0.03)	(0.51)	(0.08)	(0.04)	(0.03)	(0.06)	(0.04)
2017.year		0.037***		0.030*		0.011		0.014		0.003		0.042*		0.031		0.012
		(0.01)		(0.02)		(0.02)		(0.02)		(0.04)		(0.02)		(0.02)		(0.02)
2018.year		0.098***		0.089***		0.044***		0.035*		0.042		0.122***		0.072***		0.050**
		(0.01)		(0.02)		(0.02)		(0.02)		(0.04)		(0.03)		(0.02)		(0.02)
2019.year		0.169***		0.183***		0.112***		0.093***		0.082**		0.166***		0.193***		0.204***
		(0.01)		(0.02)		(0.02)		(0.02)		(0.04)		(0.03)		(0.02)		(0.02)
2020.year		0.301***		0.275***		0.249***		0.249***		0.226***		0.259***		0.249***		0.325***
		(0.01)		(0.02)		(0.02)		(0.02)		(0.04)		(0.03)		(0.02)		(0.03)
2021.year		0.324***		0.297***		0.266***		0.265***		0.358***		0.327***		0.259***		0.337***
		(0.01)		(0.02)		(0.02)		(0.02)		(0.05)		(0.03)		(0.02)		(0.03)
N	275	275	225	225	80	80	55	55	45	45	55	55	70	70	50	50

Note: This table shows the correlation matrix for Impact of the 2018 regulations on GHG IDQ since 2020 for 9 different industries. Standard error in parentheses. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2020. SIZE, OC, GC, FR, CR, FL, and AT respectively represent the company's scale, equity concentration, growth capability, financial risk, financial liquidity, financial leverage, and total asset turnover. *, **, *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

This is also consistent with the overall sample conclusion. The financial risk in the control variable of model A2 has passed the 5% significance test, and the regression coefficient is positive, indicating that the greater the proportion of the total liabilities of the company in the total assets, the more content the company tends to disclose.

In the customer discretionary industry, the ownership concentration of the enterprises in the control variable of model A1 passed the 5% significance test, and the regression coefficient was negative, and the financial liquidity passed the 10% significance test, and the regression coefficient was positive. The results show that the more equity the largest shareholder owns, the more concentrated the equity, and the less the company discloses about GHG and energy-related information. The ownership concentration in the control variable of model A2 has passed the 10% significance test, and the regression coefficient is negative, which is consistent with the conclusion of model A1.

In the consumer staples industry, the financial risk of enterprises in the control variable of model A1 passed the 5% significance test, and the regression coefficient was negative, indicating that the greater the proportion of total liabilities in total assets, the less information a company may disclose on GHG emissions and energy consumption.

The ownership concentration in the control variables of model A2 passed the 1% significance test, and the correlation coefficient was negative. The size of the enterprise passed the 5% significance test, and the correlation coefficient was positive. Financial liquidity also passed the 5% significance test with a negative correlation coefficient. Financial risk passed the 10% significance test, and the correlation coefficient was negative. The results show that the more dispersed the equity, the larger the scale, the lower the financial liquidity, the lower the risk, and the more information disclosure content for GHG emissions and energy

consumption.

In the healthcare industry, the company size in the control variable of model A1 passed the 1% significance test, and the correlation coefficient was positive. Financial risk passed the 10% significance test, and the correlation coefficient was positive. The results show that the larger the scale of the enterprise, the higher the financial risk, and the more information disclosure content for GHG and energy. The enterprise size in the control variable of model A2 has passed the 5% significance test, and the correlation coefficient is positive, which is consistent with the results of model A1.

In the technology industry, only the enterprise size in the control variable of model A2 passed the 10% significance test, and the correlation coefficient was negative, which was different from other industries. The results show that the GHG emissions and energy consumption information disclosure content of enterprises in this industry are negatively correlated with the size of enterprises.

In the telecommunication and utility industries, only the financial leverage in the control variable of model A2 has passed the 10% significance test, and the correlation coefficient is positive, which is also different from other industries. The results show that the higher the financial leverage of companies in these two industries, the more information is disclosed about GHG emissions and energy consumption. The total asset turnover rate passed the 5% significance test, and the correlation coefficient was positive. The results show that the more the company's operating income grows, the higher the total asset turnover rate, and the more information about GHG emissions and energy consumption the company discloses.

In the basic material industry, the control variables of model A1 and A2 both passed the 1% significance test for enterprise scale, and the correlation

coefficient was positive, indicating that the larger the enterprise scale, the more information disclosed on GHG emissions and energy consumption.

In the energy industry, the control variables of model A1 have passed the 5% significance test for corporate growth capability and financial leverage. Among them, the correlation coefficient of corporate growth ability is negative, and the correlation coefficient of financial leverage is positive. The ownership concentration in the control variables of model A2 passed the 5% significance test, and the correlation coefficient was positive. Corporate growth capability and financial liquidity passed the 5% significance test, and the correlation coefficients were both negative. Financial leverage passed the 10% significance test, and the correlation coefficient was positive. The results show that the more concentrated the company's equity, the lower the growth rate of operating income, the smaller the proportion of current assets, the higher the financial leverage, and the more information about GHG emissions and energy consumption the company discloses.

5.4 Robustness test

5.4.1 Robustness test for all industries

quantitative studies on the preceding correlations can be subject to several statistical limitations, including endogeneity, which occurs when the model ignores some variables of interest and thus cannot provide complete information (Hsu & Wang, 2013). One solution is to include all known variables and find suitable instruments to measure (or proxy) other factors. The study includes some known control variables when the regression model was initially constructed, some of which had been used extensively in previous disclosure studies. However, there may still be some variables that were neglected in the model used in the final study. In order to further test the significance of the model and whether it is robust, this study will use instrumental variables, including robust regression with one-year lag of IDQ and two-stage least squares method, to test

the robustness of all the previous models.

The previous sub-chapter results have verified hypotheses 1, 2 and 3, that is, the mandatory GHG disclosure regulation has a significant positive impact on the quality of corporate GHG information disclosure, the quality of corporate GHG information disclosure has the same positive effect on the FP and the negative effect on GHGP of enterprises. In order to test the credibility of the research conclusions, it is also necessary to conduct a robustness test of the results. In order to verify the correlation between the mandatory GHG disclosure regulation and the quality of corporate GHG information disclosure, as well as the correlation between the quality of corporate GHG information disclosure and GHGP, the research uses instrumental variables to overcome possible endogeneity problems, and uses two-stage least squares method for robustness testing.

In the process of verifying the correlation between the 2018 regulations and the quality of corporate GHG information disclosure, robust regression with one-year lag of REG is used to test the robustness of the model A1. At the same time, to verify the correlation between the quality of corporate GHG information disclosure and FP and GHG, robust regressions with one-year lag of IDQ and the two-stage lease squares method are used to test the robustness of the model. The robustness test results are shown in table 5.5.

As can be seen from table 5.5 (1), using one-year lagged REG as explanatory variable, the impact of the mandatory disclosure regulation on the GHG IDQ of enterprises pass the 1% significance test and the correlation coefficient is positive. The results of the robustness test mean that the promulgation of the 2018 regulations has a significant and positive impact on the quality of GHG information disclosure by UK listed companies, which is consistent with the results of the previous models A1 and A2. Therefore, the research result on the

positive relationship between the 2018 regulations and the quality of corporate GHG information disclosure is robust.

Table 5.5 Regression results for model A1, A2 and A3

Dependent variable	Independent variable	Dependent variable	Independent variable	
	(1)		(2)	(3)
	IDQ		ROA	GHGP
L.REG	0.278***	L.IDQ	0.141**	-0.365**
	(29.15)		(2.94)	(-2.66)
		REG	0.019	0.046
			(1.25)	(1.22)
SIZE	0.024*	SIZE	-0.025**	0.027
	(2.21)		(-2.00)	(0.98)
OC	-0.083	OC	0.013	-0.39**
	(-1.82)		(0.29)	(-2.69)
GC	-0.053**	GC	0.048	-0.037
	(-2.69)		(1.59)	(-1.06)
FR	0.054	FR	0.048	-0.009
	(1.27)		(0.99)	(-0.08)
CR	0.004	CR	0.020***	-0.013
	(0.64)		(3.96)	(-0.60)
FL	-0.115**	FL	0.089*	-0.271*
	(-2.79)		(1.78)	(-2.29)
AT	-0.0111	AT	0.037***	0.904***
	(-1.04)		(5.25)	(16.21)
cons	0.078	cons	0.133	-1.053***
	(0.77)		(1.37)	(-4.09)
firm	Yes	industry	Yes	Yes
year	Yes	year	Yes	Yes
N	855	N	855	855
F	123.7	F	9.143	51.34
R^2	0.519	R^2	0.292	0.858
Adj. R^2	0.512	Adj. R^2	0.270	0.854

Note: This table shows the results of all industry robustness tests. T statistics in parentheses. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2019. IDQ is an indicator of disclosure quality. L.REG represents REG lagged by one period, that is one year lagged. L.IDQ represents IDQ lagged by one period, that is one year lagged. ROA stands for FP Indicator. GHGP is an indicator of GHG emission intensity. SIZE, OC, GC, FR, CR, FL, and AT respectively represent the company's scale, equity concentration, growth capability, financial risk, financial liquidity, financial leverage, and total asset turnover. *, **, *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

To test the credibility of the research conclusions against hypothesis 2, the results by substitution of variables are also shown in table 5.5 (2). The impact of GHG disclosure quality on corporate FP passed the 5% significance test, and the correlation coefficient was positive. The results of the robustness test show that the disclosure of GHG information by listed companies in the UK has a significant positive impact on the FP of the company. Therefore, the research result on the positive relationship between the quality of corporate GHG information disclosure and FP is robust.

