

**CAPITAL UNIVERSITY OF SCIENCE AND
TECHNOLOGY, ISLAMABAD**



**Exploring the Relationship Between Corporate
Green Accounting and Carbon Emission
Disclosure: A Case of Pakistani Firms**

by

Soban Haider

A thesis submitted in partial fulfillment for the
degree of Master of Science

in the

**Faculty of Management and Social Sciences
Department of Accounting and Finance**

2026

Copyright © 2026 by Soban Haider

All rights reserved. No part of this thesis may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, by any information storage and retrieval system without the prior written permission of the author.



CERTIFICATE OF APPROVAL

Exploring the Relationship Between Corporate Green Accounting and Carbon Emission Disclosure: A Case of Pakistani Firms

by

Soban Haider

(MAF251003)

THESIS EXAMINING COMMITTEE

S. No.	Examiner	Name	Organization
(a)	External Examiner	Dr. Muhammad Imran Nazir	Bahria Uni., Islamabad
(b)	Internal Examiner	Dr. Imran Riaz Malik	CUST, Islamabad

Dr. Iftikhar Ali Janjua

Thesis Supervisor

October, 2026

Dr. Jaleel Ahmed Malik

Head

Dept. of Accounting and Finance

October, 2026

Dr. Arshad Hassan

Dean

Faculty of Management & Social Sci.

October, 2026

Author's Declaration

I, **Soban Haider** hereby state that my MS thesis titled “**Exploring the Relationship Between Corporate Green Accounting and Carbon Emission Disclosure: A Case of Pakistani Firms**” is my own work and has not been submitted previously by me for taking any degree from Capital University of Science and Technology, Islamabad or anywhere else in the country/abroad.

At any time if my statement is found to be incorrect even after my graduation, the University has the right to withdraw my MS Degree.



(**Soban Haider**)

Registration No: MAF251003

Plagiarism Undertaking

I solemnly declare that research work presented in this thesis titled “**Exploring the Relationship Between Corporate Green Accounting and Carbon Emission Disclosure: A Case of Pakistani Firms**” is solely my research work with no significant contribution from any other person. Small contribution/help wherever taken has been duly acknowledged and that complete thesis has been written by me.

I understand the zero tolerance policy of the HEC and Capital University of Science and Technology towards plagiarism. Therefore, I as an author of the above titled thesis declare that no portion of my thesis has been plagiarized and any material used as reference is properly referred/cited.

I undertake that if I am found guilty of any formal plagiarism in the above titled thesis even after award of MS Degree, the University reserves the right to withdraw/revoke my MS degree and that HEC and the University have the right to publish my name on the HEC/University website on which names of students are placed who submitted plagiarized work.



(Soban Haider)

Registration No: MAF251003

Acknowledgement

All praise is due to **Allah (SWT)**, the Most Gracious and the Most Merciful, whose blessings and guidance made this journey possible. Peace and blessings be upon the Holy Prophet **Muhammad (PBUH)**, whose life remains the greatest source of inspiration.

I would like to express my deepest gratitude to my supervisor, **Dr. Iftikhar Ali Janjua**, for his invaluable guidance, scholarly insight, and unwavering support throughout this research. His constructive feedback, patience, and encouragement were instrumental in shaping this thesis into its final form. I consider myself truly fortunate to have worked under his supervision.

I am also grateful to the faculty and staff of the **Department of Management Sciences, Capital University of Science and Technology (CUST), Islamabad**, for providing an intellectually stimulating environment and the resources necessary to conduct this research.

My heartfelt thanks go to my **parents**, whose prayers, sacrifices, and unconditional love have been my greatest strength. Every milestone I achieve is a reflection of their devotion and belief in me. Words are insufficient to express what they mean to me.

I am equally thankful to my **siblings and friends** for their moral support, encouragement, and for being a constant source of motivation during the most challenging phases of this journey.

(Soban Haider)

Abstract

While environmental accountability is a key issue for companies in the emerging economies, the extent to which the internal environmental accounting of a company is correlated with the extent of carbon information disclosure is not known. The current study is on the link between the corporate green accounting (GA) and carbon emission disclosure (CED) of the Pakistani listed companies. A balanced panel of 30 firms listed on the Pakistan Stock Exchange (PSX) from five pollution-intensive sectors (cement, chemical & fertilizer, energy, steel & textile) is used from 2020 - 2025 (180 firm-year observations), where both constructions are measured with binary disclosure indices created by conducting content analysis on the annual and sustainability reports; the control variables are firm size and leverage. Comparisons of pooled OLS, fixed-effects and random-effects estimators are performed with the pooling F, Breusch–Pagan LM and Hausman tests, and the inferences are investigated under conventional, firm-clustered, wild-cluster-bootstrap and Driscoll–Kraay standard errors. The association between GA and CED is positive in the baseline fixed-effects model ($\beta = 0.160$, $p = 0.011$ with Driscoll–Kraay errors), while firm size is always a positive predictor of disclosure. This result is supported by robustness and endogeneity tests. The cross-firm association is still significant following the inclusion of year effects ($\beta = 0.29$, $p < 0.01$), as well as the application of small-sample clustered inference ($p = 0.33$); however, the within-firm coefficient is not statistically significant. Lagged green accounting has nothing to predict later disclosure; past disclosure has nothing to predict later green accounting; instrumental-variable estimates are uninformative because instruments are weak. The evidence thus indicates a very strong positive relationship between green accounting and carbon disclosure, but not a direct relationship between the two in the firm. The study provides firm-level panel evidence for Pakistan to add to the literature on disclosure reporting, as sustainability reporting is being introduced from voluntary guidelines to mandatory reporting based on IFRS S1/S2, and illustrates the impact of estimator choice and inference on disclosure research findings. The results are applicable to managers, investors and regulators who are preparing for that transition.

JEL Classification: M41, M14, Q54, Q56, C23.

Keywords: Green accounting, carbon emission disclosure, sustainability, environmental reporting, Pakistani firms, panel data, Legitimacy Theory.

Contents

Author's Declaration	iii
Plagiarism Undertaking	iv
Acknowledgement	v
Abstract	vi
List of Figures	xii
List of Tables	xiii
Abbreviations	xiv
1 Introduction	1
1.1 Background of the Study	1
1.1.1 Global Context of Environmental Reporting	2
1.1.2 Regulatory Environment for Environmental Disclosure in Pakistan	3
1.1.3 Sustainability Standards	5
1.1.4 Economic Sustainability Standards	5
1.2 Theoretical Framework	6
1.2.1 Legitimacy Theory	6
1.2.2 Use of the Legitimacy Theory for This Study	6
1.2.3 Supporting Literature	8
1.2.4 Boundary Conditions of Legitimacy Theory	8
1.3 Research Gaps	9
1.4 Problem Statement	10
1.5 Research Question	10
1.6 Research Objective	11
1.7 Significance of the Study	11
1.8 Scope of the Study	13
1.9 Operational Definitions	13
1.10 Organization of the Study	13
1.11 Chapter Summary	14

2	Literature Review	15
2.1	Introduction	15
2.2	Corporate Green Accounting	15
2.2.1	Historical Evolution of Green Accounting	16
2.3	Carbon Emission Disclosure	17
2.3.1	Measurement Approaches to Carbon Disclosure in Prior Literature	18
2.4	Relationship between Green Accounting and Carbon Emission Disclosure	19
2.5	Firm Size and Environmental Disclosure	20
2.6	Leverage and Environmental Disclosure	21
2.7	Supporting Theoretical Perspectives	22
2.7.1	Stakeholder Theory	22
2.7.2	Institutional Theory	22
2.7.3	Agency Theory View on Disclosure	23
2.7.4	Brief Overview of the Four Theoretical Perspectives	23
2.8	Empirical Evidence from Asian and Emerging Markets	24
2.9	Hypothesis Development	26
2.10	Research Hypothesis	27
2.11	Conceptual Framework	27
2.12	Chapter Summary	30
3	Research Methodology	31
3.1	Research Approach	31
3.1.1	Philosophical Positioning	31
3.2	Research Design	32
3.3	Population and Sample	32
3.3.1	Population	32
3.3.2	Sample	33
3.4	Data Collection Method	33
3.4.1	Specific Data Sources by Variable	34
3.5	Study Variables	36
3.5.1	Independent Variable: Corporate Green Accounting	36
3.5.2	Dependent Variable: Carbon Emission Disclosure	37
3.6	Measurement of Variables	38
3.6.1	Measurement of Corporate Green Accounting	38
3.6.2	Measurement of Carbon Emission Disclosure	38
3.6.3	Worked Example of Index Calculation	39
3.7	Control Variables	39
3.7.1	Firm Size	39
3.7.2	Leverage	40
3.8	Model Equation	40
3.9	Data Analysis Technique	41
3.9.1	Descriptive Statistics	41

3.9.2	Correlation Analysis	41
3.9.3	Panel-Data Regression Analysis	41
3.9.4	Model Selection Tests	42
3.9.5	Diagnostic Testing	42
3.9.6	Robust Standard Error Correction	43
3.9.7	Statistical Significance Threshold	43
3.10	Ethical Considerations	44
3.11	Data Screening and Panel Balance	44
3.12	Reliability and Validity of Measurement	45
3.13	Chapter Summary	46
4	Results and Analysis	47
4.1	Overview	47
4.2	Descriptive Statistics	47
4.3	Distribution of Disclosure Scores	49
4.4	Between-Sector Variation	50
4.5	Correlation Analysis	50
4.6	Model Specification	51
4.7	Pooled OLS, Fixed Effects, and Random Effects Results	52
4.8	Model Selection: Pooled OLS vs. Fixed Effects vs. Random Effects	53
4.8.1	Why Model Selection Matters for This Study's Conclusions	53
4.9	Diagnostic Testing	55
4.10	Robust Standard Error Correction: Driscoll-Kraay	56
4.11	Endogeneity	57
4.12	Interpretation of Final Results	61
4.13	Hypothesis Testing Summary	62
4.14	Chapter Summary	63
5	Discussion and Conclusion	65
5.1	Introduction	65
5.2	Discussion of Findings	65
5.2.1	Green Accounting and Carbon Emission Disclosure	65
5.2.2	Firm Size	67
5.2.3	Leverage	68
5.2.4	Sector-Level Patterns	68
5.2.5	Reconciling with International Evidence	69
5.3	Conclusion	70
5.4	Theoretical Implications	71
5.5	Practical Implications	72
5.5.1	Implications for Corporate Managers	72
5.5.2	Implications for Investors	73
5.5.3	Implications for Policymakers and Regulators	73
5.5.4	Implications for Accounting Standard-Setters and the Accounting Profession	73

5.5.5	Consequences for Civil Society and Environmental Advocacy Groups	74
5.6	Limitations of the Study	74
5.7	Recommendations	76
5.7.1	Recommendations for Corporate Practice	76
5.7.2	Recommendations for Policy	76
5.7.3	Recommendations for Future Research	76
5.7.4	A Note on Priority Among Recommendations	78
5.8	Concluding Remarks	78
5.9	Chapter Summary	79
Bibliography		81
Appendix A		83

List of Figures

2.1	Conceptual model of the study.	28
-----	--	----

List of Tables

2.1	Theoretical Perspectives, Their Roles, and Expected Relationships .	25
2.2	Summary of Selected Prior Studies	29
3.1	Sample Composition by Sector	34
3.2	Data Sources and Documents Used for Each Variable	35
3.3	Regulatory and Institutional Developments During the Study Period	36
3.4	Description of Variables	37
3.5	Worked Example of Index Calculation for One Firm-Year	39
4.1	Descriptive Statistics	48
4.2	Mean Disclosure Levels by Sector	49
4.3	Pearson Correlation Matrix	51
4.4	Pooled OLS, Fixed Effects, and Random Effects Results (Depen- dent Variable: CED Score)	52
4.5	Panel-Data Model Selection Tests	55
4.6	Diagnostic Test Results (Fixed Effects Model)	55
4.7	Fixed Effects Model — Comparison of Standard Error Specifications	56
4.8	Endogeneity and Robustness Tests – Coefficient on Green Account- ing Score	60
4.9	Summary of Hypothesis Testing	63
1	List of Sample Firms	83
2	Disclosure Checklist	85

Abbreviations

BP	Breusch-Pagan (test)
CED	Carbon Emission Disclosure
ESG	Environmental, Social, and Governance
FE	Fixed Effects
FS	Firm Size
GA	Corporate Green Accounting
GRI	Global Reporting Initiative
HC1	Heteroskedasticity-Consistent Standard Errors (type 1)
IFRS	International Financial Reporting Standards
LEV	Leverage
OLS	Ordinary Least Squares
PSX	Pakistan Stock Exchange
RE	Random Effects
SASB	Sustainability Accounting Standards Board
SECP	Securities and Exchange Commission of Pakistan
VIF	Variance Inflation Factor

Chapter 1

Introduction

1.1 Background of the Study

Climate change, global warming, pollution, and an increase in carbon emission have now become some of the most pressing issues of the twenty first century. Industrial activity is a major contributor of environmental pollution with companies emitting greenhouse gases, industrial wastes and other pollutants during production activities ([Gray et al., 2001](#)). Stakeholders like shareholders, governments, regulators, customers and the broader community are increasingly demanding that companies operate sustainably and that they be truly environmentally responsible ([Suchman, 1995](#)). This expectation has, in turn, raised the profile of what is now becoming a legitimate academic and corporate interest in environmental accounting and sustainability reporting around the world. Corporate green accounting is a mechanism for firms to identify, quantify and report the environmental costs and benefits of their activities. ([Gonzalez and Peña-Vinces, 2023](#)) states that establishing a structured green accounting system helps companies to make the environmental impact of their operations visible in the accounting system and helps to develop long-term sustainability strategies. Although, in a similar vein, ([El Serafy, 1997](#)) stated that green accounting can also be used as a link between existing accounting systems and environmental protection, pollution costs and resource depletion impacts can be incorporated in the financial reporting process and not

just treated as an external effect. Carbon emission disclosure, which is the construct under study, is limited to the disclosure of information on greenhouse gas emissions, carbon-reduction goals, climate-related risks, and environmental management in general. (Dharma et al., 2024) conclude that "better carbon emissions disclosure leads to increased transparency in corporate environmental performance and permits external stakeholders to assess companies on an informed base".

In Pakistan, the production of heavy industries like cement, textile, energy, chemical and steel industries are major sources of environmental pollution and greenhouse gas emissions. However, the practice of environmental reporting is still quite low in the Pakistani listed companies, and disclosure of carbon emissions is still low compared to more developed capital markets (O'Donovan, 2002).

This both practically and academically raises the question of the relationship between internal environmental accounting practices and external environmental disclosure by firms in weak accounting enforcement environment like Pakistan in emerging markets. This study addresses this need through an empirical study of the relationship between corporate green accounting (GA) and carbon emission disclosure (CED) of firms listed on the Pakistan Stock Exchange (PSX).

Analysis is based on a panel data of 30 firms in five highly polluting sectors (Cement, Chemical, Energy, Steel, Textile) for the five-year period from 2020 to 2025. To control for firm size and leverage, both are included as control variables as suggested in the previous environmental disclosure literature (Clarkson et al., 2008) & (Hahn and Kühnen, 2013), because both are found to have a direct influence on the amount of disclosure made by companies.

1.1.1 Global Context of Environmental Reporting

Environmental and sustainability reporting has come a long way in the last 30 years, globally, from mostly voluntary and narrative reporting in the 1990s to more structured, standardized and in some jurisdictions required reporting frameworks.

There is an emerging international consensus of what constitutes effective environmental and climate-related disclosure, which has been informed by international

bodies including the Global Reporting Initiative (GRI), the International Sustainability Standards Board (ISSB) and the Task Force on Climate-related Financial Disclosures (TCFD). In developed markets such as the European Union (EU) and the United Kingdom (UK), there are initiatives aimed at encouraging the disclosure of carbon and environmental data, including the EU's Corporate Sustainability Reporting Directive (CSRD) and the UK's Streamlined Energy and Carbon Reporting (SECR).

The overall trend has been that emerging markets, including Pakistan, have generally been slower to follow the trend, by taking voluntary guidance ahead of the need for mandatory disclosure requirements.

The disclosure behaviour of Pakistani firms in the period of 2020-2025 is significant in the light of the global disclosure background which indicates that the disclosure activities observed during this period should be seen in the context of an ongoing process of institutional change in the disclosure norms prevailing in the world economy, rather than an unchanging environment.

In Pakistan, cement, textile, energy, chemical and steel are major sources of industrial energy use and greenhouse gas emissions. Cement alone accounted for about 49% of coal-related CO₂ emissions in 2018–19 (CREA, 2021), and energy and agriculture together account for roughly 89% of national greenhouse gas emissions (Mir et al., 2017).

Environmental and sustainability reporting by listed companies, however, remains uneven, largely compliance-driven and voluntary for most firms (Hongming et al., 2020; Abbasi et al., 2025), and mandatory climate-related reporting under IFRS S1 and S2 starts only for reporting periods beginning on or after 1 July 2025 (SECP, 2024).

1.1.2 Regulatory Environment for Environmental Disclosure in Pakistan

This section describes the regulatory environment for environmental disclosure in Pakistan, To have a good understanding of the relationship between green

accounting and carbon disclosure in Pakistan, it is necessary to have some understanding of the regulatory environment of PSX-listed companies. Over the years, the Securities and Exchange Commission of Pakistan (SECP) has made incremental efforts towards promoting the disclosure of environmental and sustainability issues through, among others, the provision of guidance to listed companies to report environmental, social and governance (ESG) issues in their annual reports. Unlike jurisdictions with carbon-reporting laws, however, environmental and carbon-related disclosure in Pakistan is at a fairly low level of disclosure and exhibits significant variation from company to company, and is likely to be more responsive to firm legitimacy pressures, firm ownership structure and management commitment than in a jurisdiction with mandatory, standardized disclosure requirements. Pakistan is also signatory to international climate commitments, such as Paris Agreement, and has presented the national commitments for reducing GHGs as part of its Nationally Determined Contributions (NDCs).

These commitments are not specific to individual firms, but rather are part of a broader institutional landscape in which disclosure of environmental performance and environmental-related matters are slowly emerging as a key focus of public debate and the expectations of internationally-oriented investors and lenders.

This changing regulatory and institutional landscape is reflected in the slight yet meaningful increase in disclosure scores for the average firm seen in the 2020-2024 sample compared to the 2020-2025 sample, as discussed in Section 5.2.4, and offers further context for the policy recommendations in Section 5.7.2.

Meanwhile, even the current voluntary guidance is not widely adhered to in comparison with developed markets and there has, so far, been no single mandatory framework to steer similar to, for instance, the UK's Streamlined Energy and Carbon Reporting (SECR) or the EU's Corporate Sustainability Reporting Directive (CSRD). The nature of the green accounting-carbon disclosure relationship identified in the current study, although statistically significant, is relatively low in economic magnitude, which may be due to the relatively permissive regulatory setting (as discussed in Chapter 5 under the discussion of practical and policy implications).

1.1.3 Sustainability Standards

These are related to minimizing the negative impact of business operations on the environment.

These standards will lead companies to regulate pollution, decrease carbon emissions, save natural resources, and manage wastes in a responsible way.

These standards address various climate change and environmental sustainability topics, such as carbon emission reduction, waste management, pollution control, energy efficiency, water conservation, and environmental reporting in general.

International frameworks relevant to the release of environmental disclosures are the environmental disclosure standards of the Global Reporting Initiative (GRI), the sustainability disclosure standards of the International Sustainability Standards Board (ISSB) and the International standard for Environmental Management Systems (ISO 14001).

All of these standards support companies in building their environmental responsibilities as well as their broader sustainability activities.

1.1.4 Economic Sustainability Standards

The economic sustainability standards are designed to practice the long-term financial sustainability of companies in order to favour a sustainable development, that companies can realize profits that are acceptable, without reducing the economic resources available to the subsequent periods.

Topics of discussion are long-term profitability, cost efficiency, sustainable investment, the management of resources, financial transparency and risk management.

Existing frameworks include the IFRS Sustainability Disclosure Standards (IFRS Foundation) and indicators for economic performance set by the Sustainability Accounting Standards Board (SASB). These standards assist companies in finding a balance between short term profit and sustainable development in the long term.

1.2 Theoretical Framework

1.2.1 Legitimacy Theory

This study is based on an idea of Legitimacy Theory originally put forward by (Dowling and Pfeffer, 1975). The theory is that organisations strive continually to reflect the values, expectations and norms of the society in which they operate. In order to survive and to be successful in the long term, a firm needs social approval, or “legitimacy.” A good reputation in society translates into trust and society’s acceptance of the company, while societal perception of company behaviour that is harmful to the environment or undermines its social responsibilities, means that society can criticize the company, that it is subject to regulatory attention and that it loses the trust of society. Accordingly, the Legitimacy Theory suggests that firms will try to sustain or restore their legitimacy by engaging in responsible actions (e.g., respecting the environment, sustainability reporting, transparent disclosure of information related to the use of carbon). In very basic terms, firms report environmental data, at least in part, because it conveys to society an image of being responsible and trustworthy.

1.2.2 Use of the Legitimacy Theory for This Study

Legitimacy Theory provides a reasoning for the likelihood of firms in Pakistan’s polluting industries (cement, textile, manufacturing, energy, chemicals) to have strengthened their green accounting practices and significantly enhanced carbon emission disclosure during the course of this study. They are under a constant pressure from government regulators, investors, customers, environmental agencies, and local communities, who all concern about the environmental performance of high-emitting companies. As a result, businesses have a strong incentive to defend their reputation and to ensure that the public can be convinced of their integrity and trustworthiness by enhancing the quality and completeness of their environmental reporting.

The independent variable of this study corporate green accounting indicates the degree to which a company recognizes, quantifies, and discloses environmental costs, including pollution-control spending, waste-management expenses, and expenses related to environmental compliance.

A company with a more advanced green accounting system, then, communicates implicitly that it is committed to environmental responsibility. The dependent variable, carbon emission disclosure, represents the degree to which a company discloses CO₂ emission levels, carbon reduction targets, climate risks and sustainability strategies to external stakeholders, thus enhancing transparency and corporate environmental responsibility.

The two activities meet the same underlying legitimacy-seeking function and, thus, support a proposition that green accounting systems that are more developed are more likely to provide more complete disclosure of carbon emissions, as Legitimacy Theory suggests.

The connection of Green Accounting and Carbon Emission Disclosure is introduced. The link between Green Accounting and Carbon Emission Disclosure are introduced. Corporate green accounting builds the internal measurement systems which companies need to monitor the costs of their environmental impacts and their sustainability performance. If the environmental spending and environmental activities have been recorded correctly in a firm, it will be much easier for the firm to report the information environmentally related to the firm that is the carbon-related information in its annual report and its sustainability report correctly and consistently. For instance, a company that tracks pollution control investments and carbon reduction cost is in a better position, as a side-benefit, to report on those costs externally. On the basis of this reasoning, there should be a direct, positive relationship between green accounting and carbon emission disclosure, with the better the internal green accounting system, the higher the quality of the carbon emission disclosure. The proposition is supported by the previous empirical studies that generally suggest that the more advanced an environmental accounting system is, the better the environmental and sustainability reporting ([Clarkson et al., 2008](#)) & ([Hahn and Kühnen, 2013](#)).

1.2.3 Supporting Literature

There are several lines of previous research that support the use of Legitimacy Theory in environmental reporting studies of this sort. (O'Donovan, 2002) discovered that corporations employ environmental disclosure to protect their corporate image and to try to maintain legitimacy in the face of environmental criticism.

More broadly, (Suchman, 1995) contended that legitimacy makes it easier for the organization to survive in the long term by being able to accommodate changing expectations of the organization's stakeholders. (Deegan et al., 2002) discovered empirical evidence that firms tend to disclose more of their environmental information when there is greater public pressure and/or scrutiny on them.

These studies are consistent with the argument that environmental reporting is not simply a legal or regulatory obligation but a strategic action that can be used to ensure social acceptance, making the concept of Legitimacy Theory particularly relevant to understanding the findings from the present study.

1.2.4 Boundary Conditions of Legitimacy Theory

Even though Legitimacy Theory has been heavily used in the environmental accounting literature, the theory has its critics and the capacity for explanation is not absolute. However, some researchers have raised doubts about the sincerity of disclosure in order to satisfy the expectations of society, or symbolic behavior that is primarily image-managing, and is only loosely connected to a firm's environmental performance, which is sometimes called "greenwashing." If this is the case, a firm may choose to make its carbon emission disclosure more lenient to convey an impression of responsibility but without actually making any changes to its actual environmental performance or its green accounting practice, then, in fact, the positive relationship between GA and CED predicted by Legitimacy Theory may not reflect any substantive improvement. This is a concern that is among the reasons why this study measures green accounting directly with a disclosure index that is developed based on specific, verifiable indicator items that are analyzed

through content analysis (Section 3.6.1). However, the symbolic nature of disclosure behavior is recognized as a legitimate constraint on index-based measurement in general, and is revisited in the discussion of limitations of the study in Section 5.6.

1.3 Research Gaps

The majority of empirical research so far on the link between green accounting and carbon/environmental disclosure has taken place in developed markets (US, UK and continental Europe) or other emerging markets like Indonesia and China. Although Pakistan is highly dependent on highly polluting industries like cement, textile and energy generation, there are relatively few studies that have looked into this relationship based on firm-level panel data.

Moreover, a large body of literature has focused on the issue of green accounting but not directly on the link between green accounting and carbon disclosure in the sense of a direct test of the linkage between the two concepts based on a panel-data regression model taking into account firm-level heterogeneity, heteroskedasticity and serial correlation. This study is the first to directly test this relation between green accounting and carbon emission disclosure using a balanced panel of 30 firms listed on the PSX spanning a period of 6 years and employing a full panel-data diagnostic and estimation sequence (pooled OLS, fixed effect, random effect, Hausman test, and Driscoll-Kraay standard error correction).

There are three gaps to be identified. Firstly, in Pakistan, there is a lack of specific evidence. Some studies on sustainability and environmental reporting (SER) in Pakistan have been done by listed-firm (Abbasi et al., 2025; Badar Ul Munir and Ishfaq, 2025; Hongming et al., 2020); while a few studies on the link between green accounting and carbon disclosure, mainly from Indonesia, have been conducted (Wardhani et al., 2026; Faeni et al., 2026). A literature search did not reveal any firm-level panel study on this relationship for Pakistan. Second, this is a methodological limitation in that the closest studies were based on a four year pooled panel (Wardhani et al., 2026) or a perceptual survey (Faeni et al., 2026),

which are incapable of distinguishing firm effects from firm change effects; the balanced six year panel with firm and year effects employed here is designed to correct for this.

Third, the integration of the Legitimacy Theory with the Stakeholder, Institutional and Agency perspectives of Section 2.7 into an integrated theoretical framework for testable predictions of the direction and magnitude of the relationship is somewhat lacking, as it is occasionally used qualitatively or in a single-firm study, but rarely combined. This study aims to overcome these three gaps.

1.4 Problem Statement

There is an enormous level of underperformance in environmental reporting by many of the Pakistani firms and also disclosure of carbon emissions by PSX listed companies is still low as compared to international practices.

Corporate green accounting should not only enhance the environmental performance but also the quality of environmental reporting but there is a lack of empirical evidence that has examined the effect of corporate green accounting on disclosure of carbon emissions in Pakistan specifically.

Most existing empirical research on this relationship has focused on developed markets (e.g. US, UK and continental Europe), or other emerging markets including Indonesia and China, with relatively weak and limited empirical panel evidence for Pakistan.

This is a clear research gap which the present study aims to fill.

1.5 Research Question

Is there a statistically significant relationship between the corporate green accounting and disclosure of carbon emission among the Pakistani firms?

1.6 Research Objective

To study the association of corporate green accounting and carbon emission disclosure in the Pakistani listed firms on Pakistan Stock Exchange with controlling size and leverage.

1.7 Significance of the Study

This study has some contributions. To begin with, it adds to the literature of environmental accounting in Pakistan, which is a developing nation, and is less studied as compared to the developed countries. Secondly, it assists business leaders to appreciate the applicability of investing in green accounting systems and sustainability reporting procedures. Thirdly, it helps investors, notably those with an environmental, social and governance (ESG) focus, assess and filter companies doing environmental business on the PSX. Fourth, it supports the policy and regulatory bodies, such as Securities and Exchange Commission of Pakistan (SECP) and Pakistan Stock Exchange (PSX) to draft and enhance environmental disclosure policies and regulations. Last, it will help firms in polluting industries make pollution disclosure and pollution performance better. This also provides a methodological template that can be utilized as such by future accounting researchers in Pakistan, without any particular consideration for the green accounting–carbon disclosure relationship analyzed in this study. All of the above panel-data model selection and diagnostic testing procedures in Chapter 4 can be directly replicated, in whole or in part, by other research students in Pakistan that may have other accounting and finance research questions involving PSX firm-year panel data, as the procedures are presented in sufficient procedural detail in Chapter 3.

Overall, this study adds to the international discourse on corporate responsibility in the face of climate change. In response to the growing attention shown to environmental accounting and disclosure practices by international lenders and export markets as they push their trading partners and borrowers to adopt them (as discussed in Section 2.10), Pakistani companies that do not improve their

environmental accounting and disclosure practices could find themselves at a disadvantage when competing against firms in markets with more developed environmental reporting cycles. In this context, the impact of the study is far-reaching and transcends the specific scope of the study to broader implications for the competitiveness and international market access of the Pakistani corporate sector in general. Contribution to recent studies. Evidence on green accounting and carbon disclosure is the closest that can be found in Indonesia recently. Wardhani, Supriyanti and Liu (2026) analyse 41 energy and basic-materials companies listed on the Indonesia Stock Exchange from 2020 to 2023, reporting that green accounting positively correlates with the disclosure of carbon emissions.