To test the credibility of the research conclusions against hypothesis 3, the results by substitution of variables are also shown in table 5.5 (3). The impact of GHG disclosure quality on corporate GHGP passed the 5% significance test, and the correlation coefficient was negative. The results of the robustness test show that the disclosure of GHG information by listed companies in the UK has a significant positive impact on environment performance. This is consistent with the previous results for model A3. Therefore, the research result on the positive relationship between the quality of corporate GHG information disclosure and EP is robust.

5.4.2 Robustness test results for different industries

5.4.2.1 Robustness test results of the impact of the 2018 regulations on the quality of corporate GHG information disclosure

Considering that there may be differences in samples from different industries, the impact of the 2018 regulations on the quality of corporate GHG information disclosure may vary to a certain extent. It is also necessary to conduct robustness checks on the previous research results for different industries. The robustness test results are shown in table 5.6.

Table 5.6 Robustness test results of the impact of the 2018 regulations on the quality of corporate GHG information disclosure in different industries

dependent variable: GHG IDQ	Industrials	Customer discretionary	Consumer staples	healthcare	Technology	telecommunication	Basic materials	utility	energy
L.REG	0.318***	0.278***	0.314***	0.330***	0.415***	0.302***	0.219***	0.271***	0.366***
	(0.03)	(0.03)	(0.04)	(0.05)	(0.09)	(0.07)	(0.04)	(0.06)	(0.07)
SIZE	0.019	0.004	0.045**	0.044	-0.074	-0.022	0.048***	-0.083*	0.021
	(0.02)	(0.02)	(0.02)	(0.03)	(0.06)	(0.05)	(0.02)	(0.04)	(0.02)
OC	-0.382***	-0.102	-0.456**	-0.128	0.225	-0.045	-0.120**	-0.849	-0.057
	(0.13)	(0.07)	(0.19)	(0.17)	(0.21)	(0.2)	(0.05)	(0.52)	(0.27)
GC	-0.039	-0.077**	-0.163**	-0.06	-0.432**	0.169	0.053	0.126	-0.112***
	(0.03)	(0.03)	(0.07)	(0.12)	(0.21)	(0.28)	(0.09)	(0.1)	(0.02)
FR	0.143***	0.067	-0.187	-0.015	-0.041	0.021	-0.004	-0.113	-0.141
	(0.05)	(0.06)	(0.14)	(0.1)	(0.15)	(0.15)	(0.09)	(0.16)	(0.12)
CR	0	0.015*	-0.046*	0.014	-0.104*	-0.067	-0.011	0.067	-0.030*
	(0.01)	(0.01)	(0.03)	(0.03)	(0.06)	(0.06)	(0.01)	(0.07)	(0.02)
FL	-0.054	-0.167**	-0.019	0.034	0.258	-0.091	-0.191**	-0.028	0.179
	(0.07)	(0.07)	(0.11)	(0.16)	(0.16)	(0.15)	(0.09)	(0.21)	(0.16)
AT	-0.005	-0.007	-0.005	0.15	-0.072*	-0.016	-0.022	-0.034	-0.01
	(0.02)	(0.01)	(0.02)	(0.12)	(0.04)	(0.2)	(0.02)	(0.08)	(0.03)
N	275	225	80	55	45	25	70	30	50

Note: This table shows the results of a robustness test of the impact of the 2018 regulations on the quality of corporate GHG information disclosure for nine industries. Standard error in parentheses. REG is a dummy variable with a value of 0 if the year is before 2020 and 1 if the year is after 2020. L.REG represents REG lagged by one period. SIZE, OC, GC, FR, CR, FL, and AT respectively represent the company's scale, equity concentration, growth capability, financial risk, financial liquidity, financial leverage, and total asset turnover. *, **, *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

The impact of the 2018 regulations on corporate GHG emissions and the quality of energy consumption information disclosure in different industries is significant at the 1% significance level, and the correlation coefficients are all positive. This is consistent with the overall sample conclusion, indicating that changes to the mandatory disclosure regime will affect any industry accordingly. This also shows that the previous research conclusions are robust.

5.4.3 Endogeneity

The focus of the research is to explore the impact of the quality of environmental information disclosure on the FP and EP of enterprises under the influence of mandatory disclosure policies. Due to the potential endogeneity between the quality of environmental information disclosure and the FP and EP of the enterprise, the two-stage least squares method is used as an endogeneity testing tool. Therefore, for the next robustness test, the study selected IDQ with a one-year lag as an instrumental variable for two-stage least squares analysis. Based on the previous literature research, the study chooses the lagged IDQ of the sample companies of listed companies in the UK as the instrumental variable for the following research.

In order to avoid the endogeneity problem caused by mutual causation in the process of verifying hypothesis 2, this research selects IDQ with a one-year lag as the instrumental variable, and uses the instrumental variable two-stage regression method to re-estimate. It can be seen from the table 5.7 that the statistic of Kleibergen-Paap rk LM statistic is 130.730, and the p value is less than 0.01, indicating that the instrumental variable has passed the unidentifiable test. The Kleibergen-Paap rk Wald F statistic is 222.499, which is greater than the Stock-Yogo 10% critical value of 16.38, indicating that the model has passed the weak instrumental variable test. The number of instrumental variables does not exceed the number of endogenous variables, so the model also passed the over-identification test.

Table 5.7 Instrumental variable two-stage regression results

	(1) Independent variable: GHGP	(2) Independent variable: GHGP
	1st	2nd
L.IDQ	0.7858***	
	(0.0527)	
IDQ		0.1792***
		(0.0470)
SIZE	0.0041	-0.0257***
	(0.0045)	(0.0089)
OC	-0.0282	0.0183
	(0.0197)	(0.0328)
GC	-0.0036	0.0488*
	(0.0108)	(0.0286)
FR	0.0109	0.0459
	(0.0188)	(0.0357)
CR	0.0019	0.0201***
	(0.0027)	(0.0035)
FL	-0.0279	0.0945**
	(0.0221)	(0.0380)
AT	0.0018	0.0365***
	(0.0036)	(0.0065)
_cons	0.0519	0.1233*
	(0.0377)	(0.0681)
industry	Yes	Yes
year	Yes	Yes
N	677	677
F	285.8877	12.0382
Kleibergen-Paap rk LM statistic	130.730	130.730
	[0.000]	[0.000]
Kleibergen-Paap rk Wald F statistic	222.499	222.499
	{16.38}	{16.38}
R2	0.8376	0.2897

Note: This table shows the results of all industry two-stage regression tests. Standard error in parentheses. P-value of the statistics in []. The value in { } is the critical value at the 10% level of the Stock-Yogo test. IDQ is an indicator of disclosure quality. L.IDQ represents IDQ lagged by one year. ROA stands for FP Indicator. GHGP is an indicator of GHG emission intensity. SIZE, OC, GC, FR, CR, FL, and AT respectively represent the company's scale, equity concentration, growth capability, financial risk, financial liquidity, financial leverage, and total asset turnover. *, **, *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

Table 5.8 Instrumental variable two-stage regression results

	(1) Independent variable: GHGP	(2) Independent variable: GHGP
	1st	2nd
L.IDQ	0.8242***	
	(0.0253)	
IDQ		-0.4426***
		(0.1482)
SIZE	0.0066*	0.0300*
	(0.0034)	(0.0183)
OC	-0.0177	-0.3973***
	(0.0167)	(0.0893)
GC	-0.0095*	-0.0412
	(0.0051)	(0.0327)
FR	-0.0029	-0.0101
	(0.0151)	(0.0883)
CR	-0.0027	-0.0141
	(0.0025)	(0.0194)
FL	-0.0305*	-0.2840***
	(0.0165)	(0.0952)
AT	-0.0052	0.9015***
	(0.0034)	(0.0484)
_cons	0.0409	-1.0351***
	(0.0338)	(0.1732)
industry	Yes	Yes
year	Yes	Yes
N	690	690
F	343.0867	115.3190
Kleibergen-Paap rk LM statistic	172.822	172.822
	[0.000]	[0.000]
Kleibergen-Paap rk Wald F statistic	1062.714	1062.714
	{16.38}	{16.38}
R2	0.8786	0.8569

Note: This table shows the results of all industry two-stage regression tests. Standard error in parentheses. P-value of the statistics in []. The value in { } is the critical value at the 10% level of the Stock-Yogo test. IDQ is an indicator of disclosure quality. L.IDQ represents IDQ lagged by one year. ROA stands for FP Indicator. GHGP is an indicator of GHG emission intensity. SIZE, OC, GC, FR, CR, FL, and AT respectively represent the company's scale, equity concentration, growth capability, financial risk, financial liquidity, financial leverage, and total asset turnover. *, **, *** represent significance at 0.1, 0.05 and 0.01 levels, respectively.

In summary, the instrumental variables selected in this thesis are appropriate. From the regression results of the second stage, it can be seen that the coefficient of IDQ is significantly positive, which verifies the hypothesis 2 of the thesis again and the conclusion of the thesis is reliable.

In order to avoid the endogeneity problem caused by mutual causation in the process of verifying hypothesis 3, this research selects IDQ with a one-year lag as the instrumental variable, and uses the instrumental variable two-stage regression method to re-estimate. It can be seen from the table that the statistic of Kleibergen-Paap rk LM statistic is 172.822, and the p value is less than 0.01, indicating that the instrumental variable has passed the unidentifiable test. The Kleibergen-Paap rk Wald F statistic is 1062.714, which is greater than the Stock-Yogo 10% critical value of 16.38, indicating that the model has passed the weak instrumental variable test. The number of instrumental variables does not exceed the number of endogenous variables, so the model also passed the over-identification test.

In summary, the instrumental variables selected in this thesis are appropriate. From the regression results of the second stage, it can be seen that the coefficient of IDQ is significantly negative, which verifies the hypothesis 3 of the thesis again and the conclusion of the thesis is reliable.