They include a government PROPER environmental performance rating in their green accounting variable, use pooled OLS on a four-year panel as their estimator, and use a quantile regression for their robustness check; they do not report year effects or endogeneity tests. Faeni et al. (2026) survey 280 Indonesian companies and they conclude that the relationship between green accounting is positive with environmental disclosure, but only in perceptual and cross-sectional, and not in environmental disclosure, but in general disclosure.

Recent studies on listed-firms for Pakistan have focused on environmental disclosure quality and environmental awards (Badar Ul Munir and Ishfaq, 2025) and ESG reporting and earnings quality (Majeed et al., 2026); but neither of these studies has considered the connection between accounting for environmental costs and carbon-specific disclosure.

In the following study, the literature is extended in four ways. First, it has a firm-level carbon specific panel for Pakistan which is available for years 2020 to 2025, in which sustainability reporting shifted from voluntary guidance to mandatory IFRS S1/S2 reporting. Secondly, green accounting is not an external rating or survey of perceptions, but an item by item index on environmental cost recognition done by the firms themselves. Thirdly, the empirical design is a firm effect, year effect and inference appropriate for a panel of small clusters. Fourth, it presents explicit endogeneity and robustness tests (Section 4.11), which allow to differentiate the cross-firm association from the within-firm effect.

1.8 Scope of the Study

This study only covers 30 firms listed at the Pakistan Stock Exchange (PSX) from five pollution intensive industries (Cement, Chemical, Energy, Steel, and Textile) for a period of six years from 2020 to 2025. This analysis is based only on secondary data from annual reports, sustainability reports and other corporate disclosures released to the public. The study does not cover the firms in the other sectors or include primary data collection techniques like interviews or surveys.

1.9 Operational Definitions

The following operational definitions will be used for the purposes of this thesis. Corporate Green Accounting (GA) is defined operationally as the result of a year-by-year disclosure index for the firms, with the score expressed as a ratio ranging from 0 to 1, based on the number of environmental-cost and environmental-management items disclosed in firms' annual reports or sustainability reports and the maximum number of items defined in Section 3.6.1 of this document (see Appendix table A2). Similarly, Carbon Emission Disclosure (CED) is operationally defined, as a firm-year disclosure index score, based on the number of the predefined carbon-related disclosure items reported, divided by the maximum number of carbon-related disclosure items that can be reported (7) (Section 3.6.2). Firm Size is defined as the natural log of a firm's total assets in the year the firm was evaluated and Leverage is defined as the ratio of a firm's total debt to its total assets in the year the firm was evaluated. These operational definitions are used throughout the thirty sample firms and for the six years of the study.

1.10 Organization of the Study

The thesis is organized by executing the following steps: The rest of this thesis is arranged as follows: This paper critically reviews the theoretical and empirical studies relating to the corporate green accounting, carbon emission disclosure and

the hypothesized link between the two and also pinpoints the existing research gap that this study targets. In Chapter 3, the research methodology is described, which incorporates the research design, population and sample, data collection, variable measurement, regression model, and data analysis techniques used. Empirical results are shown in Chapter 4, in terms of description, correlation analysis, model selection for panel data and diagnostic testing, and regression results. The findings are presented in Chapter 5 by discussing them in relation to the study's theoretical framework and previous literature, as well as the conclusion, limitations, and recommendations for practice, policy, and further research.

1.11 Chapter Summary

This chapter has presented the background and motivation for the study, which is in the backdrop of the increasing significance of environmental sustainability reporting in the global and local context in Pakistan. It has presented the theoretical basis of this study based on Legitimacy Theory, and provided an explanation of how this theory leads to the expectation that green accounting and the disclosure of carbon emissions are positively related. It has explained the problem addressed in the study, the research objective, the research question, and the research hypothesis, and has shared the significance of the study for managers, investors, policy makers and academics. Lastly, it has established the study's scope and key operational terms and provided a structure for the rest of the chapters.

Chapter 2

Literature Review

2.1 Introduction

The theoretical and empirical literature related to corporate green accounting and carbon emission disclosure is reviewed. First, it reviews the definition and the quantification of corporate green accounting, and then it reviews the disclosure of carbon emission and the theoretical mechanisms that are hypothesized to connect the two concepts. The chapter then summarizes the role of firm size and leverage as determinants of environmental disclosure, summarizes the empirical literature in tabular form and concludes with highlighting the specific research gap that this study addresses.

2.2 Corporate Green Accounting

Green accounting is a type of accounting that combines environmental costs into traditional accounting systems, enabling companies to track their environmental performance in a way that promotes sustainable development. Although firms in the developing country context studied by ([Gonzalez and Peña-Vinces, 2023](#)) recognize the value of environmental cost accounting, the two researchers conclude that formal environmental cost accounting is still not widely adopted, highlighting the practical need to measure green accounting first-hand as in this study. In the

same vein, (El Serafy, 1997) stated that green accounting is a link between traditional accounting and environmental protection and pollution prevention, which would otherwise be paid by the whole society.

Environmental accounting generally involves a number of related activities: Environmental cost management, investment in pollution-control technology, waste-management reporting, energy-efficiency programs and sustainability performance reporting. Such practices all contribute to enhancing a firm's corporate image, assisting in regulatory compliance and building trust among stakeholders, as noted by (Schaltegger and Burritt, 2000). It is commonly seen in the literature that green accounting is a prerequisite for the more evolved types of external environmental and sustainability reporting as companies must establish the internal measurement and reporting systems to be able to report on environmental costs.

2.2.1 Historical Evolution of Green Accounting

The concept of green accounting has evolved in history. Since its inception as a separate academic and policy interest in the late 1980s and early 1990s, the idea of green accounting has progressed significantly. Researchers and policy makers were becoming aware that traditional financial accounting systems did not effectively reflect the environmental costs incurred by business operations. Early work in this area has been mainly concerned with Green national accounting at the macroeconomic level (the changes that are made to national income accounts to take account of resource depletion and environmental degradation) and this idea was slowly extended to the individual firm (El Serafy, 1997). (Gray et al., 2001) outline the subsequent evolution of the practice of environmental accounting in the 1990s, when accounting researchers and standard-setters started to create ways of accounting for environmental costs, liabilities and contingencies in traditional financial statements and supplementary sustainability reports. By the 2000s, green accounting had expanded even more, and now included, besides cost recognition, environmental performance measurement, environmental management accounting, as well as the type of carbon-specific accounting and disclosure that was the focus of the present study. The historical evolution is of relevance to the present

research as it sheds light on the reasons why, despite being conceptually distinct, green accounting and carbon emission disclosure have become so intermingled in current corporate reporting practice: carbon disclosure happened, largely as a special strand of the wider project of green accounting, which is specifically concerned with the emission of greenhouse gases, given the increasing salience of climate change in the global policy agenda.

2.3 Carbon Emission Disclosure

Carbon emission disclosure is a disclosure of greenhouse gas emissions, and other climate-related information, in corporate annual reports, sustainability reports and related communications. The researchers, (Dharma et al., 2024), investigate carbon emission disclosure of emerging market energy companies and conclude that disclosure of carbon emissions by external stakeholders helps to assess the environmental responsibility of the company and its overall commitment to sustainability. Typical disclosures are emissions, carbon-reduction targets, climate-risk disclosures, carbon-management strategies, and reporting on environmental compliance. Companies that are transparent about these factors are usually found to have high investor confidence and better market reputation (Clarkson et al., 2008).

(Mobus, 2005) Mobus classifies mandatory and voluntary environmental disclosures on the clear basis of the legitimacy theory, which states that disclosure is not merely a routine reporting process, but a strategic response to stakeholders' pressure. (Neu et al., 1998) find that companies do actively manage the impression they make with their environmental reporting, their response being disproportionate to the concerns of financial stakeholders such as regulators, and institutional investors rather than the general public.

International reporting standards have been instrumental in defining the content of carbon emissions disclosure around the world. The GRI 305 (Emissions) standard offers detailed reporting guidance for both direct and indirect GHG emissions, and the recommendations of the Task Force on Climate-related Financial

Disclosures (TCFD) focus on reporting on climate-related governance, strategy, risk management and metrics.

The specific carbon-disclosure indicator items used in this study (CO₂ emission reporting, carbon-reduction targets, climate-risk disclosure, and carbon-management strategies) are direct models of the categories emphasized in these international frameworks, and therefore, in this study, the empirical analysis is content-valid (see Section 3.6.2).

2.3.1 Measurement Approaches to Carbon Disclosure in Prior Literature

According to the prior literature, there are measurement approaches to carbon disclosure. The prior literature refers to measurement approaches to carbon disclosure. There are a number of different ways that disclosure of carbon emissions have been measured in previous empirical research and it is helpful to briefly discuss these methods before explaining the method employed in this study (Section 3.6.2). The straightforward method is based on third party disclosure scores, such as those produced by the Carbon Disclosure Project (CDP), which polls the firms directly and assigns a disclosure and performance score (based on a standardised scale); this is generally not possible for firms (most PSX-listed companies) that do not participate in the CDP survey process, but it does provide a degree of comparability. The second method is based on binary or weighted content-analysis indices derived by researchers directly from annual and sustainability reports, as was done in the present study and is common in the rest of the social and environmental accounting literature (Clarkson et al., 2008) & (Hahn and Kühnen, 2013). The third method is the analysis of narrative disclosures, in which the frequency of text words or phrases related to climate or carbon is counted in an annual report, requiring this approach to be based on the content of the words or phrases. This approach counts the number of words or phrases related to climate or carbon in the annual report, which can be a weaker indicator of substantive completeness of disclosure than a content-analysis index derived from a set of criteria. As there is a

lack of CDP data for majority of the listed firms in Pakistan, and for the environmental disclosure literature as a whole, this study uses the binary content-analysis index approach as detailed in Section 3.6.

2.4 Relationship between Green Accounting and Carbon Emission Disclosure

The relationship between Green accounting and carbon emission disclosure is explored in the following section. 2.4 Green Accounting and Carbon Emission Disclosure Corporate green accounting is the basis for the internal accounting that is needed to measure environmental costs and investments related to sustainability. Proper internal record keeping of environmental costs and environmental performance will, almost automatically, put the firms in a better situation to make transparent and consistent disclosures of carbon-related information to external stakeholders.

The direct or indirect channels are listed below. The following is a list of the direct or indirect channels. It is important to separate two channels of possible green accounting impact on carbon emission disclosure. The first is a direct measurement channel, namely a firm which has invested in the internal systems necessary to identify, track and report environmental costs – what is captured as the essence of green accounting as defined in Section 2.2 will find it less difficult and less costly to report carbon-specific information externally, as much of the underlying data collection and categorisation work has already been undertaken. The second is an indirect, reputational or cultural channel: a company that has implemented green accounting can also, independently, have established a culture of environmental responsibility and transparency within the company, which also, in turn, encourages more thorough carbon disclosures that do not necessarily correspond to the company's specific green accounting data. The data and methodology employed in this thesis is not meant to formally distinguish between both channels, and this is acknowledged as a limitation in Section 5.6; however, it is recommended as an avenue for further research in future studies, e.g. mediation analysis, employing a

mediation variable such as a firm's general corporate governance or sustainability-culture indicator, as an explicit third channel between the two.

Previous research, in general, indicates that companies with more robust green accounting grow more likely to produce better sustainability reporting and have greater environmental responsibility overall (Clarkson et al., 2008) & (Hahn and Kühnen, 2013). This body of evidence suggests green accounting and carbon emission disclosure are linked, and this study therefore posits that companies that have more advanced green accounting systems will have good carbon emission disclosure, as per the hypothesis formulated in Chapter 1, and as per either or both of the two channels mentioned above.

2.5 Firm Size and Environmental Disclosure

One of the most consistent significant determinants found in the environmental and social disclosure literature is firm size. Larger companies tend to be more open to public criticism, more heavily regulated and have higher expectations of environmental responsibility, partly because they have a bigger absolute impact and their operations are more visible. Consequently, larger firms tend to report more environmental information than smaller firms, not only because they have more resources available to produce such reports, but also because they have more legitimacy pressures for reporting more information (Clarkson et al., 2008). Firm size is thus taken as a control variable in this study and represented by the natural log of total asset size.

It should also be noted that although the empirical link between firm size and environmental disclosure has been positive overall, this link has not been completely consistent across the literature. (Hahn and Kühnen, 2013) conducted a systematic search of 178 empirical studies and found that firm size is one of the most examined and most significant factors in sustainability reporting, but also reported that a non-negligible portion of studies do not establish a statistically significant firm size effect, especially in studies with only one industry, or with few industries, and with limited size ranges. The present study's sample encompasses firms in five

sectors and a relatively broad range of firm sizes (as measured in log-assets), as indicated by the Firm Size range in Table 4.1, which ranges between 15.96 and 21.24 log-assets; such a wide range is likely to make the Firm Size effect more easily detectable in the present study's data than in a more size-homogeneous sample, and this is particularly true for the present study's data, as the Firm Size coefficient is consistently statistically significant in each and every specification in Chapter 4.

2.6 Leverage and Environmental Disclosure

Principles of leverage Leverage is typically defined as the ratio of total debt to total assets, and it reflects how much of the firm's activities are funded with debt as opposed to equity. The disclosure literature gives two conflicting predictions about the leverage-disclosures linkage. On the other hand, more highly leveraged firms might provide more environmental information to decrease information asymmetry with creditors and to give creditors comfort about the firm's environmental risk exposure.

However, highly leveraged companies with short-term funding difficulties may not have discretionary environmental reporting as a priority compared to the primary financial reporting requirements. The direction of this relationship is not clear and therefore, leverage is not measured as a variable of primary theoretical interest in this study, but simply as a control variable. This is also seen in practice: Some prior studies find that high leverage is correlated with high levels of environmental or social disclosure, which aligns with the debt-holder information-asymmetry argument summarized above; others find a negative or statistically insignificant correlation between leverage and environmental or social disclosure, which aligns with the resource-constraint argument.

This variation in the results of the previous studies may partly be due to the differences in the financial systems studied – in a market-based financial system, like the United States and the United Kingdom, the information-asymmetry channel is stronger than in a financial system where banks are more dominant, like in

Pakistan, where creditors might rely on direct monitoring relationships with borrowing firms more than on public disclosure as a way of managing environmental and other risks. This institutional consideration is one possible explanation of the negative leverage coefficient that resulted from this study's own Fixed Effects results, which is discussed in further detail in Section 5.2.3.

2.7 Supporting Theoretical Perspectives

2.7.1 Stakeholder Theory

It is mainly proposed by (Freeman, 1984), provides an alternative viewpoint to Legitimacy Theory in analyzing corporate environmental disclosure. Legitimacy Theory sees disclosure as a reaction to broader public expectations, while Stakeholder Theory holds that companies react differently to different stakeholder groups based on the power, legitimacy and urgency of the stakeholder claims. (Neu et al., 1998) make a direct link between this argument and environmental disclosure, and suggest that firms' responses are disproportionately sensitive to the financially powerful stakeholder. In the scope of this study, Stakeholder Theory explains why Firm Size is a good predictor of Carbon Emission Disclosure: larger firms have more and more powerful stakeholders, so that cumulative pressure on them to disclose the environmental information is greater than that of smaller firms.

2.7.2 Institutional Theory

According to Institutional theory, disclosure practices in organizations evolve toward each other over time because other organizations in the same institutional field or industry are subject to similar regulatory pressures, professional norms, and/or imitations (DiMaggio and Powell, 1983). This viewpoint is helpful for understanding the sectoral level patterns highlighted in Chapter 4: disclosure practices could be expected to cluster by sector, consistent with the level of mean disclosure scores reported in Table 4.2.

2.7.3 Agency Theory View on Disclosure

Agency Theory ([Jensen and Meckling, 1976](#)) offers another complementary explanation for environmental disclosure by a company, viewing it as a way to lessen the information gap between the managers and outside parties like shareholders and lenders. This view would lead firms with higher leverage to report more environmental information to ease concerns of lenders about environmental liabilities and compliance risk, in line with one of the two rival explanations proposed in Section 2.6 for the leverage-disclosure nexus.

2.7.4 Brief Overview of the Four Theoretical Perspectives

The theory that is used as a basis of this study is legitimacy theory. It is the only one of the four perspectives that directly explains the central proposition. The measurement of environmental costs in firms' reports (GA) and the disclosure of carbon information (CED) are both forms of seeking or regaining legitimacy (Dowling and Pfeffer, 1975; Suchman, 1995). It's the best option for three reasons. First, the central object of it is the disclosure choice of the firm that is a reaction to social pressure (O'Donovan 2002; Deegan et al. 2002; Möbus 2005). Secondly, the regime in Pakistan has been voluntary for most of the study period, thus legitimacy pressure seems to be the likely motive behind disclosure, rather than legal coercion. Third, it is widely used in the environmental disclosure literature.

The other three theories are supportive theories. They are not mutually exclusive of Legitimacy Theory, but each accounts for a different pathway between the variables (as outlined in Table 2.1). Under Stakeholder Theory, information about environment is sought by whom and for what purpose does disclosure increase with size and visibility of the firm? Year and sector effects in the disclosure are explained by Institutional Theory, which posits that disclosure practices tend to converge in sectors and over time as regulatory guidance and international standards diffuse. Agency Theory provides an explanation for both of these facts: (1) that an internal accounting system makes it cheaper to produce credible external information and (2) that leverage might matter. This means that each theory suggests a positive

relationship between GA and CED in a different way, and H1 comes to a major extent from the Legitimacy Theory.

Table 2.1 is a summary of the four theoretical approaches discussed in this section, and the aspect of the findings of this study that each approach is best suited to explain. Each of the four perspectives supports the same directional hypothesis (H_1), each underlines different mechanisms, and, together, each perspective offers a fuller account of the results of the study than any one of them would be able to provide alone. Table 2.1 shows the comparison of theoretical perspective used in this study. Table 2.1 illustrates the comparison of theoretical perspective used in the present study.

2.8 Empirical Evidence from Asian and Emerging Markets

This study is conducted in a developing country like Pakistan, which has unique institutional structures, so empirical evidence from other Asian and emerging market countries is relevant, as well as from developed countries. In general, the studies in the Chinese, Indonesian and other South and East Asian markets indicate that the state ownership, regulatory enforcement level and industry membership of firms have a significant influence on environmental disclosure, and that voluntary environmental disclosure in these markets is not as well developed as in Western markets – primarily due to lower level of regulatory enforcement and lower maturity of the level of market pressures for environmental, social and governance disclosure. In the field, (Dharma et al., 2024) investigate energy-sector companies in Indonesia and conclude that carbon emission disclosure is positively associated with the profitability of the firms and their market value, when conditioned on environmental performance of the firms, broadly consistent with the notion that carbon disclosure carries market-relevant information even in emerging market contexts with comparatively weak mandatory disclosure regimes. The overall pattern of the green accounting–carbon disclosure linkage appears to be comparable in developed and emerging economies, but the relationship may be

TABLE 2.1: Theoretical Perspectives, Their Roles, and Expected Relationships

Theory	Role	Link to GA and Expected Relationship	Link to CED and Control Variables
Legitimacy	Main	GA and CED are complementary legitimacy-seeking activities; a firm with a more developed GA system signals environmental responsibility and is expected to disclose more carbon information (+).	Explains why disclosure is higher in high-scrutiny, pollution-intensive sectors.
Stakeholder	Supporting	Regulators, lenders and investors ask for environmental information; GA is the internal system that produces it, so disclosing to these groups is less costly (+).	Larger firms face more and more powerful stakeholders, so Firm Size is expected to be positive.
Institutional	Supporting	Coercive and normative pressures (SECP guidance, IFRS S1/S2) and imitation push GA and CED upward together within a field (+, partly through shared sector and time effects).	Explains sector clustering of scores and the rising trend of CED over 2020–2025.
Agency	Supporting	GA lowers monitoring and information costs between managers and outside parties, making verifiable carbon disclosure easier (+).	Leverage: creditors may demand more disclosure (+), or debt pressure may crowd it out (–); the sign is an empirical question.

stronger or not as strong and the degree of improvement in disclosure practices may vary significantly by country, depending on the country's regulatory and institutional framework, thus reinforcing the importance of country-specific studies like the present one.

2.9 Hypothesis Development

Another point of comparison that can be noted is that some studies on emerging market firms, such as Chinese state-owned enterprises and firms listed on the Gulf Cooperation Council (GCC) stock exchanges, derive data on ownership structure and include this variable in their analysis of the relationship between environmental performance and disclosure, a relationship that is not directly tested in the present study because ownership structure data was not added to this study's sample. This is another specific research design constraint besides those mentioned in Section 5.6 and is noted as an extension for future research in the cement, energy and chemical sectors of PSX listed firms, given the mixed nature of the ownership of these firms in both the state and family sectors as well as foreign ownership. The single formal hypothesis developed from the theoretical discussion presented in Sections 2.2 - 2.10 is presented below.

According to Legitimacy Theory, companies which are facing environmental pressure will fight to defend their social legitimacy by increasing their internal environmental accounting and external environmental disclosure. The more the firm's green accounting system is developed, the easier and cheaper it will be for that firm to report credible carbon information, since the data underlying carbon disclosure is also provided by green accounting. According to Stakeholder Theory, managers need to provide such information to regulators, lenders and investors; Agency Theory also states that an internal measurement system diminishes information asymmetry between managers and outside parties (Section 2.7.4). From an empirical perspective, previous research reports that companies with more robust environmental practices report more, even in developed and emerging markets (Clarkson et al., 2008; Hahn and Kühnen, 2013; Wardhani et al., 2026). This theoretical and empirical discussion is then followed by a test of the following hypothesis:

H1: Corporate green accounting positively influences the disclosure of carbon emissions by the listed companies in Pakistan, while controlling firm size and leverage. That H1 is not a causal effect, but rather an association is discussed in

Section 4.11, where it is stated how far the evidence goes beyond an association. The null hypothesis (H_0) is: The relationship between corporate green accounting and carbon emission disclosure is not significant amongst Pakistani firms.

2.10 Research Hypothesis

H_0 (Null Hypothesis): Pakistani Firms do not have any significant relationship between corporate green accounting and carbon emission disclosure. Alternative Hypothesis H_1 : The relationship between green accounting and disclosure of carbon emissions among the Pakistani firms is positive and significant. This research follows the convention to test the null hypothesis (H_0) against the alternative hypothesis (H_1) at a 5% significance level ($p < 0.05$) in the empirical accounting and finance literature, as outlined in the data analysis technique set in section 3.9. If (H_0) is rejected in favor of (H_1), it means that corporate green accounting is a statistically significant factor influencing carbon emission disclosure for the sampled firms after controlling for firm size and leverage, while if (H_0) is not rejected, there is no statistically significant relation between the two variables, as of the sampled firms, after controlling the factors of firm size and leverage.

2.11 Conceptual Framework

Theoretically, the conceptual framework of this study considers Corporate Green Accounting (GA) as an independent variable, Carbon Emission Disclosure (CED) as a dependent variable and Firm Size and Leverage as control variables. The framework foresees a direct, positive relationship between GA and CED, which follows the Legitimacy Theory and the empirical literature presented in this chapter. The influence of Firm Size on CED is estimated independently and the direction of the Leverage effect is considered as an empirical question because of mixed results from the previous literature.

This framework can be shown as a single equation causal path that has two arrows converging to the chief theoretical proposition of the study, Corporate Green

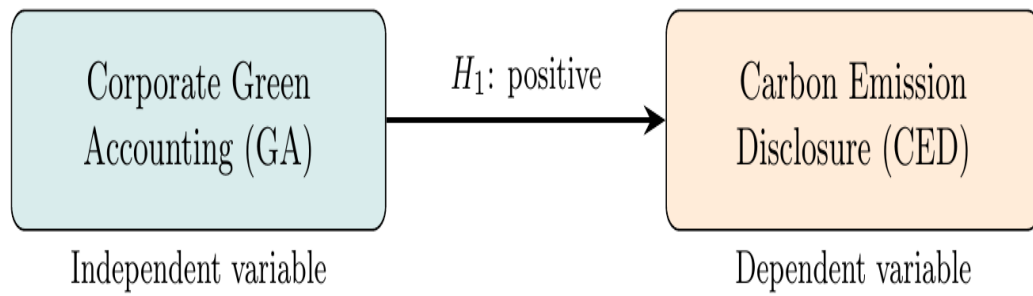


FIGURE 2.1: Conceptual model of the study.

Accounting, and two other arrows from the other variables that could influence disclosure, as they were introduced as control variables to isolate the relationship between GA and CED from other factors known to influence disclosure. There is no arrow drawn from Firm Size or Leverage to Corporate Green Accounting because this study does not consider the disclosure of green accounting as a dependent variable that can be explained by firm size or leverage; instead, all three independent variables are modeled as determinants of the disclosure of Carbon Emission together, contemporaneously, in the same firm-year, as outlined formally in Section 3.8 and estimated in Chapter 4. The conceptual framework presented in this chapter, and the specific hypothesis it entails, is directly integrated in the research methodology presented in Chapter 3.

Selected empirical studies are summarized in Table 2.2. Combining all the above, previous studies have identified three findings: First, there is a positive relationship between the quality of environmental practices or performance and the amount of environmental and carbon information that is published (Clarkson et al., 2008; Wardhani et al., 2026; Faeni et al., 2026); Second, firm size is one of the most consistent factors that influences sustainability reporting practices (Hahn and Kühnen, 2013); Third, disclosure is lower and more volatile when regulation is voluntary. There is still fourfold that is not explored. Little firm level panel evidence is available in Pakistan for the relationship between accounting for environmental costs and carbon specific disclosure. Cross-sectional or pooled and perceptual designs exist most often and are difficult to determine whether observed association

is due to true difference in firms, or change in firms over time. Few studies account for both variables potentially moving in the same direction over time in response to changing regulations and/or do not test for endogeneity.

When it comes to green accounting, external ratings are more commonly used than it is measured through the firm's accounting disclosures. The present study tackles these issues by combining a balanced panel of 30 companies listed on the PSX for the period from 2020 to 2025, an item-level green accounting index, firm and year effects and small-sample inference, as well as explicit endogeneity tests.

TABLE 2.2: Summary of Selected Prior Studies

Study	Context	Design	Main Finding
Clarkson et al. (2008)	US environmentally sensitive industries	Environmental performance and voluntary environmental disclosure	Positive relation between performance and disclosure.
Hahn and Kühnen (2013)	International review	178 empirical studies of sustainability reporting determinants	Firm size and industry are among the most examined determinants.
Dharma et al. (2024)	Indonesian energy firms	Carbon disclosure, profitability, market value	Market value related to carbon disclosure; profitability not.
Badar Ul Munir and Ishfaq (2025)	300 non-financial PSX firms, 2016–2020	Environmental awards and disclosure quality	Awards are associated with disclosure quality.
Wardhani et al. (2026)	41 Indonesian energy and basic-materials firms, 2020–2023	Pooled OLS; green accounting proxied by PROPER rating	Green accounting positively associated with carbon disclosure.
Faeni et al. (2026)	280 Indonesian firms	Survey, PLS-SEM	Green accounting positively related to environmental disclosure.

2.12 Chapter Summary

The chapter has discussed the theoretical and empirical basis of the study. It started by outlining what is meant by corporate green accounting and carbon emission disclosure and then examined the theoretical mechanisms that underlie the central hypothesis for this study, namely the Legitimacy Theory, Stakeholder Theory, Institutional Theory and Agency Theory. It discussed the role of firm size and leverage as known factors affecting environmental disclosure and summarized the existing prior empirical literature as presented in Table 2.1, and thought about the emerging regulatory context in both the emerging markets and in Pakistan in particular, and finally identified the specific research gap it aimed to address in this study, which was the lack of rigorous panel data evidence on green accounting-carbon disclosure relationship in Pakistan specifically. The chapter ended with the final restatement of the study's hypothesis (H_1) and the presentation of its conceptual framework. Now in Chapter 3, the research methodology is presented to test this hypothesis.

Chapter 3

Research Methodology

3.1 Research Approach

3.1.1 Philosophical Positioning

This research is designed to fit into the framework of a post-positivist research philosophy, which assumes that social and organizational phenomena, such as corporate disclosure behavior, can be observed and measured by quantitative methods, and that generalizable relationships between the variables can be discovered and tested by formal hypothesis testing procedures. A positivist approach is deemed suitable for this study because the research is based on second-hand, quantitative and panel data which would not usually require an interpretivist approach, and because the research question is expressed as a testable proposition with respect to the statistical relationships between two measurable constructs (green accounting and carbon emission disclosure). This philosophical stance is of a deductive nature, which means that instead of starting with the observation of open-ended data and then constructing theory from that, the study begins with a theory (Legitimacy Theory, as outlined in Section 1.2), from which a testable hypothesis is deduced (Section 1.6), and data are then collected and analyzed specifically to test that hypothesis.

This study is conducted with quantitative research approach due to the measurement and statistical testing of the relationship between corporate green accounting

and carbon emission disclosure with numerical, firm-level panel data. A quantitative approach is suitable here because the research is intended to test a specific hypothesis, and to explore the strength, direction, and statistical significance of the relationship between the variables of the research, instead of exploring subjective interviewee perceptions. The study, then, will be based on objective measurement, that is disclosure indices that are built by content analysis of annual reports, and not on personal opinions or on information gathered from interviews. This method will enhance the reliability, objectivity, and replicability of the results, and will allow for the generalisation of the results within the boundaries outlined in Chapter 5, to other firms listed on the PSX and in similar industries.