5.5 Discussion of findings

The results of the empirical analysis show the impact of the 2018 regulations on the degree of GHG disclosure and how to further adjust the EP and FP of enterprises. According to the statistical evidence provided by the empirical analysis results of the overall sample and sample classification, it can be seen that the mandatory disclosure policy will indeed have a significant impact on the quality of GHG disclosure of enterprises, which can be seen mainly through the increase in the number of GHG information disclosure indicators . This is

consistent with the proposed hypothesis that, ceteris paribus, there is a positive relationship between the publication of 2018 regulations and the quality of corporate GHG-related information disclosures. This is also consistent with the theoretical framework proposed by the New Institutional School to investigate and understand various organizational behaviors and analyze organizational phenomena in the context of the organizational environment.

From the perspective of organizational society, according to institutional theory, enterprises need to make social rules and norms that conform to legal behavior (Dimaggio & Powell, 1983). In order to gain legitimacy, the organization must abide by the mainstream value system of the society and enhance the ability of the enterprise to obtain resources and support from the external society. Although the participation of enterprises in social welfare activities cannot increase productivity to a certain extent, under the continuous development of a sound institutional framework, enterprises can be persuaded or forced to adopt legal organizational structures and behaviors to improve their social status and social recognition (Zhou, 2003). Although the social welfare activities that many enterprises participate in have nothing to do with production, their purpose is not to increase productivity, but to improve the social status and social recognition of enterprises, and to establish a sound institutional framework for enterprise development. The legal system is mandatory. Under the mandatory system, enterprises must abide by the rules and regulations formulated by the government. At the same time, this is also consistent with the three processes proposed by Dimaggio and Powell (1983) that the institutional environment has an impact on the organization: coercive mechanism, imitation mechanism and social norm mechanism. Organizations within society need to adapt to institutionalized normative standards, face pressure from competing organizations, and complete implicit contracts with external economic societies to gain recognition and avoid punishment..

According to the statistical evidence provided by the empirical analysis results, it can be seen that in the context of mandatory disclosure policies, there is also a positive correlation between the quality of GHG disclosure and the company's FP, which can be achieved mainly by controlling the variable whether there is a mandatory disclosure regulation. The conclusion is consistent with the proposed hypothesis that there is a positive correlation between the quality of corporate GHG-related information disclosure and corporate FP in the context of the 2018 regulations. This result is also consistent with the results of the stakeholder theory and voluntary disclosure theory proposed by the theoretical framework. If business managers consider this issue from the perspective of stakeholder theory, they will find that it may be beneficial for companies to disclose relevant greenhouse gas information. Stakeholder theory emphasizes that corporate governance needs to fully balance the interests of various stakeholders. The growth of any organization is inseparable from the input or participation of different stakeholders. Enterprises should promote the overall interests of stakeholders (Freeman, 1984; Clarkson, 1995). According to this view, businesses have a responsibility to take steps to implement social activities. By meeting and balancing the needs of many stakeholders (Freeman & Evan, 1990), managers need to further enhance the organization's ability to respond quickly to external demands (Orlitzky et al., 2003). Actively participating in information disclosure activities is conducive to attracting investors who are highly sensitive to environmental protection projects and obtaining financial resources (Barnett & Salomon, 2006; Graves & Waddock, 1994), because companies that actively disclose information can often obtain tax breaks from local communities or governments and use public facilities.

According to the statistical evidence provided by the empirical analysis results, it can be seen that under the background of mandatory disclosure policies, there is also a positive correlation between the quality of GHG disclosure and the EP of enterprises. This is mainly achieved by controlling the variable whether there is a

mandatory disclosure regulation. The conclusion is consistent with the proposed hypothesis that there is a positive correlation between the quality of corporate GHG-related information disclosure and corporate EP in the context of the 2018 regulations. This result is also consistent with the results of legitimacy theory and signaling theory proposed by the theoretical framework. From a legitimacy perspective, a business enterprise and its operations must or should appear to be consistent with the values of a society's operating system (Deegan, 2002; Dowling & Pfeffer, 1975). When corporate carbon emissions are particularly high, firms must take necessary steps to close the gap between corporate performance and larger societal ideals (Gray et al., 1995). Therefore, as the government and the public's awareness of the need to reduce carbon emissions continues to expand and society's expectations for companies to address climate change continue to increase, companies will adopt various strategies to reduce GHG emissions (Bebbington et al., 2008). Firms fight or counteract negative publicity by repairing, maintaining or gaining legitimacy (O'Donovan, 2002). At the same time, companies inform the public of their improved carbon status and avoid adverse selection problems by publishing more reliable and objective emissions data. From a corporate internal management perspective, appropriate disclosures that meet the needs of stakeholders and the public can serve as a signal that enables organizations to measure and manage operations, thereby driving improvements in corporate sustainability performance (Burritt & Schaltegger, 2010).

5.6 Summary

This chapter analyzes and validates the assumptions based on the model established in the previous chapter. The study not only verified the correlation between different variables by selecting all enterprises as samples, but also verified the impact of the 2018 regulations on the quality of environmental information disclosure of enterprises in different industries through nine types of samples.

The quantitative findings support hypothesis 1, hypothesis 2 and hypothesis 3. The implementation of the mandatory GHG and energy disclosure regulation will have a positive impact on the quality of disclosures by UK-listed companies. Although companies' disclosures have increased to a certain extent with the time of year, companies' information on GHG emissions and energy consumption has increased significantly after the promulgation of the 2018 regulations. At the same time, using ROA as an indicator representing corporate FP, it has been verified that the increase in the content of information disclosed by enterprises for GHG emissions and energy consumption has a certain degree of promotion effect on the FP of enterprises. In addition, there is a significant negative correlation between the quality of corporate disclosure content and corporate GHGP.

Considering the problem of endogeneity, some robustness tests are also carried out after the research results are obtained. The instrumental variables, such as the least squares method and quantile regression, are used to further test different models. According to the research results, it can be seen that the previous research results are robust, which further proves the correlation between variables.

Chapter 6 – Conclusions, Contributions, Limitations, Implications and Areas for Further Study

6.1 Summary and Conclusion

The motivation for this study stems from the growing concern of external stakeholders about disclosure issues related to corporate environmental performance. The government has taken action to promulgate a series of mandatory disclosure regulations in the hope that enterprises will significantly improve GHG emissions. However, there is a lack of relevant research on mandatory disclosure policies' specific impact and extent. Therefore, the main purpose of this study is to figure out how the implementation of the mandatory regulation affects the corporate environmental IDQ and how the company's IDQ affects its EP and FP.

The research sample is selected from the FTSE 350 listed companies in the UK, mainly because the British government has always been in a leading position in environmental protection and governance. It is also the first country to attach importance to corporate environmental information disclosure and the first country to implement mandatory disclosure regulations (Camilleri, 2015). The sample companies not only voluntarily disclose relevant information about the environment to meet external stakeholders' needs (Akbaş & Canikli, 2019), but also must comply with the requirements of the mandatory disclosure system to disclose relevant content (Reid & Toffel, 2009). At the same time, the mandatory disclosure regulation adopts the latest 2018 regulations. In addition to the content required by previous mandatory disclosure laws, this regulation requires relevant companies to disclose information on GHG emission intensity and energy use (SECR, 2019).

This research adopts the method of combining content analysis and quantitative analysis. Through the content analysis of the relevant reports of the sample firms

from 2016 to 2021, which correspond to the established environmental information disclosure indicators, quantifiable statistics on the quality of the company's environmental information disclosure are acquired. Therefore, the content analysis provides a data basis for empirical research on the quality of environmental information disclosure. The next three empirical studies are mainly to verify three hypotheses, including the impact of the 2018 regulations on the quality of corporate environmental information disclosure and the relationship between changes in the quality of corporate environmental information disclosure and corporate FP and EP.

From this, this research is not limited to studying the financial consequences of carbon information disclosure on companies, but also includes non-financial consequences, namely EP. The results of the study are in chapter five. The first empirical model mainly verifies the impact of the 2018 regulations on corporate GHG emissions and energy consumption as measured by the IDQ. Institutional background and resource-based perspectives are used as theoretical frameworks. Through content analysis, disclosure indicators are formulated, and specific quantitative disclosure scores are obtained based on the annual disclosure indicators of sample companies. Through time-fixed effects and individual fixed effects, the study finds convincing evidence that the regulations in 2018 have significantly affected the quality of corporate environmental information disclosure. Businesses are increasingly complying with legal requirements through new mandatory disclosures. In the measurement of the quality of environmental information disclosure, the time-fixed model shows that after the implementation of the policy in 2019, the disclosure content of enterprises has significantly improved, which proves that the mandatory disclosure policy is applicable. In addition, the study also divides the sample into nine different industries, which are tested separately. The results show that the introduction of laws and regulations in 2018 correlated significantly with the quality of environmental information disclosure by enterprises in different industries,

which is consistent with the results of the overall sample.

The second study's objective is to examine GHG disclosure's effect on FP by testing the correlation between the quality of GHG disclosure and ROA. The study uses panel data and the combination of institutional, stakeholder, and voluntary disclosure theory as a theoretical framework to build an interaction model between institutions and the IDQ. The financial data of the sample companies and the data of the control variables are all from the Refinitiv-Eikon database. The quantitative research results show a significant positive correlation between GHG information disclosure and FP. When mandatory disclosure policies are put into place, the more GHG information a company shares, the better its FP will be.

The third study aims to investigate the effect of GHG disclosure on EP by testing the correlation between the quality of environmental disclosure and GHGP. The research also uses panel data based on institutional theory and signal theory and uses the OLS interaction model to test the hypothesis. The EP data of the samples are taken from their GHG emission intensities, which are more comparable to the GHG emission figures. The findings suggest that positive carbon disclosure can reduce a company's most significant share of GHG emissions and improve a company's overall EP. Consistent with the second study, the main objective is to understand the firm-specific consequences of changes in the quality of environmental disclosures.

For the first time, the findings provide new insights and policy implications for management, investors, and regulators. The findings strongly suggest that effective strategic management should include consideration of corporate information disclosure and implement clearer, uniform standards and enforceable mandatory disclosure regulations, which will help expand the transparency of corporate environmental information disclosure and help gather related

information from external stakeholders (Mitchell et al., 2012).

6.2 Research contribution

Through the content analysis method, the relevant disclosure content is divided into more detailed indicators, which can more objectively reflect the significant response of enterprises to the mandatory carbon disclosure regulation (increase or decrease in disclosure content). In addition, not only will carbon-intensive industries such as industrial and energy industries respond positively to the regulation, but other industries will also increase disclosures. In addition to the mandatory disclosure of GHG emissions and energy consumption by the 2018 regulations, voluntary disclosures for which companies have discretionary powers will also increase. This finding can make enterprise management pay special attention to the problem of GHG emissions, take measures and actions to curb the increase of enterprise GHG, and disclose more environment-related information. Each research objective is hypothesis-tested in the quantitative chapter. However, these are all unifying components of the overall research goal. The research objective is to study the impact of the 2018 regulations mandatory disclosure regime on the disclosure quality of UK sample companies and the impact of changes in disclosure quality of major UK companies on the financial and EP of companies. The 2018 regulations, disclosure quality, FP and EP form the entire chain of mandatory environmental disclosures are more effective than looking at one aspect alone.

This study contributes to the quantitative and theoretical literature in the field of mandatory disclosure regimes, corporate GHG-related environmental disclosures, and material impacts on firms. In particular, it reinforces the findings that corporate environmental disclosures have a positive impact on firms' FP. One of the main contributions of this thesis is that this is the first study on the impact of the latest mandatory GHG and energy information disclosure regulation - the 2018 regulations - on corporate reporting. Only by mastering the ever-changing

system can have an epic impact on the behavior of the enterprise, which can play a guiding role in the development and reform of the system in the future.

In addition, the literature identifies the underlying institutional influences, stakeholder roles, cost-benefit incentives, and information asymmetries that firms may be behind to increase their environmental disclosures. The results of the quantitative study in this thesis provide a new perspective. By promoting the development of mandatory systems, it is necessary to encourage listed companies further to pay more attention to the environmental issues of GHG emissions and energy use. This perspective is important because a firm's environmental disclosures reflect the impact on the overall environmental quality of a firm that a combination of forces or powers embedded in corporate governance, relationships, organization, and structure. At the same time, it will also have a series of effects on the company's substantial FP and EP. Previous studies on environmental disclosure were mainly based on the analysis of the motivation of disclosure alone or the impact of disclosure content on the performance of a certain aspect of the enterprise.

This study links the causes of disclosure behaviour to its performance, the FP that companies value most and the EP that stakeholders care about. This new perspective overcomes the limitations of previous studies. It provides a way to comprehensively analyze the impact of companies' environmental disclosures from mandatory disclosure regimes since most of the previous literature focus on the impact of comprehensive factors within the enterprise or stakeholders on the disclosure of enterprise environmental information. There needs to be more research in the corporate environmental disclosure literature on the impact of mandatory environmental disclosure laws on the content of corporate GHG disclosures. This thesis is an essential addition to the prioritized research on corporate responses to environmental disclosures under the legal system.

At the same time, the real impact of corporate disclosure of environmental information is still a problem. Existing literature focuses on the value relevance of GHG disclosure reports by considering the impact of corporate environmental voluntary disclosure alone on EP or FP. Few studies have investigated corporate environmental disclosures' actual performance, including financial and EP, in the context of mandatory disclosure regimes. These studies are almost exclusively on globally listed companies, and the conclusions are not uniform.

Few studies have focused on the link between environmental disclosures and their financial and EP in the context of mandatory disclosure regimes. This study fills this gap by using the methods of content analysis and quantitative research. Through the collection and analysis of six-year corporate annual reports, independent reports and environmental-related disclosures, financial data and emissions data, the conclusion is drawn through scientific and practical quantitative analysis on the correlation between environmental information disclosure and FP and EP in a relatively long time frame.

In addition, to the best of my knowledge, this study is the first to classify disclosures by time nodes, particularly the divisions before and after the 2018 regulations were enacted. The disclosure content includes qualitative and quantitative indicators and conducts statistical analysis on the amount of disclosure content of the company. The amount of disclosure helps to assess the quality of information disclosure of a company's GHG emissions and energy consumption. This classification method is simple, direct and easy to apply and has practical significance for classifying other environmental information disclosures. This study conducts a coherent and detailed analysis of corporate environmental disclosure research through qualitative and quantitative methods. Statistical analysis is also carried out according to different industry types, finally providing a robust research conclusion.

Nowadays, climate change poses a significant threat to the global environment and economic stability and can significantly impact a company's financial health and EP. This study concludes that the 2018 regulations have a significant relationship with the disclosure quality of corporate GHG emissions and energy consumption information. There is also a significant positive relationship between corporate GHG emissions, energy consumption information disclosure, and FP and EP. This forms a basis that the mandatory information disclosure system should be improved and increased, and more detailed and practical regulations should be proposed to improve corporate disclosures' content and overall quality. In addition, greater emphasis needs to be placed on clearly explaining the benefits of climate mitigation activities to dispel the perception by investors and business managers that the costs associated with them negatively impact company performance.

6.3 Research implications

The findings of this study have many implications for business managers, outside investors and policymakers (including regulators). First of all, corporate environmental information disclosure is related to mandatory disclosure policies, indicating that policymakers need to strengthen the requirements and improvement of relevant regulations for corporate environmental information disclosure so that companies can effectively disclose GHG emission and energy consumption information and satisfy stakeholder needs while satisfying legality.

Secondly, since many countries require companies to disclose corporate environmental information voluntarily, voluntary disclosure has certain advantages. That is, in the case of satisfying stakeholders, the report's content can be innovated according to the company's development. However, the obvious disadvantage is that there may be incomparability and inconsistency of information due to the need for a unified standard and verification by a third-party authority. At the same time, there are considerable differences in the

choice and formulation of carbon emission measurement methods and carbon disclosure standards, which reduces the comparability of the company's GHG emission data to a certain extent, and companies may be more willing to report information that is more beneficial to the company's reputation and performance. It also provides a green cleaning opportunity for companies to revise their reports (Bowen, 2014; Kalesnik et al., 2021). For example, brown companies may be mistaken for green companies to invest in, which is contrary to their investment strategy (Kalesnik et al., 2021). For investors, the data in the report is the most convenient, relevant, and accurate data available to the enterprise. However, the quality of the relevant data is deficient, the data availability is limited, and there is a particular reporting bias (Kalesnik et al., 2021), influencing investors' decisions. The selection of indicators in the study comes from numerous studies and related guidelines, which can be used as a guide for investors to pay attention to environmental content and help them have a general understanding and comparison of the company's emissions.

Thirdly, not all companies have disclosed mandatory contents, and only some companies have provided externally assured data and reports. Therefore, it is very necessary to strengthen the supervision of corporate carbon emission data, and at the same time increase certain penalties, which is more conducive to the disclosure of more content and the improvement of data availability.

In order to better reflect the actual EP of the company, it can be used and compared by external stakeholders and better evaluated by regulators. In changing corporate environmental information disclosure from voluntary to mandatory, government departments should carefully consider the selection of mandatory disclosure indicators and content. One of the most critical steps in this process is assessing its target audience's suitability. The greater the coverage, the more significant the impact. At the same time, mandatory targeted requirements can also be put forward for different industries.

With the growing concern about GHG, the need for companies' GHG emissions and related information is increasing, which is caused by many factors. For example, business executives can demonstrate their strengths and leadership in the marketplace by increasing their awareness of GHG emissions reporting and quantities and better-identifying energy and resource reduction opportunities. The outside public can learn more about the actual performance of the company and the details of the company's report through a more official channel to further understand the company's operation and emission reduction. External investors can understand and analyze the risks and opportunities the company may face based on the disclosed content and, at the same time, judge whether to cooperate with or invest in it based on the relevant measures and behaviours the company has taken. By disclosing the content of the report, it can reflect the relevant organization's strategy, governance, performance and future development. The outside world's reaction to the disclosure also provides a reference for companies to create short-term, medium-term and long-term value in the external environment.

Of course, it is also critical to accurately measure and effectively assess the impact of environmental disclosures on a company's actual FP and emissions. For some non-carbon-intensive companies, increased environmental disclosure has a significant positive impact on FP in the short term. For companies in other industries, the increase in environmental disclosure did not improve FP significantly. Nevertheless, as this article shows, across the industry as a whole, companies' FP has improved somewhat as disclosures have grown. The impact of environmental disclosure on GHG emissions is also positive. With the increase in disclosure, companies will reduce GHG emissions, especially in the industrial and energy industries. Undoubtedly, some necessary projects through environmental reporting can make environmental reporting a tool for environmental communication, which may bring some financial benefits while

meeting the increasing demand for emission reductions. Therefore, it is necessary to improve the quality of environmental information disclosure and make it an integral part of organizational governance and structure.

6.4 Limitations and areas for Future Research

The sample of this research is limited to large companies listed on the FTSE 350 of the London Stock Exchange. Therefore, caution should be exercised when generalizing the results on correlations between different variables to firms of different sizes and to firms in other countries.

In the process of variable selection, there are gaps in the data of certain variables of different companies, namely R&D expenditure and intangible asset expenditure, which may also affect the analysis of interest relations. In addition, corporate governance, ownership structure, and audit-related issues may also be important explanatory variables. Due to the limited scope of the study and the difficulty of controlling for all relevant variables, the study did not consider all of these variables in all relationships examined in one study.

This study is mainly based on quantitative and dichotomous methods for index construction of relevant indicators for most content analysis. While this approach maximizes reproducibility and reduces subjectivity bias in judgment, it fails to capture nuances in the scope of the disclosure for some qualitative metrics.