3.2 Research Design

This study is a type of descriptive and explanatory research. The descriptive part reports the current level of environmental reporting practice of the sampled Pakistani companies which helps to understand the level of environmental costs reporting and environmental disclosure of carbon emission in the annual and sustainability reports of the sample companies. The explanatory component then investigates the cause-and-effect relationship between the independent variable (green accounting) and the dependent variable (carbon emission disclosure) to see if a stronger green accounting is linked to better carbon emission disclosure. This design is explanatory in nature and will enable the study to determine the statistical significance of the hypothesized relationship.

3.3 Population and Sample

3.3.1 Population

The Stock Exchange of Pakistan (PSX) lists all firms as the population. The study is a study on environmental reporting and carbon emissions, so the targeted population is of five groups of industries that are high polluters: cement, chemical

industry, including fertilizer, energy industry (oil & gas exploration, power generation or gas distribution), steel and textile industry. Environmental significance of the selected sectors: In Pakistan, the coal-based CO₂ emissions in the cement sector accounted for 49% of the total in 2018-19, followed by power generation (28%) and brick kilns (22%) (CREA, 2021). The energy sector contributes about 89% of the national GHGs in association with agriculture (Mir et al., 2017). In 2018-19, Pakistan's natural gas use was approximately 16% of the total in fertilizer production (CREA, 2021).

3.3.2 Sample

The sample consists of 30 firms (Table 3.1) selected purposively from five sector groups including 7 cement, 8 textile, 7 energy, 5 chemical and 3 steel firms listed on the PSX. The inclusion criteria were: (i) continuously listed on the PSX in 2020–2025; (ii) belonging to one of the five sector groups; (iii) having five annual reports that were audited; and (iv) annual reports that provided enough detail to code the content of the GA and CED indices for the six years. This provides a balanced design with $30 \times 6 = 180$ firm-year observations. The most covered is the cement group (7 of 19 or so listed firms), coverage is less in the more numerous textile and chemical groups and none of the steel firms are covered. The patterns in each sector, therefore, should be interpreted with care (see the results for each sector, one at a time, in Section 4.11).

3.4 Data Collection Method

This study uses only secondary data because the information needed to create the disclosure indices used in this study is already included in published company reports. Secondary data from official corporate sources are much utilized in environmental disclosure research because they offer the history of disclosure over a number of years, enable the objective and replicable content analysis approach rather than self-reported responses (Krippendorff, 2018; Milne and Adler,

TABLE 3.1: Sample Composition by Sector

Sector Group	PSX Sector Classification(s) Included	Sample Firms	% of Sample	Listed Securities (approx.)
Cement	Cement	7	23.3	19
Textile	Textile Composite; Textile Spinning; Textile Weaving	8	26.7	88
Energy	Oil & Gas Exploration; Power Generation & Distribution; Oil & Gas Marketing (gas utilities)	7	23.3	30
Chemical	Chemical; Fertilizer	5	16.7	32
Steel	Engineering (steel producers)	3	10.0	17
Total		30	100.0	

1999), and are not as expensive or time-consuming to collect as primary survey or interview data (Saunders et al., 2019).

Information was gathered from company annual reports, sustainability reports, corporate websites, Pakistan Stock Exchange information, published audited financial statements and, if applicable, publications of the State Bank of Pakistan. The information from these sources is combined to build the study's Green Accounting Index and Carbon Emission Disclosure Index, and the study's financial information is combined to create the Firm Size and Leverage control variables.

3.4.1 Specific Data Sources by Variable

It is helpful to indicate the source for each of the variables used in the study's model for clarity. The Green Accounting Index and the Carbon Emission Disclosure Index (Sections 3.6.1 and 3.6.2) were developed with most of the data in the narrative part of the annual report – often the directors' report, chairman's statement, and a standalone sustainability or CSR report (if one was available in the annual report). The control variables were prepared from raw financial data obtained from each firm's audited balance sheet as reported in their annual financial

TABLE 3.2: Data Sources and Documents Used for Each Variable

Variable	Document Used	Where Obtained
Green accounting index	Directors' report, chairman's statement, notes to the accounts, standalone sustainability or CSR report, FY2020–FY2025	Company websites; PSX company filings
Carbon emission disclosure index	Same documents, including sustainability and ESG reports	Company websites; PSX company filings
Firm size, leverage	Audited statement of financial position (total assets, borrowings)	Annual audited financial statements
Sector	PSX sector classification	Pakistan Stock Exchange listed-companies lists

statements, which facilitates the presentation of the control variables based on audited financial data instead of self-reported or unaudited financial data. The sector classification of each firm (Section 3.3.1) was based on the classification adopted by Pakistan Stock Exchange itself without any ad hoc or researcher classification of industries.

These fiscal years (2020 to 2025) are presented for three reasons. These fiscal years (2020 through 2025) are covered for three reasons. First, it is the latest period for which there are complete annual reports for all sample firms, thus enabling a balanced panel. Second, it represents a significant evolution in the sustainability-reporting landscape of Pakistan (Table 3.x): SECP released its ESG Regulatory Roadmap in June 2022, followed by the release of the voluntary ESG Disclosure Guidelines in 2024 (along with an update on the Code of Corporate Governance on sustainability committees) and the introduction of IFRS S1 and S2 standard adoption requirements in December 2024. In 2021, Pakistan has submitted an updated NDC and in September 2025, a third NDC. Thirdly, the time frame is sufficiently long to have seen changes in reporting within the organization. The reporting in the sample is largely voluntary with almost all of it prepared prior to the mandatory requirement kicking in (first phase: reporting periods on or after 1 July 2025). These data reflect the increasingly heightened regulatory interest: the

average CED score increases from 0.47 to 0.82 from 2020 to 2025, while the average GA score goes from 0.44 to 0.62. Year effects are added to the robustness tests (Section 4.11) since these pressures are common across the years and therefore likely to increase both variables.

TABLE 3.3: Regulatory and Institutional Developments During the Study Period

Date	Development
2020	COVID-19 disruption to operations and reporting.
2021	Pakistan's updated NDC (conditional target of a 50% reduction of projected emissions by 2030).
June 2022	SECP ESG Regulatory Roadmap.
June 2023	ISSB issues IFRS S1 and IFRS S2.
June 2024	SECP issues voluntary ESG Disclosure Guidelines and amends the Code of Corporate Governance (sustainability committee).
31 Dec 2024	SECP mandates phased adoption of IFRS S1/S2 for listed companies; first phase for reporting periods beginning on or after 1 July 2025.
Sept 2025	Pakistan submits its third NDC (NDC 3.0).

3.5 Study Variables

3.5.1 Independent Variable: Corporate Green Accounting

It is the technique of identification, measurement and reporting environmental costs and sustainability-related costs in firm's accounting system. It is a way of recording the level of commitment a company has to its environmental responsibilities within the company.

TABLE 3.4: Description of Variables

S.No.	Variable (abbr.)	Definition	Measurement	Data Source	Reference
1	Carbon emission disclosure index (CED Index)	Number of carbon-related items disclosed	Sum of 7 binary items, range 0–7	Annual/ sustainability reports	Author checklist; consistent with Wardhani et al. (2026)
2	Carbon emission disclosure score (CED)	Proportion of carbon items disclosed	CED Index / 7, range 0–1	Derived	As above
3	Green accounting index (GA Index)	Number of environmental-cost items disclosed	Sum of 3 binary items, range 0–3	Annual/ sustainability reports	Comparable indicators in Faeni et al. (2026)
4	Green accounting score (GA)	Proportion of green accounting items disclosed	GA Index / 3, range 0–1	Derived	As above
5	Firm size (FS)	Scale of operations	Natural log of total assets (PKR '000)	Audited balance sheet	Wardhani et al. (2026); Hahn and Kühnen (2013)
6	Leverage (LEV)	Debt financing	(Long-term + short-term borrowings) / total assets	Audited balance sheet	Clarkson et al. (2008); Hahn and Kühnen (2013)

3.5.2 Dependent Variable: Carbon Emission Disclosure

It means disclosure of data on Greenhouse Gases (GHGs), climate risks, carbon-reduction objectives, and carbon-management approaches. It is designed to be

a reflection of transparency of a company's outward communication on environmental sustainability. The main argument of this study, which is directly in line with the Legitimacy Theory, is that enhanced green accounting is correlated with greater carbon emission disclosure.

3.6 Measurement of Variables

Both the independent and dependent variables are measured by disclosure index method which is widely used in accounting and sustainability research field in that it offers the possibility of direct and standardized measurement of the variables across the firms. All disclosures are scored on a binary basis, with a score of 1 given for an item disclosed, and a score of 0 for an item not disclosed. The overall disclosure level for each firm for each year is the total score of all items.

3.6.1 Measurement of Corporate Green Accounting

Corporate Green Accounting is measured by the indicators, which are identified by the content analysis of the annual reports, such as environmental cost reporting, pollution-control investment disclosure, waste-management expense reporting, etc., and other related items. All disclosed items are given a score of 1, and the Green Accounting Index (GA_Index) is determined for each firm-year. The raw index is then scaled into a proportional GA_Score (the index divided by the maximum possible score), with higher scores representing higher level of green accounting practices.

3.6.2 Measurement of Carbon Emission Disclosure

It is the carbon emission disclosure (CED) measure. Carbon Emission Disclosure is quantified by the reporting of CO₂ emissions, emission reduction targets, disclosure of climate risks, carbon management policies, emission control policies, environmental sustainability initiatives, carbon compliance reporting, etc. One point is assigned to each item disclosed and a final Carbon Disclosure Index (CED_Index)

is computed for each firm-year (a maximum of 7 items). This raw index then is translated into a proportional CED_Score, with higher scores reflecting more full disclosure of carbon emissions.

3.6.3 Worked Example of Index Calculation

For illustrative purposes, Table 3.5 shows how one firm-year is scored. The scores shown are given for a firm that reports on 2 of the 3 Green Accounting items and 5 of the 7 Carbon Emission Disclosure items. All 180 firm-year observations are converted proportionally so that the indices are on a common scale of 0 to 1.

TABLE 3.5: Worked Example of Index Calculation for One Firm-Year

Index	Items Disclosed	Score
GA Index = 2 of 3	GA1, GA2 (not GA3)	$2/3 = 0.667$
CED Index = 5 of 7	CED1–CED5 (not CED6, CED7)	$5/7 = 0.714$

Source: Author's illustration using the checklist in Appendix Table A2; each index is divided by its maximum score (GA: 3; CED: 7).

3.7 Control Variables

This study includes control variables Firm Size and Leverage to get more reliable and unbiased estimates. Both are included because they might have an independent impact on Carbon Emission Disclosure, apart from the impact of Corporate Green Accounting, and the effect of these variables is controlled for to make the study more accurate in capturing the impact of Corporate Green Accounting on Carbon Emission Disclosure.

3.7.1 Firm Size

The scale of a company's operations, as measured by the natural logarithm of total assets, that is, Firm Size, is in line with the conventions of the accounting and finance literature. Higher expectations for environmental responsibility by

stakeholders, and regulatory pressure and public scrutiny more intense for larger companies, mean that the latter are expected to provide more information on carbon emission than smaller companies.

3.7.2 Leverage

It is the amount that a company borrows to buy its assets; it is calculated as total debt divided by total assets. Higher leverage could lead to the firms reporting more environmental data because of information asymmetry and transparency requirements towards creditors and investors; it is therefore included as a control variable to account for the possibility that a firm's capital structure independently affects its carbon emission disclosure practices.

3.8 Model Equation

$$CED_Score_{it} = \beta_0 + \beta_1 GA_Score_{it} + \beta_2 Firm_Size_{it} + \beta_3 Leverage_{it} + \varepsilon_{it} \quad (3.1)$$

Where: CED = Carbon Emission Disclosure (dependent variable) GA = Corporate Green Accounting (independent variable) FS = Firm Size (control variable) LEV = Leverage (control variable) β_0 = constant/intercept; $\beta_1, \beta_2, \beta_3$ = coefficients of GA, Firm Size, and Leverage respectively ε = the error term i = individual firm t = year

This model investigates the impact of Corporate Green Accounting on Carbon Emission Disclosure after controlling for Firm Size and Leverage. Firm Size is added as there is a correlation between the size of the firm and the amount of information disclosed by the firm; the larger the firm, the more resources are available, and the more pressure is placed by stakeholders on the firm to provide environmental information, the more information will be disclosed. Leverage is included as the amount of leverage a firm has is correlated to the amount of environmental information disclosed; as the leverage of a firm increases, so do the expectations of the firm to disclose environmental information to reduce information asymmetry and to meet the information needs of creditors. A positive

coefficient on GA_Score (when green accounting practices are improved, carbon emission disclosure must be improved as well) would support the study's alternative hypothesis (H_1), and if the coefficient is statistically significant, it would support the study's main hypothesis.

3.9 Data Analysis Technique

Panel data collected was analysed using the R statistical computing environment, with the main packages used being: plm, lmtest, sandwich, car, psych and stargazer, which all provide estimation, diagnostic testing, and robust standard error corrections for panel data.

3.9.1 Descriptive Statistics

All the study variables were summarized using descriptive statistics such as the mean, standard deviation, minimum and maximum to describe the average level of green accounting and carbon disclosure among the sampled firms and the variation among the sectors.

3.9.2 Correlation Analysis

A correlation matrix was created to look at how strong and significant the associations were between the variables of the study and the direction of those associations before formal regression testing was conducted, so as to provide some initial evidence on the direction of the associations between green accounting and carbon emission disclosure.

3.9.3 Panel-Data Regression Analysis

The main empirical approach used is panel-data regression, as the data set consists of a cross-section of thirty firms, and each firm has a 6-year time series (2020 to 2025). Three estimators were compared: Dynamic panel estimators, such as

the difference and system GMM (Arellano and Bond, 1991; Blundell and Bond, 1998) are appropriate for situations in which the dependent variable is persistent, the regressors are endogenous, and the number of firms is large compared to the number of periods. The small number of instruments with the time dimension is a concern because this can inflate the endogenous variables and the specification tests, and because two-step standard errors are negatively biased in small samples (Roodman, 2009). In order to see if the results were sensitive to the model specifications, difference and system two-step GMM and collapsed instruments are also reported in Section 4.11. The results are not stable between the two estimators, and hence, the main analysis is based on the static panel models.

3.9.4 Model Selection Tests

The selection of the most appropriate estimator was conducted in the following sequential specification tests: (i) F-test for individual (firm) effect (pooled OLS vs. fixed effects) (ii) Breusch-Pagan Lagrange Multiplier test (Pooled OLS vs. random effects) (iii) Hausman test (random effects vs. fixed effects). If the p-value is less than 0.05, then the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted, meaning that the Fixed Effects model is preferred as the firm-specific effects are correlated with the regressors and the Random Effects estimator is inconsistent.