Impact on corporate FP and EP suggests some interesting directions for future research. This study shows that a sample of top FTSE 350 companies, including companies from different industries, is more representative and strategic in meeting emission reduction targets and disclosing carbon emissions information. It better reflects the real impact of mandatory regulation on companies and is more likely to lead the way in GHG reporting. The study focuses on disclosures from large companies in different industries but does not cover small and

medium-sized companies or LLPs. This will be a useful avenue for future research to examine whether a similar phenomenon occurs in smaller companies and LLPs.

Furthermore, this single-country study can be developed into a comparative study by comparing firms in two or more countries, as there are significant differences between countries, especially in terms of regulatory and business environments. In addition, the investigation of the UK's largest companies could also be extended to other smaller companies. Small companies have different characteristics, especially in size, so they will be less pressured by stakeholders, including regulators, to be more environmentally responsible. Recognizing that carbon density is not the only proxy for emissions data, more different or multiple emissions data may be included in future research. Upcoming research may also introduce market factors such as carbon trading regimes as influences on corporate EP. Finally, investor responses to mandatory disclosures can be compared to voluntary disclosures.

This study highlights the correlation between mandatory disclosure regimes, environmental IDQ, and a company's FP and EP. Considering that the amount of research in this area is very limited and there is no uniform conclusion, there are many avenues for further research to expand the correlation between different regulation backgrounds, national contexts, and external pressure, especially to further investigate the relevant degree of relationship. At the same time, there are differences between enterprises in different industries, and further research can be carried out for further detailed research on the correlation between different industries. For future research, it is very important to pay attention to other factors that affect information disclosure, FP, and EP of enterprises. The more aspects considered, the more comprehensive the conclusions of the research. Situations vary across industries, especially carbon emissions-intensive companies, and non-intensive companies expect different behaviors in

environmental disclosures. Although limited prior studies have come to different conclusions on the consequences of environmental disclosure by firms in different industries (Gerpott et al., 2008; Purwanto & Agustin, 2017), few studies compare the differences in the performance of companies in different industries. Future research could be conducted to compare companies' disclosure and impact of environmental information across different industries.

In the future, researchers are being urged to look at a range of possible impacts of mandatory disclosure policies on businesses and to investigate the UK's overall carbon footprint after leaving the EU. Such an exit could be significant, as exiting the EU ETS is also likely to have certain implications for policy and corporate EP. At the same time, since the outbreak of new coronavirus pneumonia after 2020 will also have a certain impact on the economic situation and EP of enterprises, researchers can analyze these influencing factors in the future. Another area that could be considered for future research is firm size and the impact of board size on environmental disclosures. For example, the larger the scale of the enterprise, the more external supervision it will receive, the more attention it may take to the requirements of the relevant legal regulations, and the tendency to disclose more GHG and energy information (Cho & Patten, 2007; Rankin et al., 2011; Berthelot & Robert, 2012). Board size is also positive and significant for GHG disclosures (Peters & Romi, 2014; Tauringana & Chithambo, 2015).

Even though quantitative research (i.e., experimental research) is employed in this thesis, which provides an in-depth study of the relationship between the quality of companies' environmental disclosures and their FP and EP, future research can be extended to use other methods, e.g., quantitative research, to test the relationship between corporate environmental management capabilities and FP and EP, to link this relationship with more aspects of the enterprise. In addition, future research can focus more on the use of other qualitative methods,

such as ethnographic studies, in-depth interviews, and focus groups, because qualitative methods can provide rich data, obtain practical measures and responses to relevant problems in the real world, and be more targeted in the process of collecting, analyzing and interpreting data. In the future study of using quantitative research methods, it also has the potential to explore more specific index frameworks based on different characteristics of different indicators. Ideally, future research could set different evaluation scales based on setting indicators.

Overall, as emerging and hot topics, mandatory disclosure regulations and environmental information disclosure provide excellent opportunities for developing future research, and it is expected that future research on corporate GHG emissions will attract more attention from academia.

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Appendix

Appendix 1: The sources and coding methods of the three types of indicators

The source of the first， the second and the third category indicators and the chosen encoding method of indicators are as follows as table 1, 2 and 3.

Table A1 Source and coding of the first category of indicators

Indicators	Sources disclosed in corporate reports	Content Analysis Coding
1.Direct (Scope1) GHG emissions	Forms or content statements	Direct GHG/Scope1 emissions amount/emissions from company-owned or controlled sources (CCA, 2006)
2.Indirect (Scope2) GHG emissions	Forms or content statements	Indirect GHG/Scope2 emissions amount/emissions from purchased electricity, consumed in owned or controlled equipment or operations (CCA, 2006)
3.Excluded emission (estimation)	Forms or content statements	Excluded emission from companies other than scope 1/2/3/emission from the use of renewable fuels, considered to be net zero
4.State the reason of exclusion emission	content statements	Explanations for some emissions are too small to be ignored/difficult to account for
5.GHG emission intensity ratio	Forms or content statements	Emission per headcount/per turnover ect.
6.description of the methodology used to calculate GHG emission	content statements	methodology for calculating corporate GHG emissions
7.Comparative emission data from previous reporting	Forms or content statements	Comparable emissions from previous years
8.Reporting period covered	Forms or content statements	Description of the time period covered by the emissions data

Table A2 Source and coding of the second category of indicators

Indicators	Sources disclosed in corporate reports	Content Analysis Coding
1.Global energy use	Forms or content statements	Basic global energy use used to calculate GHG emissions
2.Energy efficiency actions	content statements	Adopting fuel management, updating technology, energy-saving transportation vehicles, etc. to improve energy efficiency in operating business
3.Energy consumption and GHG emission in UK	Forms or content statements	Separate UK emissions and energy consumption

Table A3 Source and coding of the third category of indicators

Indicators	Sources disclosed in corporate reports	Content Analysis Coding
1.Sustainability committee	content statements	company has established a sustainability committee
2.GHG policy statement	content statements	A clear statement of sustainability or GHG policy regarding business operations
3.Commitment to external initiatives	content statements	Clear commitment to external initiatives, including various external initiatives to act on global warming
4.stakeholders engagement activities	content statements	Collaboration with stakeholders (including suppliers, the public) indicated in the report, such as training on emissions reduction, sharing information on GHG management, developing low-carbon supply chain procurement plans.
5.GHG management team/person responsible	Forms or content statements	The report shows that the company has a team dedicated to GHG management/an environmental management team involved in GHG management issues/set up special departments, groups, and leaders to manage environmental issues
6.Identification regulatory risk to climate change	content statements	Clearly demonstrate that the business recognizes institutional regulatory risks related to climate change and takes preventive measures
7.reporting guideline used in GHG reporting	content statements	The disclosure report clearly indicates that it refers to relevant guidance, such as DEFRA guidance.
8.Organizational boundary	content statements	The report identifies the organizational scope of GHG emissions, including financial controls (consolidating 100% of emissions into units it controls financially) and operational controls (consolidating 100% of emissions into units it controls operationally)
9.Regular internal calculation of GHG emissions	content statements	Reports the time a company devotes on a regular (monthly or quarterly) basis to collecting data on different types of GHG emissions by sector or region.
10.Regular external audits of GHG emissions	content statements	Reports contain periodic (quarterly or yearly) external calculations and statements of audits

		of the company’s GHG emissions
11.External assurance/Third party assurance statement	content statements	The report includes a separate audit report statement issued by a third-party auditor for the relevant emissions data or process
12.Existence external verification of quantity of GHG emission	content statements	Reporting includes external verification of GHG emissions
13.Disclosure of GHG emission by source (coal, electricity, etc.)	Forms or content statements	Report identifies detailed sources and amount of GHG emissions, including coal, electricity, etc.
14.Disclosure of GHG emission based on market or location	Forms or content statements	Report identifies the relevant emissions based on the market or location
15.Historical base year selected and base-year GHG inventory	Forms or content statements	Report identifies a base year for the calculation and comparison of GHG disclosure data
16.Other indirect (Scope 3) GHG emission	Forms or content statements	emissions from other sources that the company does not own or control, such as business travel, external distribution, supply chains (for example, mining and production of purchased fuels and materials) or the use/disposal of the company’s products and services (CCA,2006)
17.Total gross emission	Forms or content statements	Report identifies a total sum of all GHG emissions
18.Reduction/increase of GHG emission	Forms or content statements	Report identifies the reduction or increase in GHG emissions in the current year compared to the previous year
19.Emission of ozone-depleting substances	Forms or content statements	Report identifies ozone-depleting substances emission
20.Emission of Nitrogen oxides , sulfur oxides, and other significant air emissions	Forms or content statements	Report identifies nitrogen oxides, sulfur oxides, and other significant air emissions
21.Carbon offsetting	content statements	Report identifies companies offset carbon emissions by planting trees or high-tech means
22.Green tariff	content statements	Report disclose green levies paid by companies
23.Base year emission data	Forms or content statements	Report includes GHG emissions for the GHG base year

24.Base intensity ratio for bunchmarking	Forms or content statements	Report includes GHG emission intensity ratio of the base year
25.Environmental fine	content statements	Report discloses environmental fine paid by companies
26.State and specify each scope	content statements	Report contains a detailed description of the GHG emissions (meaning, source) for each scope
27.Initiatives to reduce GHG emission	content statements	Report contains the company's Initiatives to reduce GHG emission
28. CEO and /or chairman statement	content statements	CEO and/or chairman statements highlighting views or opinions on emissions reductions or improvements
29.Vision and /or value and /or mission statement	content statements	Report contains the task of recognizing the importance of emission reduction and the future development of the company
30.GHG emission reduction strategies/details/action	content statements	Report discloses the clear energy-saving and emission-reduction plans or measures formulated by the enterprise to improve the performance of GHG emission reduction
31.Specification of GHG emission reduction target level and target year	content statements	Report contains target level and target year for GHG reductions
32.State the reason for intensity measurement indicators choice	content statements	Report contains the reason for the selection of the intensity measurement metric
33.State the reason for any significant changes in intensity measurement from the previous year	content statements	If there is a change in the selection of indicators, the enterprise shall explain the reason and process of the change in the report
34.State the conversion tools/emission factors used	content statements	Emissions need to be converted into a unified measurement unit for cumulative comparison, so companies state their chosen conversion factors in the report
35.State the reason for restated emission	content statements	Report explains recalculated data
36.State the reason for reduction emission	content statements	The report explains the reasons for the emission reduction this year compared with the previous year, including replacing related energy-saving equipment, reducing the use of vehicles, and closing stores
37.The use of SECR guidance	content statements	The report mentions that it refers to the SECR 2018 guidance

Appendix 2：Example collection of relevant indicators disclosed in the report of the sample company

According to the relevant indicators of the sample companies to be collected, some examples corresponding to the actual disclosure content in the enterprise report are found as follows. The relevant indicators disclosed in the report add one point to the disclosure content indicators of the enterprise.