3.9.5 Diagnostic Testing

After the model is selected, a set of diagnostic tests were performed on the selected model specification, namely the Breusch-Pagan test for heteroskedasticity, the Variance Inflation Factor (VIF) for multicollinearity of the dummies and the Breusch-Godfrey/Wooldridge test for serial correlation among the idiosyncratic errors of the panel. If heteroskedasticity is present and/or serial correlation is present, the standard errors of the regression coefficients are conventionally known to be biased (usually underestimated), and this would lead to an overstatement of the statistical significance of the regression coefficients if not corrected.

3.9.6 Robust Standard Error Correction

In cases where diagnostic testing suggested the presence of heteroskedasticity and/or serial correlation, the study used the Fixed Effects model with Driscoll-Kraay (1998) standard errors.

This estimator is shown to be robust to heteroskedasticity, serial correlation and cross sectional dependence, and is particularly adequate for this panel data, where the number of time periods $T = 6$ is considered moderately large relative to the number of cross sectional units $N = 30$ in the asymptotic justification of the estimator.

As a comparison, the conventional (uncorrected), the HC1-clustered and the Driscoll-Kraay standard errors are all presented together with the Fixed Effects coefficients in Chapter 4.

3.9.7 Statistical Significance Threshold

As is common in accounting and finance literature, the level of significance for both the results of the test and the tests of the hypotheses of the study is applied within the 5% limit ($p < 0.05$), and at the level of 10% ($0.05 \leq p < 0.10$) the results of the tests and hypotheses are reported and discussed as “marginally significant”.

This threshold determines whether or not a formal rejection or non-rejection of the null hypothesis in Section 1.6 occurs. The Type I error here would be to believe that green accounting and carbon emission disclosure have a significant relationship where in reality there is not such a relationship in the population of Pakistani firms; the Type II error is to fail to detect a true relationship.

Note that the use of Driscoll-Kraay standard errors (Section 3.9.6) is specifically to protect against an inflated Type I error rate that would otherwise result from using the conventional standard errors on data that includes heteroskedasticity and serial correlation, as demonstrated to be the case for this data set in Section 4.7.

3.10 Ethical Considerations

This study uses only secondary data which is publicly available and not personal interviews or surveys or the collection of confidential or personally identifiable information. This has been achieved throughout by the use of only original, publicly published company reports, the absence of any manipulation or selective omission of data, all sources cited, and the use of academic honesty and originality in analysis and write-up. The following practices have been observed in conducting this research in a professional and responsible manner.

There were two matters of particular concern in this study: First, the disclosure indices used in the study were only identified by a single researcher, and a great deal of effort was made to employ the disclosure scoring checklist (Appendix Table A2) in a mechanical and consistent manner for the 180 firm-year observations to minimize the possibility that any rater's subjectivity in borderline cases might systematically overrepresent a certain sector or firm and thus result in an undisclosed bias of the results. Second, the study deliberately contrasts the results of this study with an earlier and unbalanced version of the dataset used in 2020–2024, and the earlier and later results are presented separately, rather than omitting or hiding results that do not support the hypothesis of the study, following the general rule that the researcher's responsibility is to provide truthful results, rather than suppressing or being selective about results.

3.11 Data Screening and Panel Balance

The raw data were checked for missing values, duplicate firm-year observations, and coding errors before the estimation. All the firm identifiers, sector classification and year variables were converted to categorical (factor) variables in R to enable proper panel data indexing. An earlier version of the dataset was unbalanced ($N = 150$ across 31 firms, with some firms reporting fewer years over this shorter period) as several sample firms had incomplete reporting histories for this shorter period. This study used a dataset that was extended by an additional

year (2025) and revised to include only firms with six years of complete reporting, resulting in a fully-balanced panel of 180 firms observed across the six years, with a sample of 30 firms per year. A balanced panel is preferred for this study because it makes the interpretation of the Fixed Effects estimator easier, it avoids the potential selection bias that can occur from firms that report intermittently, and it increases the reliability of the diagnostic tests reported in Section 4.7, a number of which are assumed or perform best under this type of panel structure.

3.12 Reliability and Validity of Measurement

Content-analysis based indicators, such as the ones used to measure both Corporate Green Accounting and Carbon Emission Disclosure in this study, have been extensively used in accounting literature and similar studies, precisely because they have good construct validity and replicability: each disclosure item is defined a priori, coded using a binary scoring rule, and applied in a uniform manner across sample firms and years. In order to ensure the reliability of the coding process, all annual and sustainability reports were checked for the same checklist of indicator items (summarized in Appendix Table A2) and coding decisions were checked for consistency over firms and years. The specific indicator items used in the Green Accounting Index and the Carbon Disclosure Index are also selected from and in line with internationally recognized sustainability-reporting frameworks, such as the Global Reporting Initiative (GRI) Standards and ISO 14001, as explained in Section 3.10.

Coding in practice was three step process. First, sections of the annual report that are relevant to the particular firm-year were read, and where a separate document had been prepared, the sustainability report, with special focus on those parts most likely to contain environmental and carbon-related information, such as the directors' report, the chairman's statement and any separate sustainability or corporate social responsibility or environmental section. Secondly, each of the indicator items listed in Appendix Table A2 was examined in the report text and a score of 1 recorded if the indicator item was stated explicitly and could

be identified in the report as referring to specific text or data; a score of 0 was recorded if the indicator item was not found, was ambiguous or was only asserted without any supporting information. Third, the scores obtained at the item level were aggregated to create the raw GA_Index and CED_Index for each firm-year, and then translated to the proportional GA_score and CED_score used in the rest of the regression analysis presented in Chapter 4. In cases where the information of a certain item appeared contradictory in the annual report and sustainability report of a given company, the information in the more detailed and specific report was used as a basis for the coding, as is customary in the literature dealing with content-analysis.

3.13 Chapter Summary

In this chapter, the quantitative, explanatory research design used in this research, the purposive sample of 30 firms listed on the PSX for five pollution-intense sectors during 2020–2025, the data collection procedure for secondary data, the measurement of the independent variable (disclosure levels), the dependent variable (Sustainable development goals), the control variable (Bond rating), and the procedure of model-selection, diagnostic, and robust standard-error correction applied to the data have been described. The results of this analysis are presented in Chapter 4.

Chapter 4

Results and Analysis

4.1 Overview

The empirical results are reported for the 180 firm-year observations in this chapter. It presents descriptive statistics, sector differences and correlations; the specification of the panel model; the comparison of pooled OLS, fixed effects and random effects and the model-selection tests; diagnostic tests and robust standard errors; the hypothesis test; and endogeneity and robustness tests.

4.2 Descriptive Statistics

Descriptive statistics of the main variables of the study are presented in Table 4.1. The average score of the sampled firms was 0.52 (52%) for the Green Accounting Index and 0.63 (63%) for the Carbon Emission Disclosure Index, suggesting that, on average, carbon disclosure practices are a bit more advanced than green accounting practices among the sampled firms. The standard deviations for both of the indices are 0.32 and 0.24 respectively, and are meaningful in terms of having meaningful variation of disclosure behavior across firms, which is required for the subsequent regression analysis. The firms included in the sample ranged from mid-sized to very large as indicated by the average of Firm Size (log total assets) of 18.47 with a minimum of 15.96 and a maximum of 21.24. Average Leverage

of 0.27 and a maximum of 0.93 suggest that some of the sampled firms are very heavily financed by debt.

TABLE 4.1: Descriptive Statistics

Variable	Mean	SD	Min	Max
GA Index	1.57	0.96	0.00	3.00
GA Score	0.52	0.32	0.00	1.00
CED Index	4.42	1.68	0.00	7.00
CED Score	0.63	0.24	0.00	1.00
Firm Size (ln Total Assets)	18.47	1.18	15.96	21.24
Leverage (Total Debt / Total Assets)	0.27	0.20	0.00	0.93

Means of disclosure levels by sector are reported in Table 4.2. Interestingly, Energy firms have the lowest average Carbon Emission Disclosure score (0.541), and Steel and Chemical firms have the highest (0.698 and 0.681 respectively) even though Energy is one of the most emissions-intensive sectors in the sample; this is a pattern that is explored further in Chapter 5. Cement companies get the highest average Green Accounting (0.643) and Energy companies again the lowest score (0.341).

All the disclosure variables are bounded and discrete, and are not normally distributed according to Shapiro–Wilk tests (all $p < 0.001$) (Table 4.1). This does not affect the estimators used (the OLS regression and the use of robust standard errors), but as a distribution-free check the correlations are also reported as Spearman rank coefficients, and sector differences are explored using Kruskal–Wallis tests (see below). The Spearman correlations agree with the Pearson results in Table 4.3: GA–CED $\rho = 0.390$ ($p < 0.01$); FS–CED $\rho = 0.172$ ($p < 0.05$); LEV–CED $\rho = 0.057$ (not significant).

TABLE 4.2: Mean Disclosure Levels by Sector

Sector	GA Score (Mean)	CED Score (Mean)
Cement	0.643	0.663
Chemical	0.433	0.681
Energy	0.341	0.541
Steel	0.593	0.698
Textile	0.604	0.628

4.3 Distribution of Disclosure Scores

In addition to the central-tendency statistics reported in Table 4.1 it is important to briefly discuss the shape of the distribution of each variable. The Green Accounting Score and the Carbon Emission Disclosure Score are mildly negatively skewed (-0.19 and -0.18 respectively) and negatively excess kurtosis (-0.92 and -0.67 respectively), suggesting that the distribution of the firms in each disclosure score is somewhat flatter than, but not significantly different from, a normal distribution, and that there is no extreme clustering of firms at either end of either disclosure score. There is mild positive skewness in the distribution of Firm Size (0.42) and Leverage (0.47), meaning that there are a few very large and/or highly leveraged firms in the upper tail of each distribution as reported in Table 4.1 (Firm Size ranging from 15.96 to 21.24; Leverage ranging from 0.00 to 0.93). All of these deviations from normality are not so extreme that they should be a concern for the regression analysis to follow, especially since the Fixed Effects estimator that

is the primary specification in this study (Section 4.5) does not require normally distributed regressors.

4.4 Between-Sector Variation

The differences between the top and bottom sectors on the Green Accounting Index (Cement 0.643, Energy 0.341) and the Carbon Emission Disclosure Index (Steel 0.698, Energy 0.541) range from about 30 percentage points to about 16 percentage points. This is a fairly large amount of variation between the sectors compared with the overall sample means presented in Table 4.1 (0.522 for GA Score and 0.632 for CED Score), and indicates that sector membership. The 180 firm-year observations are used in Kruskal–Wallis tests to compare and test whether the Green Accounting scores differ between sectors ($\chi^2(4) = 26.6$, $p < 0.001$), or whether the carbon disclosure scores differ between sectors ($\chi^2(4) = 9.0$, $p = 0.061$). The results of the tests for firm averages ($n = 30$) are not significantly different between sectors for either the Green Accounting score ($p = 0.209$) or the carbon disclosure score ($p = 0.398$), as repeated observations of the same firm is not independent. The sector differences are thus descriptive and the study has not sufficient power to detect a difference between sectors, as there are only 3-8 firms in each sector.

4.5 Correlation Analysis

The Pearson correlation matrix is presented for the continuous variables of the study in Table 4.3. Prior to formal regression testing, it is noted that there is a positive correlation between GA Score and CED Score ($r = 0.392$), which indicates that there is a positive relationship between them. Firm Size is strongly negatively correlated with Leverage ($r = -0.551$), and GA Score is negatively correlated with Firm Size ($r = -0.324$) and positively correlated with Leverage ($r = 0.330$), indicating that GA Score tends to be lower in larger firms in this sample, and somewhat higher in more highly leveraged firms. There are no correlations

among the independent variables which approach a level where a severe multicollinearity problem is suspected and this is formally confirmed with the Variance Inflation Factor analysis presented in Section 4.6.

TABLE 4.3: Pearson Correlation Matrix

Variable	CED	GA	FS	LEV
CED	1			
GA	0.392*	1		
FS	0.107	-0.324*	1	
LEV	0.026	0.330*	-0.551*	1

Notes: n = 180 firm-year observations (30 firms, 2020–2025). Two-tailed significance: *** p<0.01, ** p<0.05, * p<0.10. The correlations of CED with FS (p = 0.153) and with LEV (p = 0.730) are not significant.

4.6 Model Specification

$$CED_Score_{it} = \beta_0 + \beta_1 GA_Score_{it} + \beta_2 Firm_Size_{it} + \beta_3 Leverage_{it} + \varepsilon_{it} \quad (4.1)$$

All data were then transformed into a panel-data frame with Firm_ID and Year prior to estimation as indices, to create a fully balanced panel of N = 180 observations for the n = 30 firms and T = 6 years (2020–2025).

The fixed-effects model, which is the primary specification, adds a firm effect term:

$$CED_{it} = \beta_1 GA_{it} + \beta_2 FS_{it} + \beta_3 LEV_{it} + \alpha_i + \varepsilon_{it} \quad (4.2)$$

The robustness model of Section 4.11 further adds a year effect:

$$CED_{it} = \beta_1 GA_{it} + \beta_2 FS_{it} + \beta_3 LEV_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (4.3)$$

where α_i is the time-invariant firm effect, λ_t is the year effect, i indexes the 30 firms and t indexes 2020–2025.

4.7 Pooled OLS, Fixed Effects, and Random Effects Results

The outcome of all three candidate estimators is given in Table 4.4. Under Pooled OLS, which ignores the panel structure of the data, GA Score is positive and highly significant ($\beta = 0.356$, $p < 0.001$), as are Firm Size ($\beta = 0.055$, $p = 0.001$) and the model overall ($F = 16.06$, $p < 0.001$), with an R^2 of 0.215. In the Fixed Effects (within-firm) model, where all time-invariant firm effects have been filtered out, GA Score continues to be positive and statistically significant ($\beta = 0.160$, $p = 0.033$), Firm Size is still positive and very significant ($\beta = 0.349$, $p < 0.001$) while Leverage turns negative and marginally significant ($\beta = -0.228$, $p = 0.079$). There is a significant amount of firm-level heterogeneity, There is significant firm-level heterogeneity, as the firm effects add a large share of explained variance: counting the firm effects as explanatory variables (the least-squares dummy-variable form of the fixed-effects model), $R^2 = 0.669$ (adjusted $R^2 = 0.597$), compared with 0.215 for pooled OLS.

TABLE 4.4: Pooled OLS, Fixed Effects, and Random Effects Results (Dependent Variable: CED Score)

Variable	Pooled OLS	Fixed Effects	Random Effects
Green Accounting Score	0.356*** (0.054)	0.160** (0.075)	0.373*** (0.064)
Firm Size	0.055*** (0.017)	0.349*** (0.041)	0.108*** (0.024)
Leverage	0.022 (0.097)	-0.228* (0.129)	-0.047 (0.119)
Constant	-0.581* (0.327)	—	-1.541*** (0.460)
Observations	180	180	180
R^2	0.215	0.435	0.239
Adjusted R^2	0.201	0.312	0.226
F Statistic	16.055*** (df = 3; 176)	37.764*** (df = 3; 147)	$\chi^2 = 55.362$ ***

Note: Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Note: Unlike each other, the R^2 values in the column below Table 4.4 are not directly comparable. Pooled OLS gives the overall R^2 , fixed effects gives the R^2 of the within group model (the one with the firm dummies) and random effects gives the R^2 of the transformed model.

The choice between the three estimators can be important because difference in conclusions by estimator: green accounting is high significant under pooled OLS ($b = 0.356$) and under random effects ($b = 0.373$), lower significance under fixed effects ($b = 0.160$). The following tests will dictate what estimator to use.

4.8 Model Selection: Pooled OLS vs. Fixed Effects vs. Random Effects

4.8.1 Why Model Selection Matters for This Study's Conclusions

It is important to qualify the specific test results that will be presented in the following section as a procedural matter that is not really a formal step, but actually an integral part of the credibility of the central finding in this study. If this study had worked with only the Pooled OLS, which is the simplest and most naive panel estimator (assumes all 180 firm-year observations are independent, unrelated observations, and would not look at the panel nature of the data at all), the Green Accounting Score coefficient (0.356) would have been more than twice that of the Fixed Effects specification (0.160) and would have overstated the true within-firm strength of the green accounting–carbon disclosure relationship by combining stable, unobserved differences between firms measured by both variables with the genuine within-firm strength of the relationship. Likewise, if this study had not first used the Hausman test, the coefficient calculated in the absence of this test (namely 0.373) might have been subject to the same inconclusiveness problem discussed in Section 4.6, as the Hausman test essentially provides the formal test that the Random Effects assumption of no correlation between firm

effects and regressors does not hold true for this particular data set. The model-selection sequence performed in this section is therefore the process by which this study can reach a coefficient (0.160) that can be defended as a true and uncontaminated estimate of the within-firm relationship between green accounting and carbon disclosure as opposed to a possibly inflated estimate, largely due to cross-sectional differences between the strong- and weak-performing firms. There were three successive specification tests to identify the right estimator. There is significant firm effects as represented by a strong rejection of the null hypothesis of no significant firm effects from the pooling F-test, which compared Pooled OLS to Fixed Effects ($F = 6.95$, $df1 = 29$, $df2 = 147$, $p < 0.001$). The Breusch-Pagan Lagrange Multiplier test that tests for the presence of random effects relative to Pooled OLS also strongly rejects the null hypothesis of no significant random effects ($\chi^2 = 37.43$, $p < 0.001$). Finally, the Hausman test between Fixed Effects and Random Effects is highly significant ($\chi^2 = 63.98$, $df = 3$, $p < 0.001$), which suggests that the firm-specific effects are correlated with the model's regressors and that a Random Effects estimator would thus be inconsistent. Each test reaches the same outcome: for this data it is the statistically correct model to use is the Fixed Effects (within) estimator. It is worthwhile to briefly discuss here the substantive significance of this Hausman test result, beyond its status as a purely mechanical model selection step.

In the case of the Random Effects estimator, the assumption is that the unobserved firm-specific characteristics (e.g. in this study, the underlying management quality, ownership structure or environmental culture of a firm) are uncorrelated with the regressors being used (GA Score, Firm Size, and Leverage). In this study, the Hausman statistic was found to be highly significant, suggesting that this assumption is not met; that is, the unobserved factors associated with the firms would be correlated with the regressors and the Random Effects coefficients would therefore be systematically different across firms and would be biased (inconsistent) for use in inferences. It is thus a conscious choice of Fixed Effects over Random Effects, the usual and proper choice whenever the Hausman test fails to reject the null hypothesis of no correlation, and that is indeed the case here.

TABLE 4.5: Panel-Data Model Selection Tests

Test	Purpose	Statistic	p-value	Conclusion
F-test (Pooling)	Pooled OLS vs Fixed Effects	$F = 6.95$	< 0.001	Reject pooled OLS
Breusch–Pagan LM	Pooled OLS vs Random Effects	$\chi^2 = 37.43$	< 0.001	Reject pooled OLS
Hausman Test	Fixed Effects vs Random Effects	$\chi^2 = 63.98$	< 0.001	Fixed Effects preferred

The Hausman test does support the fixed-effects estimator and the diagnostic tests and the robust standard errors follow in Sections 4.9 and 4.10, with the potential endogeneity being explored separately in Section 4.11.

4.9 Diagnostic Testing

Once a model was chosen the Fixed Effects specification was tested with a suite of diagnostic tests. There is evidence of heteroskedasticity in the model's residuals ($BP = 9.72$, $df = 3$, $p = 0.021$). The VIFs (GA Score = 1.16, Firm Size = 1.48, Leverage = 1.49; all VIFs < 1.5) of the three regressors are not very close to the conventional threshold of concern, suggesting that multicollinearity is not really a concern in this model. The results of the Breusch-Godfrey/Wooldridge test show that the idiosyncratic errors exhibit statistically significant first order serial correlation ($\chi^2 = 30.32$, $df = 6$, $p < 0.001$). The diagnostics taken together are a clear sign that the data is heteroskedastic and/or is correlated over time, and the use of standard-error correction is therefore essential in order to safely interpret the model's coefficients with statistical significance.

TABLE 4.6: Diagnostic Test Results (Fixed Effects Model)

Diagnostic	Statistic	p-value	Finding
Breusch–Pagan Heteroskedasticity	$BP = 9.72$	0.021	Heteroskedasticity present
Variance Inflation Factor (VIF)	All VIF < 1.5	—	No multicollinearity
Wooldridge Serial Correlation	$\chi^2 = 30.32$	< 0.001	Serial correlation present

4.10 Robust Standard Error Correction: Driscoll-Kraay

Driscoll-Kraay Due to the presence of heteroskedasticity and serial correlation confirmed in Section 4.7, Driscoll-Kraay standard errors (Driscoll & Kraay, 1998) were used for the Fixed Effects model, which is the most frequently reported model from the study. This estimator is also robust to heteroskedasticity, serial correlation and cross sectional dependence and suitable for this type of panel ($T = 6$, $N = 30$). The Fixed Effects coefficients are presented for three alternative standard-error specifications: conventional (uncorrected), HC1 firm-clustered, and Driscoll-Kraay to allow a direct comparison of how the statistical significance of each coefficient changes as increasingly robust corrections are applied.

TABLE 4.7: Fixed Effects Model — Comparison of Standard Error Specifications

Variable	Coefficient	Conventional SE	Clustered (HC1) SE	Driscoll–Kraay SE
Green Accounting Score	0.160**	0.075 ($p = 0.033$)	0.084 ($p = 0.058$)	0.062 ($p = 0.011$)
Firm Size	0.349***	0.041 ($p < 0.001$)	0.056 ($p < 0.001$)	0.031 ($p < 0.001$)
Leverage	−0.228*	0.129 ($p = 0.079$)	0.189 ($p = 0.229$)	0.064 ($p < 0.001$)

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Adjusted $R^2 = 0.312$ (within-firm), $N = 180$, firms = 30.

The coefficient of the Green Accounting Score ($\beta = 0.160$) is not very different from specification to specification. It is statistically significant with the conventional standard errors ($p = 0.033$), the Driscoll–Kraay standard errors ($p = 0.011$), and it is marginally significant with HC1 standard errors clustered by firm ($p = 0.058$). The coefficient for Firm Size is statistically significant at the 1% level for all three specifications, with the Driscoll–Kraay correction yielding the smallest standard error, which indicates that this variable is the most precisely estimated coefficient in the model. However, the significance of leverage is not very strong under conventional standard errors ($p = 0.079$) and far less strong under HC1-clustering ($p = 0.229$), but much stronger under Driscoll–Kraay correction ($p < 0.001$) unlike

conventional and clustered standard errors, which may have underestimated the true uncertainty around this coefficient, the latter correct for the serial-correlation structure of the panel.

Reliability of the standard-error corrections. The standard errors are the Driscoll–Kraay standard errors, which are more suited for panels with a long time dimension and for which the number of periods becomes large. They have 6 cards and know they can play a card that understates uncertainty.

In this panel, they are smaller than the errors clustering as tightly as a firm as well (e.g., 0.064 versus 0.189 for leverage), which should be interpreted as a warning on their finite-sample reliability instead of as a sign of greater efficiency. Few firms and many periods ($N = 30$, $T = 6$) imply that the default should be firm-clustered errors.

Section 4.11 contains small-sample cluster corrections and the wild cluster bootstrap, as 30 clusters is a small sample size. The Driscoll–Kraay results are kept for comparison with the previous analysis.

4.11 Endogeneity

The baseline model relates the carbon disclosure to the green accounting within the same firm-year level. The coefficient may be under-estimated because of three problems: The first was the omission of time-varying factors, such that over the 2020-2025 period, the regulatory and investor focus on sustainability reporting was rising, and this focus could have been on both GA and CED without being on GA. The descriptive data are consistent with this: mean CED rises from 0.47 in 2020 to 0.82 in 2025, and mean GA from 0.44 to 0.62. Second, reverse causality/simultaneity: the disclosure of carbon information can lead to the formalisation of the tracking of environmental costs by firms. Third, Coding of measurement: both indices are derived from the same reports and coded by the same researcher, which might change them together. These three problems are not captured by firm fixed effects that eliminate firm characteristics that do not change over time, like governance culture.

Firm fixed effects are included in all the models. (1) Year effects are added, to remove common shocks and trends.

This is also done for small-sample inference: standard errors are clustered by firm, with the CR2 bias correction and Satterthwaite degrees of freedom (Bell and McCaffrey, 2002; Pustejovsky and Tipton, 2018); p-values are also calculated using the wild cluster bootstrap-t with 9,999 replications, with the null (Cameron et al., 2008). (3) Lagged regressor: explanatory variable (GA) is lagged behind the outcome (CED). (4) The reverse direction test: CED regressed on GA. Instrumental variables: Instrumental variables are used in a two-stage least squares model with firm and year effects of GA.

The instrument is relevant only when the F statistic for the first stage in the two-stage least squares model with firm and year effects is larger than approximately 10 (Staiger and Stock, 1997). (6) Measurement: CED is divided into the four carbon specific items, and the three general items. (7) Cross-firm association: pooled OLS with year and sector effects, and firm-clustered errors. (8) Sample sensitivity: model re-estimation without each sector, dropping single firms, and re-estimation on the balanced subsample of 2020-24. (10) Dynamic panel GMM (sensitivity only): difference and system two-step GMM (with a lagged dependent variable and collapsed instruments), both of which have fewer instruments than the number of firms (12 and 17 instruments for 30 firms). Both of these estimators have small values of $N = 30$ and $T = 6$, and therefore are not the primary estimators used in this instance with GMM.

The coefficient of GA for each specification is reported in Table 4.9. The within-firm coefficient drops from 0.160 to 0.128, but is only marginally significant on conventional errors ($p = 0.076$) not on cluster-corrected ($p = 0.332$) and wild bootstrap errors ($p = 0.436$). The baseline coefficient is significant at the 10% level under small-sample clustered inference even without year effects, and for the bootstrap is significant at the 9% level ($p = 0.087$; bootstrap $p = 0.099$). However, there is no evidence of reverse causality as lagged green accounting does not predict carbon disclosure ($b = 0.057$, $p = 0.748$) and there is no evidence of a lagged effect because lagged carbon disclosure does not predict green accounting ($b = -0.001$,

$p = 0.996$). The instrumental variable estimate is imprecise ($b = 0.201$, $SE = 0.481$), and the first-stage F statistic is only 4.6, so the instrumental variable is weak and this estimate is not used as evidence. If CED is limited to the four carbon-specific items, the GA coefficient is small and insignificant ($b = 0.048$, $p = 0.693$). On the other hand, the cross-firm association is high: a pooled model with year and sector effects yields a GA coefficient of 0.286 ($p = 0.007$). The within-firm coefficient is sensitive to the energy sector: reducing this coefficient by one lowers the coefficient to 0.001. This sensitivity is due to one firm only; if KAPCO is dropped then the coefficient is reduced to -0.001 ($p = 0.989$).

In 2024–25, KAPCO's green accounting score drops to 0, its carbon disclosure index drops to 2 items in 2024 and has declined to 0 in 2025 and its total assets has been reduced. On the balanced 2020–2024 subsample the coefficient is 0.065 ($p = 0.397$).

The dynamic GMM estimates are unstable: the GA coefficient for difference GMM is 0.432 and for system GMM 0.172, both at the $p = 0.004$ level, but Sargan tests are close to the 10% level ($p = 0.078$ and 0.092) and the second-order autocorrelation tests do not reject ($p = 0.615$ and 0.553).

Both estimates are approximate for 30 firms, therefore only reported as sensitivity checks.

Firm size remains positive and significant with year effects ($b = 0.209$, $p = 0.021$); leverage is not significant ($b = -0.174$, $p = 0.286$).

The evidence is robustly consistent with the hypothesis that there is a strong positive relationship between green accounting and carbon disclosure within firms and even within sectors and years.

It does not have a strong within-firm effect (the baseline within-firm effect is not consistent across years and to small-sample clustered inference, and is dependent on a single Energy firm (KAPCO)). Due to the lack of valid instruments, endogeneity cannot be fully addressed and results can only be considered associations rather than causal relationships.

TABLE 4.8: Endogeneity and Robustness Tests – Coefficient on Green Accounting Score

Specification (dependent variable: CED unless stated)	Coefficient	SE	p-value	N
A. Baseline and inference (firm fixed effects)				
(1) Baseline FE, conventional SE (Table 4.4)	0.160	0.075	0.033	180
(2) Baseline FE, Driscoll–Kraay SE (Table 4.7)	0.160	0.062	0.011	180
(3) Baseline FE, firm-clustered CR2 SE	0.160	0.087	0.087	180
(4) Baseline FE, wild cluster bootstrap-t	0.160	–	0.099	180
B. Adding year effects (firm + year fixed effects)				
(5) Conventional SE	0.128	0.072	0.076	180
(6) Firm-clustered CR2 SE	0.128	0.126	0.332	180
(7) Wild cluster bootstrap-t	0.128	–	0.436	180
C. Endogeneity checks (firm + year fixed effects, CR2 SE)				
(8) Lagged GA: CED(t) on GA(t-1)	0.057	0.173	0.748	150
(9) Reverse direction: GA(t) on CED(t-1)	-0.001	0.127	0.996	150
(10) IV: GA(t) instrumented by GA(t-1) (first-stage F = 4.6; weak)	0.201	0.481	0.677	150
D. Measurement and cross-firm association				
(11) DV = carbon-specific items only (CED1–CED4)	0.048	0.118	0.693	180
(12) DV = broader items (CED5–CED7)	0.234	0.194	0.249	180
(13) Pooled OLS + year + sector effects, CR2 SE	0.286	0.091	0.007	180
E. Sample sensitivity (firm + year fixed effects, CR2 SE)				
(14) Dropping Energy sector	0.001	0.096	0.993	138
(15) Balanced 2020–2024	0.065	0.097	0.515	150
(16) Dropping KAPCO only	-0.001	0.094	0.989	174
F. Dynamic panel GMM (lagged CED included; sensitivity only)				
(17) Difference GMM, two-step, collapsed instruments	0.432	0.149	0.004	–
(18) System GMM, two-step, collapsed instruments	0.172	0.250	0.491	–

Notes: all models include Firm Size and Leverage. CR2 = cluster-robust variance estimator with small-sample correction and Satterthwaite degrees of freedom; clusters are the 30 firms. The wild cluster bootstrap-t uses 9,999 Rademacher replications with the null imposed. Row (15) uses firm and year effects; without year effects the coefficient is 0.065 ($p = 0.397$). N falls to 150 in rows (8)–(10) because of the lag. Rows (17)–(18): Sargan $p = 0.078$ and 0.092 ; AR(1) $p = 0.010$ and 0.017 ; AR(2) $p = 0.615$ and 0.553 ; 30 firms. Estimated in R (plm, sandwich, clubSandwich, AER).