Category 1-Disclosure required after implementation of MCR and before regulations 2018

According to the detailed introduction of MCR law in Chapter 2, after the implementation of regulations 2013, the law requires companies to make detailed disclosure of some emissions, including Scope 1, Scope 2, exclude emission and reason, method used to calculate the emission information, at least one ratio, previous years' emission, and report period. Therefore, I list these 6 items as the range of indicators after implementation of MCR and before regulations 2018. The explanations for each indicator are as follows.

(1) Direct (Scope 1) GHG emissions

Scope 1 emissions are emissions from company-owned or controlled sources (including electricity generation, heat or steam, physical or chemical processing, company-owned/controlled vehicle transportation, no stationary emissions). (Climate Change Act, 2008).

Table B1: Example of direct GHG emissions comes from 2021 year annual report of Ssp plc:

Global GHG emission and energy use data	Current reporting year 2020-2021		Comparison reporting year 2019-2020		Comparison reporting year 2018-2019	
	UK and offshore	Global (excluding UK and offshore)	UK and offshore	Global (excluding UK and offshore)	UK and offshore	Global (excluding UK and offshore)
Emissions from which activities the company own or control including combustion of fuel and operation of facilities (Scope1)(tCO2e)	528	6194	1311	8326	2012	11241

(2) Indirect (Scope 2) GHG emissions

Scope 2 emissions are emissions from purchased electricity, consumed in owned or controlled equipment or operations (Climate Change Act, 2008).

Table B2: Example of indirect (Scope 2) GHG emissions comes from 2021 year annual report of Ssp plc：

Global GHG emission and energy use data	Current reporting year 2021-21		Comparison reporting year 2019-2020		Comparison reporting year 2018-2019	
	UK and offshore	Global (excluding UK and offshore)	UK and offshore	Global (excluding UK and offshore)	UK and offshore	Global (excluding UK and offshore)
Emissions from purchase of electricity, heat, steam and cooling purchased for own use (Scope 2) (tCO2e)	4835	37496	8999	62553	12732	89400

(3) Excluded emission (estimation)

Excluded emission refers to the exclusion of other GHG emissions from companies other than scope 1, 2, and 3, which may result from the use of renewable fuels, considered to be net zero.

Table B3: Example of excluded emission from COUNTRYSIDE PROPERTIES PLC 2021 annual report：

Total outside scopes	2021	2020	2019
Biodiesel CO2e (tonnes)	104	n/a	n/a

(4) State the reason of exclusion emission

This indicator mainly provides relevant explanations for excluded emissions, including some emissions are too small to be ignored or difficult to account for.

Example comes from 2021 annual report of CINEWORLD GROUP PLC: As refrigerant use generates no kWh, this has been omitted.

(5) Description of the methodology used to calculate GHG emission

The report points out the methodology for calculating corporate GHG emissions. Companies need to select certain calculation methods when calculating greenhouse gas emission data. Different calculation methods may produce different results. Generally, companies will choose the same method to calculate related emissions, which is conducive to data comparison.

Example comes from 2021 annual report of SSP: Methodology: We have followed the GHG Reporting Protocol – Corporate Standard (2015 revised edition) and our reporting is consistent with the Environmental Reporting Guidelines: Including streamlined energy and carbon reporting guidance (March 2019).

(6) GHG emission intensity ratio

This indicator refers to the disclosure of the GHG emission intensity ratio in the company's report.

Table B4: Example of GHG emission intensity ratio from 2020 annual report of 888 holdings Plc：

Corporate metric	Ratio performance indicators (per Scope 1 and Scope 2)	
Emission per headcount	2.00	tCO2e/employee
Emission per square metres area of offices	0.17	tCO2e/m2 office area
Emissions per turnover	3.94	tCO2e/M US $

(7) Comparative emission data from previous reporting

The disclosure of GHG in corporate reports includes not only the amount of emissions in the current year, but also data from previous years, so that report users or company management can clearly see the changes in emissions in the current year.

Table B5: Example of carbon emission from Annual Report and Accounts 2020 of AO World Plc：

Carbon emission(tonnes of CO2e)	FY20	FY19
Emission from operations and combustion of fuel(Scope 1)	26587	25836
Emission from energy usage(Scope 2)	3679	3887
Total	30266	29723

(8) Reporting period covered

The time period for which the business collected the calculated GHG is indicated in the report. When companies disclose GHG, they will select a certain period of time, which can help managers and external users to understand the GHG in which period of time when emission data refers. This also helps accountants to collect relevant data and define emission time intervals and compare emission amount.

Examples from 2021 annual report of SSP Plc: Global GHG emissions and energy use data for period 1 October 2020 to 30 September 2021.

Category 2 - Disclosure required after the implementation of regulations 2018

Following the implementation of regulations 2018, in addition to the 2013 law requiring companies to make disclosures about some emissions, three additional indicators have been added that require mandatory disclosure, including global energy use, energy efficiency actions and UK energy consumption and emission. Therefore, I list these 3 items as the indicator categories of Disclosure required after the implementation of regulations 2018. The explanations for each indicator are as follows.

(1) Global energy use

Basic global energy use used to calculate GHG emissions, including prior year figures (in the first year, no previous numbers)

Table B6: Example of energy use from Annual Report and Accounts 2020 of AO World Plc:

Energy use kWh (Scope 1 and 2)	FY20
UK	14573240
Global(excluding UK)	3047216

(2) Energy efficiency actions

Companies report on energy efficiency actions they took during the reporting year.

Example from Annual Report and Accounts 2020 of AO World Plc: We aim to run our operations with a strong focus on environmental impact, fuel management and operational efficiency, and constantly seek at both a corporate and local level to help improve our performance in all areas. In order to drive

energy efficiencies: our home delivery fleet comprises 3.5 tonne “Hi-Cube” trucks – these trucks are light and have a greater space and weight capacity...

(3) Energy consumption and emission related to UK

The report includes UK-related GHG emissions and energy use.

Table B7: Example of energy consumption and emission related to UK from 2021 annual report of CINEWORLD GROUP PLC:

2021 Scope1 and 2 emission (tonnes CO2e) & consumption (kWh) by territory

Territory	Scope	tCO2e	kWh
UK	1	2659	9162454
Global		28750	114296556
UK	2	9264	43630907
Global		135760	390871162
Total		176433	557961079

Category 3-Voluntary Disclosure

Beyond the mandatory disclosure of emissions, the law gives companies a large degree of discretion. The relevant guidance provides guidance on what companies can disclose. Therefore, in this study, I mainly refer to the disclosure guidelines for British companies and related literature to summarize 37 indicators. It includes qualitative indicators, such as the governance and participation of listed companies on GHG emissions, the relevant guidelines they follow, GHG management commitments, relevant active measures taken, and reasons for reducing emissions, etc. It also includes quantitative indicators, such as other indirect (scope 3) GHG emission, emission of ozone-depleting substances, environmental fine and so on. The main purpose of the selection of voluntary disclosure indicators is to judge whether companies comply with relevant policies and regulations when making disclosures, whether they attach importance to emission reduction and energy conservation, pay attention to climate change and their commitment to continuous improvement. Each indicator

is explained in detail below.

(1) Sustainability committee

The report indicates that the company has established a sustainability committee. Sustainability committees help companies manage issues related to environmental change, especially consultation and advice (De Villiers et al., 2011). The establishment of a special large-scale sustainable development committee can promote enterprises to fulfill their greenhouse gas emission reduction responsibilities more effectively, and at the same time help enterprises to better deal with interests and conflicts related to the environment and GHG issues. In view of the complexity and uncertainty of environmental issues, it is even more necessary for enterprises to establish relevant committees to communicate with other departments of the concept, and allocate sufficient financial resources, human resources, etc. to help the environmental development of enterprises. At the same time, it can better help enterprises to implement environmental initiatives. Sustainability management can be seen as central to a company's efforts to create social value, helping companies identify risks, manage, report, monitor, and audit environmental systems.

Example of setting up indicators for the sustainability committee: In the 2021 annual report of BHP group plc, the company has established a sustainability committee, which is responsible for overseeing and monitoring major HSEC (human rights, safety. environment and community) matters, Includes the adequacy of the Group HSEC Framework and HSEC Management System, as well as the Group HSEC Report and Performance, which includes existing areas such as climate risks and opportunities.

(2) Sustainability/GHG policy statement

Sustainability or GHG policy statements regarding business operations are clearly stated in the report. Sustainability policy disclosure and the promulgation and implementation of GHG policies may play an important role in a company's

entire environmental operating mechanism, including regulating processes, building frameworks, setting areas, and implementing guidance measures. The disclosure of this indicator can be used to reflect the importance and standardization of the enterprise's environmental management process.

Examples of disclosures for Sustainability Policy and GHG Policy Statements: As indicated in Reach plc's 2021 Annual Report, the Environmental Policy has been adopted by the Board which ensures that it is progressively implemented through a programme of annual targets and action plans. Progress against policy commitments is regularly audited, analyzed and reported, to ensure that environmental management system arrangements continually improve, and our environmental performance is enhanced.

(3) Commitment to external initiatives

Businesses explicitly commit to external initiatives in their reports. A growing number of initiatives are promoting and supporting companies to adopt an "outside-in" approach to setting business goals, including: The Science Based Targets initiative initiated by the Carbon Disclosure Project, World Resources Institute, World Wide Fund for Nature and the UN Global Compact. The aim of these initiatives is to develop tools and methodologies for companies to take action against the 1.5°C global warming target. Companies are therefore disclosing relevant commitments based on their chosen initiative on a case-by-case basis.

For example, Antofagasta plc's 2021 annual report showed that companies are concerned about environmental issues not only in fulfilling our commitments under the Environmental Qualifications Resolution and the Regulations, but also in implementing international sustainability guidelines. These include in Chile, where large projects undergo rigorous environmental and social impact assessments by the Environmental Assessment Agency to obtain an

Environmental Approval Decision. These RCAs include legally binding commitments related to project development, prevention and mitigation of the project's environmental impacts, and any necessary compensatory measures.

(4) Stakeholders engagement activities

Companies disclose in relevant reports that they cooperate with suppliers or other stakeholders. When enterprises implement sustainable measures to reduce environmental pollution, participating in some activities with external stakeholders can better help the company achieve relevant goals, better implement relevant activities, and improve overall GHG emission reduction performance. For example, companies develop a unified procurement plan for low-carbon supply chains, hold regular training on GHG reduction, and share some information about GHG management with the public and stakeholders, such as energy use, GHG management performance and experience, so as to jointly Efforts to reduce GHG emissions.

An example of this indicator is shown in the 2021 Annual Report of Mark & Spencer group Plc: "We have also introduced new propositions including our partnership with Hiretreet (the clothing hiring business), and our Sparking Change Challenge encouraging customers to live more sustainably by reducing food waste and exploring more plant-based protein. Bringing customers along on our sustainability journey is and will increasingly become vital; to ensure, alongside our own sustainability efforts, we are positively influencing the sustainability of our wider community."

(5) GHG management team/person responsible

The report indicates that the company has a team dedicated to GHG management or an environmental management team involved in GHG management issues. Similar to the establishment of a special department by an enterprise to manage environmental issues, the establishment of a special team and a special person in

charge can implement relevant responsibilities to the special person in charge, which can help the enterprise to better deal with related problems, and also reflects the importance of the enterprise to environmental issues.

An example of this indicator is disclosed in Reach plc's 2021 annual report: "environmental management in 2021 was overseen by the Corporate Social Responsibility (CSR) Steering Committee, chaired by the Chief Financial Officer. The Steering Committee had oversight of the targets and progress of the environmental programme, ensuring that it continues to deliver against the Environmental Policy objectives..."

(6) Identification regulatory risk to climate change

In disclosure reports, companies indicate that they identify risks of physical damage associated with climate change and take preventive measures. If climate change is not mitigated, extreme weather will create more serious physical risks to assets and supply chains. At the same time, policy actions to decarbonize the global economy are creating transition risks for companies and industries that cannot adapt. If poorly managed, both climate risks could lead to lower economic growth, with pervasive adverse effects on investment. Investors should not only know how climate change affects investments, but also recognize the impact of investments on climate. This dual significance means that investments are both affected by climate change and can play a role in addressing (or exacerbating) the climate crisis. Therefore, external stakeholders and professionals (such as portfolio managers, trustees, accountants) will also pay more attention to the disclosure of such information.

Examples from the 2021 annual reports of Reach plc:"We face physical and transitional risks and opportunities from climate change, and we are committed to assessing and mitigating risks that are critical to our business. We have incorporated an analysis of how climate change affects our individual businesses

into our business disruption plans at each site. The group's operations are primarily in the UK, including light manufacturing, office activities and business travel, and we believe the risks from climate change are relatively low. We review this as part of our annual risk review."

(7) Reporting guideline used in GHG reporting

Businesses clearly identify reference guidelines in their reports. The disclosures used in the reporting guidelines reflect that companies have adopted relevant standards and indicators for GHG disclosure in their reports, which are not only more standardized in content, but also more reliable and comparable in the disclosure process and data.

Example from 2021 annual report of REDDE NORTHGATE PLC: "This section incorporates the new requirements for reporting of GHG emissions, energy consumption and energy efficiency actions included in the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2018 (the Regulations). The Regulations build on the Mandatory Carbon Reporting requirements of the Companies Act 2006 (Strategic and Directors' Reports) Regulations 2013, applied in prior years."

(8) SECR guidance

Primarily disclosures for the latest SECR guidance. In order to judge the impact of the latest guidelines on enterprises, and to adopt the standards of relevant guidelines for disclosure, we can also see the importance and implementation of Aoba's latest mandatory laws, which are also indicators that are easy to measure and observe.

Example from 2021annual report of Ssp PLC:"SSP is required to report its global and UK energy use and carbon emissions in accordance with the Companies (Directors' Report) and Limited Liability Partnerships (Energy and Carbon

Report) Regulations 2018. The data detailed in these tables represent emissions and energy use for which the Company is responsible and is incorporated by reference in the Directors' Report."

(9) Organizational boundary

Standard ISO 14064-1 describes two consolidation modes used to determine the organizational scope for reporting GHG emissions:

The "share of capital" approach: the organization consolidates emissions for equipment and activities, equivalent to capital invested in the latter (equity share);

The "control" approach: either financial: the organization consolidates 100% of emissions for units which it controls financially, or operational: the organization consolidates 100% of emissions for units which it controls operationally (i.e. it operates).

the "operational control" approach - limited to sites where all equipment and activities are controlled by the subsidiaries of the company, and the associated emissions therefore must be consolidated.

An example of this indicator is indicated in 2021 ANNUAL REPORT of REDDE NORTHGATE PLC:"We have derived the emissions data presented using the operational control approach, required under the Companies (Directors' Report) and Limited Liability Partnerships (Energy and Carbon Report) Regulations 2018."

(10) Regular internal calculation of GHG emissions

The report discloses that companies regularly conduct internal calculations of greenhouse gas emissions. The regular calculation of GHG emissions within an enterprise refers to the labor time invested by the enterprise in the early stage to collect different types of GHG emission data from various departments or

regions on a monthly or quarterly basis. It not only helps corporate managers to verify relevant disclosure processes and data, but also represents the importance of companies on GHG emissions.

Examples of relevant companies' disclosure of this indicator are as follows, for example, HALMA PLC 2021 annual report contained the content "given the acquisitive nature of Halma, we expect to regularly recalculate our base year for the structural change trigger of acquisitions and disposals, and have chosen to apply an 'all-year' approach".

(11) Regular external audits of GHG emissions

The report includes a statement of periodic external calculations and audits of corporate GHG emissions. Implementing regular external audits of GHG emissions not only improves the credibility and accuracy of the data, but also increases the credibility of the entire disclosure. External audits include an objective and impartial review of their emissions data by relevant third parties, as well as a review of their integrated measurement conversion disclosure process.

Examples of companies that disclose this indicator in 2021 annual report of HILL & SMITH HLDGS PLC includes:"during the year we engaged an independent third party, Trident Utilities, to verify our emissions data using BEIS conversion factors. The validated Scope 1 and Scope 2 emissions data has been used to prepare our carbon reduction plan. We have also conducted a limited audit of our supply chain of the products considered in the Sustainable Products section of this report on page 38 to identify a Scope 3 start point."

(12) External assurance/Third party assurance statement

This reporting parameter refers to a third-party audit agency issuing a separate audit report statement for the relevant emissions data or process. It mainly includes the third-party monitoring report on environmental quality and the

corporate environmental audit report reviewed by the local government.

Examples from 2021 annual reports of CENTRICA PLC： "included in DNV Business Assurance Services UK Limited (DNV)'s independent limited assurance engagement using the International Standard on Assurance Engagements (ISAE) 3000 (Revised): 'Assurance Engagements Other Than Audits or Reviews of Historical Financial Information'. See page 242 or centrica.com/assurance for more."

(13) Existence external verification of quantity of GHG emission

This reporting parameter refers to the existence of a third-party audit agency to verify the company's relevant GHG emission data.

Examples from 2021annual report of ROTORK PLC:"Independent verification: Electricity, gas and GHG emissions data presented here has been independently verified by Make UK. "

(14) Disclosure of GHG emission by source(eg. coal, electricity, ets)

Companies report in detail the fuels and values of the various GHG they produce. This indicator mainly means that enterprises should identify the main sources of GHG emissions, and clearly identify the sources of GHG emissions, including the main GHG emission activities and their main types of GHG emissions.

Table B8: Example from 2021annual report of Cineworld group Plc:

Cineworld group Plc 2021emission (tonnes tCO2e)

Emission source	2020 tCO2e	2021 tCO2e
Electricity	212160	152948
Natural gas	42386	22147
Refrigerant	2459	8644
Transportation	712	618
Total emission(tCO2e)	257717	184357

(15) Disclosure of GHG emission by facility or segment level (based on market or location)

This indicator is a company's indication in the relevant report whether the company discloses the relevant emissions based on the market or location.

Table B9: Example from 2018 annual report of Marks & Spencer group Plc:

	2015/2016 000 tonnes	2013/2014 000 tonnes
Total gross/location-based emissions	566	567
Remaining market-based emission	266	265

(16) Historical base year selected and base-year GHG inventory

This indicator means that companies need to select a base year for the calculation and comparison of GHG disclosure data, which is conducive to the comparison of emission data and the setting of goals.

Example from 2021 annual report of CRODA INTERNATIONAL PLC:"Since 2018, our baseline year, our total scope 1 and 2 greenhouse gas (GHG) emissions have reduced by 12.7%".

(17) Other indirect (Scope 3) GHG emission

Scope 3 emissions are emissions from other sources that the company does not own or control, such as business travel, external distribution, supply chains (for example, mining and production of purchased fuels and materials) or the use/disposal of the company's products and services" (Climate Change Act,2006).

Table B10: Example from 2021annual report of Countryside properties Plc:

Scope3	2021	2021	2019
Total Scope 3 CO2e(tonnes)	839	25	35

(18) Total gross emission

Total gross emission refers to a total sum of all GHG emissions made by an enterprise when calculating GHG.

Table B11: Example from 2021 annual report of Ssp plc:

Global GHG emission and energy use data	Current reporting year 2020-2021		Comparison reporting year 2019-2020		Comparison reporting year 2018-2019	
	UK and offshore	Global(excluding UK and offshore)	UK and offshore	Global(excluding UK and offshore)	UK and offshore	Global(excluding UK and offshore)
Total gross Scope 1 and Scope 2 emissions (tCO2e)	5363	43690	10310	70897	14744	100641

(19) Reduction/increase of GHG emission

Companies report in their reports the reduction or increase in GHG emissions in the current year compared to the previous year.

Example from 2021 annual report of Clarkson Plc: “Overall, on a location basis, our emissions were 3,014 tCO2e, which is down 68% on 2019 and slightly lower than 2020 (10%).”

(20) Emission of ozone-depleting substances, Nitrogen oxides, sulfur oxides , and other significant air emissions

Disclosure of ozone-depleting substances, Nitrogen oxides, sulfur oxides, and other significant air emissions in corporate reports.

Table B12: Example of thermal generation emissions to air by fuel typefrom 2021 annual report of Drax group Plc:

	Unit	2020	2019
Biomass generation			
Nitrogen oxides	t	6971	7104
Sulphur dioxide	t	1806	986
Particulates	t	419	415

(21) Carbon offsetting

The report shows that companies offset carbon dioxide emissions by planting trees or high-tech means.

Example from 2016 annual report of Marks & Spencer group Plc: The conservation and offset of 11,000 ha of forest will capture an estimated 25,000 tonnes of CO2 equivalent per year.

(22) Green tariff

In the Climate Change Levy (CCL) Act, the government imposes certain tariffs on energy, and through energy tariffs, it hopes to reduce energy use to a certain extent and help build a greener, cleaner, and healthier world. Therefore, according to the government system, some enterprises will also disclose the green levy they pay, which can also reflect the degree of participation of enterprises in reducing greenhouse gas emissions.

Table B13: Example from 2016 annual report of Marks & Spencer group Plc:

	2015/2016 000 tonnes	2013/2014 000 tonnes	% change
Green tariffs and bio-methane procured	299	302	-1

(23) Base year emission data

The report contains the disclosure of the value of the GHG base year.

Examples from 2021 annual reports of Centrica Plc: FY21/22 Production output is 333,260 tonnes. In the event of future changes in operating infrastructure through acquisitions or divestments the FY20/21 baseline will be recalculated to allow a consistent comparison of performance.

(24) Base intensity ratio for bunchmarking

Businesses disclose their base year intensity ratio in their reports.

Table B14: Example of base intensity ratio from 2020 annual report of Rentokil Initial plc:

Intensity indicator	2020	2019	2018	2016 (baseline year)
Index of energy and fuel derived CO2 emission at constant exchange rate	77.55	84.37	84.89	100

(25) Environmental fine

The report disclosed by the company includes the corresponding fines for the impact on the environment, and in some cases, the amount is stated and explained.

Example from 2016 annual report of JOHNSON MATTHEY PLC: During 2015/16 no significant spillages to the environment of raw materials, intermediates or products have been reported by the group and there were no significant fines or non-monetary sanctions for non-compliance with environmental laws and regulations in the year.

(26) State and specify each scope

The company's report contains a detailed explanation of the GHG emissions from each scope. Include the meaning, source, and scope of emissions associated with the company for each emission.

Example from 2021 annual report of Reach Plc: Scope 1 covers the annual quantity of emissions in tonnes of carbon dioxide equivalent from emission sources that are under the operational control of Reach.

(27) Initiatives to reduce GHG emission

In order to reduce greenhouse gas emissions, enterprises will put forward relevant initiatives in the report, on the one hand, it reflects the strong willingness of enterprises to participate in relevant emission reduction activities and measures, and on the other hand, in order to better implement the next measures.

Example from 2021 annual report of Clark plc：“Our energy efficiency initiatives: We recognise that our operations have an environmental impact, and we are committed to monitoring and minimising our emissions year on year. In the period covered by this report, the Company has undertaken the following emissions and energy reduction initiatives:

– Continued replacement of fluorescent strip lighting with LED lighting in our London office.

– Increased use of technology to enable online meetings.”

(28) CEO and /or chairman statement

As senior managers and decision-makers, CEOs and chairmen need to emphasize the importance of climate change in their statements. The statement will include the company’s efforts to reduce greenhouse gas emissions and the effectiveness of emission reductions, as well as the implementation of certain policies or initiatives. The wide-ranging impacts of climate change mean that it is changing the entire environment in which global business and investment operate. This makes climate an issue of strategic importance, requiring the attention of the top leadership of the board and management. Although many institutions have already established governance structures and processes related to environmental

issues, these structures and processes usually focus on the compliance of investment objects under traditional environmental regulation. Addressing climate as a tactical issue and adjusting governance to address it is relatively new: more than 75% of PRI signatories now require specific board members, committees or specific managers to be responsible for climate-related oversight.

Example from 2021 sustainability report of Anglo American PLC: Chairman statement showed that we added to these targets in the year by committing to being carbon neutral across the operations by 2040, and roughly a third of the business by 2030, by which time we also aim to have made a 30% improvement in energy efficiency, ... a 30% absolute reduction in greenhouse gas emissions.

(29) Vision and /or value and /or mission statement

In related reports, companies disclose their attitudes about GHG reduction, realize its importance and regard it as an important task in the future development of the company.

Example from 2021 annual report of reach plc: “We recognise the increasing importance of climate change triggered by GHG from burning fossil fuels which poses a threat to the whole of humanity and continue our journey to reduce our environmental impact.”

(30) GHG emission reduction strategies /details /action

In the report, the enterprise discloses that in order to improve the performance of GHG emission reduction, it has formulated clear energy conservation and emission reduction plans or measures for GHG emissions in its business activities, including the coverage of the emission reduction plans or measures, specific methods, etc.

Example from 2021 annual report of the SSG Enterprise: As part of developing

the roadmap, we will consider additional measures including: – Increasing the use of renewable energy – Upgrading equipment for more efficient, low-carbon-intensive alternatives...

(31) Specification of GHG emission reduction target level and target year

Businesses should set annual GHG reduction targets and commit to continuous improvement. This includes setting firm year-specific targets, committing to science-based emission reduction targets, and how much reductions need to be achieved.

Example from 2021 annual report of the SSG Enterprise: “Our Scope 1, 2 and 3 net-zero emissions to help limit global warming to 1.5°C by 2040...Over the next year, set science-based goals based on the 1.5-degree assumption; and develop a roadmap of how we will achieve those goals.”

(32) State the reason for intensity measurement indicators choice

The reason for the selection of the intensity measurement indicators is stated in the report, which is a detailed statement of the selection process of the GHG reporting indicators, indicating that the company adopts an objective, responsible and evidence-based way to calculate its data.

Example from 2021 annual report of Rank group Plc: For purposes of baselining and ongoing comparison, it is required to express the GHG emissions using a carbon intensity metric. The intensity metric chosen is £m revenue.

(33) State the reason for any significant changes in intensity measurement from the previous year

There may be changes in the selection of indicators, and companies need to explain the reasons and processes for their changes.

Example from 2020 annual report of Capital PLC: “Total gross tonnes of CO2e/£1m revenue (location-based) in 2020 has been calculated using unadjusted revenue. In 2019 and 2018, adjusted revenue has been used.”

(34) State the conversion tools/emission factors used

The amount of emissions needs to be converted into a unified measurement unit for totalization and comparison, so the conversion factor selected is also very important. Different conversion factors may result in different data. The detailed description of the conversion tool by the enterprise is helpful for users to compare the data.

Example from 2021annual report of Cineworld group Plc: Emissions have been calculated using the 2021 conversion factors provided by The Department for Business, Energy and Industrial Strategy (“DBEIS”) for the UK, the 2020 factors provided by the Association of Issuing Bodies (“AIB”) for European countries and the 2020 factors from the United States Environmental Protection Agency (“EPA”) for the US. The US emissions have this year been reported by state for the first time; previously the aggregated emissions factor for the US was used.

(35) State the reason for restated emission

Recalculation of data in the report requires an explanation. Many reports indicate that data analyzed in previous years need to be recalculated, which may include emissions from consolidated companies, different measurement standards, or errors that need to be corrected, which need to be explained.

Example from 2021 annual report of Renishaw: 2020 figures have been restated due to improvements in our methodology, the addition of employee commuting and home working emissions and replacing the calculation used for the June 2020 data.

(36) State the reason for reduction emission

The company provides a detailed description of the emission reduction in the current year compared to the previous year, including the replacement of relevant energy-saving equipment, the reduction of the use of transportation vehicles, the closure of stores, and so on.

Example from 2021 annual report of SSP Plc: Efficiency measures: We have again seen a significant reduction in our overall GHG emissions over the last year as many of our units were closed for all or part of the year.

(37) The use of SECR guidance

It is mainly aimed at the publication of the latest guidelines. In order to judge the impact of the latest laws on enterprises, and to adopt the standards of relevant guidelines for disclosure, it can also show the importance and implementation of the latest mandatory laws by enterprises.

Example from 2021 annual report of Ssp Plc: SSP is required to report its global and UK energy use and carbon emissions in accordance with the Companies (Directors' Report) and Limited Liability Partnerships (Energy and Carbon Report) Regulations 2018. The data detailed in these tables represent emissions and energy use for which the Company is responsible and is incorporated by reference in the Directors' Report.