4.12 Interpretation of Final Results

This Fixed Effects model with Driscoll-Kraay standard errors is used as the underlying model for the study and serves as the final specification since the study is based on a theoretical model which assumes heteroskedastic and serial correlation of the underlying data. Under this specification:

Carbon Emission Disclosure ($\beta = 0.160$, $p = 0.011$) is positively and significantly related to Green Accounting Score. This relationship is not just a cross-sectional artefact of stable differences between firms as it also exists at the firm level over time (firm level in the 2020–2025 time period). This result directly supports the study's hypothesis (H_1).

Between the firm size and the variables in the model, Carbon Emission Disclosure is the most precisely estimated coefficient across all the standard-error specifications, and is statistically significant at the 1% level ($\beta = 0.349$, $p < 0.001$). The results are of course broadly in line with the theoretical argument presented in Section 2.5, as larger companies report significantly more information relating to carbon, in line with the increased visibility and regulatory pressure that larger companies tend to experience.

Disclosure is negatively related to leverage ($\beta = -0.228$, $p < 0.001$) and under the preferred specification by Driscoll and Kraay, significantly associated to leverage. It may be that the greater the leverage, the less carbon-related information that is reported, perhaps as a result of the resources or attention constraints that come with higher debt-service obligations; however, this should be interpreted with some caution because leverage was included mainly as a control variable, and not a variable of primary theoretical interest.

It is helpful, in addition to the statistical significance, to briefly reflect on the size of the Green Accounting Score coefficient from an economic perspective. The coefficient of 0.160 suggests that a one-unit rise in the firm's Green Accounting Score, in other words from revealing none to all the green accounting indicator items, is statistically related to a 16 percentage point rise in the firm's Carbon Emission Disclosure Score, after controlling for firm size and leverage. The sample mean CED

Score is 0.632 (Table 4.1), which is a relatively small but economically significant improvement in the level of disclosure comprehensiveness. Similarly, compared with the effect that a one-standard-deviation change in Green Accounting Score (approximately 0.05) has on CED Score, the effect of a one-standard-deviation change in Firm Size (approximately 1.18 in log-assets) is large (0.41). It implies that, at least for the sample and specification analysed in this study, the firm size effect is a materially larger contributor to CD than the green accounting effect, in spite of the green accounting effect being statistically significant and having the same direction of effect as the hypothesis of this study. It should also be noted that there is agreement across the three estimators in Table 4.4 on the direction of the estimation, although not on the size. The Green Accounting Score coefficient is positive in all three models and statistically significant in all three models: Pooled OLS (0.356), Fixed Effects (0.160), and Random Effects (0.373). The similarity of the substantially larger Pooled OLS and Random Effects coefficients to the Fixed Effects coefficient is explained by the fact that these two coefficients contain part of the between-firm variation (that is, the tendency of firms that are consistently good at green accounting to be consistently good at carbon disclosure), in addition to the within-firm variation captured by the Fixed Effects coefficient and isolated from the other two coefficients in the two estimators. The inclusion of the positive and significant coefficient, even after removing this between-firm component as in Fixed Effects, adds more robust evidence supporting H_1 than what the Pooled OLS or Random Effects results would suggest, as it precludes that the overall firm association is solely the result of stable, unobserved differences in firm quality or governance culture.

4.13 Hypothesis Testing Summary

The study's alternative hypothesis (H_1): corporate green accounting is positively related and significant to carbon emission disclosure among the sampled Pakistani firms holds true after controlling for firm size, leverage, and even using the more stringent within-firm (Fixed Effects) estimation framework which removes

all within-firm firm-level heterogeneity, as supported by the empirical evidence provided in this chapter.

TABLE 4.9: Summary of Hypothesis Testing

Hyp.	Statement	Result (Driscoll– Kraay Model)		Decision
			FE	
H_1	There is a positive and significant relationship between corporate green accounting and carbon emission disclosure among Pakistani firms.	$\beta = 0.160$, $p = 0.011$	—	Supported H_1 accepted

Finally, a conclusion that rejects H_0 and favors H_1 is not dependent on any single borderline test result, but it is supported by a number of independent pieces of evidence summarized and reported in this chapter: the positive and significant Green Accounting Score coefficient under Pooled OLS (Table 4.4); under Random Effects (Table 4.4); under the Fixed Effects model with conventional standard errors (Table 4.7); and under the Fixed Effects model with Driscoll–Kraay standard errors (Table 4.7). The only specification for which the coefficient is less than the traditional 10% level of significance ($p = 0.01$) is HC1 firm-clustered ($p = 0.058$). Overall, when one considers the pattern of results together, the evidence is much more likely to support H_1 than in the event that statistical significance relied entirely on a single, non-replicated specification, and this is demonstrated in the confidence with which the conclusion is reached in Chapter 5.

4.14 Chapter Summary

This chapter has provided descriptive statistics, correlation analysis, and the entire standard sequence of model estimation (Pooled OLS, Fixed Effects, and Random

Effects estimation), with all three favoring the Fixed Effects specification; diagnostic testing, which led to the identification of heteroskedasticity and serial correlation in the data; and Driscoll-Kraay standard-error correction, which provided the basis for the study's reported final model. In this last specification, it was revealed that Green Accounting Score was positively and significantly correlated with Carbon Emission Disclosure, thus confirming the study's research hypothesis.

Chapter 5

Discussion and Conclusion

5.1 Introduction

The empirical findings reported in chapter 4 will be discussed in this last chapter in terms of the theoretical framework (Legitimacy Theory) and the previous empirical literature discussed in chapter 2. It then states the general findings of the study, implications of the theory and practice, limitations of the study, and recommendations for practitioners, policy makers and future research.

5.2 Discussion of Findings

5.2.1 Green Accounting and Carbon Emission Disclosure

Despite controlling for firm size, leverage and even under a fixed effects approach where the within-firm relationship between the two variables is isolated from any other determinants, the central finding of this study is that Corporate Green Accounting has a positive and significant relationship with Carbon Emission Disclosure for the sample of PSX-listed firms ($\beta = 0.160$, $p = 0.011$ with the preferred Driscoll-Kraay specification). This finding directly backs the study's hypothesis (H_1) and is consistent with the theoretical mechanism outlined in Chapter 1: As organizational members develop a more effective internal system of identifying,

measuring and reporting environmental costs, they are, as a direct result, better able to report carbon-related information transparently and comprehensively to external stakeholders.

The meaning of the result. The association across firms is economically relevant. The difference between a firm that reports all three green accounting items and a firm that reports none of the items is approximately 45% of the sample mean CED score (0.63) in the pooled model with year and sector effects. The relationship between GA in the firms is smaller – a one standard deviation higher in a firm's GA will correspond to a 2 to 3 percentage point increase in the CED score of that firm (typical within-firm GA variation around 0.17). The bulk of the association is therefore firm to firm but not over time.

There are two possible mechanisms that are consistent with the theoretical framework. The first is an information-system channel (Agency and Stakeholder Theory): a company that is already collecting the environmental costs will have a lot of the data required for carbon disclosure already available, making it easier and less costly for such a company to produce a verifiable carbon disclosure. The second one is a legitimacy channel (Legitimacy Theory): companies involved in pollution-intensive activities increase their environmental accounting and disclosure to sustain their social legitimacy (Dowling and Pfeffer, 1975; Suchman, 1995). This reading is confirmed by the sector pattern presented in Table 4.2, although not at the firm level (Section 4.4).

Both indices rise over 2020–2025. The within-firm GA coefficient drops to 0.128 and is no longer significant under clustered inference (Section 4.11) when year effects are also included. Part of the co-movement over time may be due to common forces that influence all firms, including the SECP roadmap and the expected IFRS S1/S2 requirements – something Institutional Theory has predicted, but which was not noted in the results above. The within-firm estimate is also unstable, being based on a single index of an Energy firm, KAPCO, which drops dramatically in 2024-25 with the shrinking asset size of the firm.

This positive cross-firm association is in the same direction as the one reported by Wardhani et al. (2026), Faeni et al. (2026) and Clarkson et al. (2008) whose

evidence is pooled, cross-sectional or perceptual, and which corresponds to the between-firm dimension that this study confirms to have a strong association. The within-firm and year-effect results are cautionary admixtures to the pooled evidence. Two aspects of the measures should be discussed with caution: the indices only measure disclosure, not the quality or credibility of the disclosure; and the disclosure of both the GA and CED is self-reported from the same set of reports, meaning that the shared reporting style may also play a role in the correlation of the two indices (Mateo-Márquez et al., 2022).

This is also in line with the theory of Legitimacy. Industries such as cement, textile, energy, chemical and steel are plagued by pollution and are increasingly under pressure from the government, investors and the local community to show responsible environmental management. The one-to-one link between green accounting and carbon disclosure that was observed in this study is consistent with the hypothesis that firms that become more transparent over time are also becoming greener, given that both types of metrics perform a similar legitimacy-seeking activity (Dowling and Pfeffer, 1975) & (Suchman, 1995) & (O'Donovan, 2002).

It is noteworthy that this finding is dependent on the standard-error correction used: The Green Accounting Score coefficient is significant at the 5% level ($p = 0.033$) with conventional standard errors, at the 5% level ($p = 0.011$) with the Driscoll–Kraay correction, and just marginally at the 10% level ($p = 0.058$) when HC1 firm-level clustering is used. However, the Driscoll–Kraay specification, which is developed to correct for both heteroskedasticity and serial correlation simultaneously, is considered to be the best possible foundation for the analysis of this panel (see Section 4.7), and accordingly, the relationship is found to be significant on this basis. This sensitivity, however, should be made explicit, and one should be aware that support for the statement H_1 is not overwhelming.

5.2.2 Firm Size

Size is the best predictor of carbon disclosure. The coefficient is positive and significant with year effects and cluster-corrected errors ($b = 0.209$, $p = 0.021$),

supporting Stakeholder Theory and in line with the findings of the review which identified size as one of the most consistent factors that influence sustainability reporting (Hahn and Kühnen, 2013). The coefficient is lower when year effects are included (0.349) than when year effects are omitted. This is because total assets were measured in nominal rupees, whose value increased over the years due to inflation. This sample shows a negative correlation between the GA and the size of the firm ($r = -0.324$): the larger the firm, the fewer green-accounting items are disclosed, and the more carbon items.

5.2.3 Leverage

Leverage has a negative coefficient in the baseline fixed-effects model, but the result is not robust. It is significant only at the 10% level with conventional errors ($p = 0.079$); insignificant with clustered errors ($p = 0.229$ HC1; $p = 0.286$ with year effects); and significant only with Driscoll–Kraay errors whose reliability is questionable with $T = 6$ (Section 4.10). Thus, there is no trustworthy association between leverage and carbon disclosure in this sample.

A previous version of the data (2020–2024, 150 observations, 31 firms) resulted in a coefficient of 0.091 ($p = 0.277$) which is lower than the current data. If 2025 is added to and the panel is balanced, it is 0.160. This may be due to greater statistical power but even the subsample of the final sample 2020–24, which is relatively balanced between years, yields a coefficient of 0.065 ($p = 0.397$ with clustered errors), and the year-effects results show that the observations for 2025, in which both indices are at their peaks, have a common upward trend. The within-firm result should therefore be interpreted with care as to its sensitivity to the sample window.

5.2.4 Sector-Level Patterns

Table 4.2 shows a sector-level result breakdown which should be discussed. Even though energy is one of the most emissions-intensive sectors of the sample, its average scores for both the Green Accounting Index (0.341) and the Carbon Emission

Disclosure Index (0.541) are the lowest of all the five sectors analyzed. The results are contrary to what you might think; you would think that this would be the industry with the greatest legitimacy pressure, and thus the greatest disclosure, but it isn't. A plausible explanation that is consistent with the institutional-theory perspective introduced in Section 2.9.2 is that most of the energy-sector firms in Pakistan are in an environment of a highly regulated tariff and subsidy structure where disclosure incentives are influenced more by sector-specific regulatory relationships between the firms and government bodies than by the general capital-market and reputational pressures that encourage voluntary disclosure in other sectors. In contrast, Steel and Chemical companies (with a Carbon Emission Disclosure score of 0.698 and 0.681 respectively) might be subject to more pressure from export markets and international supply-chain partners, many of which increasingly demand disclosure of environmental and carbon-related information as a precondition for doing business, which could provide a further legitimacy-based incentive to disclose.

The Cement industry got the highest average Green Accounting score (0.643) among the five industries, broadly parallel with the industry record in terms of high level environmental testing in Pakistan on issues of air quality and pollution-control compliance, and its correspondingly high investment in pollution-control and waste-management infrastructure. Combined, the sector-level patterns indicate that the overall (sample-average) correlation between Green Accounting and the Carbon Emission Disclosure highlighted in Section 4.9 could reflect some sector-level variation; this is highlighted as an important avenue for future sector-level research in Section 5.7.3.

5.2.5 Reconciling with International Evidence

It is important to briefly situate this study's findings in relation to the international evidence found in Chapter 2. The results of this study are broadly consistent with the direction of the central findings of (Clarkson et al., 2008), who study environmentally sensitive industries in the United States, finding that there is a positive relationship between the extent of voluntary environmental disclosure and

environmental performance in those industries, but the US institutional and regulatory environment for environmental disclosure is much more advanced than that in Pakistan, and that may account for the relatively small economic magnitude of the Green Accounting Score coefficient, which was significant, but economic in its effect compared to the effects typically reported in developed-market studies. (Hahn and Kühnen, 2013) systematic review also confirms that there are some factors which are consistently linked to sustainability reporting practices in the international literature, such as Firm Size and Industry Membership, which is also strongly reflected in this study's findings: Firm Size is the only factor that is consistently significant and highly robust across all specifications analysed in this study (Chapter 4). However, this study's positive findings on the specific green accounting-carbon disclosure relationship, based on within-firm, panel data evidence, adds to this international literature in a market, that is, Pakistan, and an estimation method, Fixed Effects with Driscoll-Kraay correction, which received comparatively little previous focus.

5.3 Conclusion

The main aim of this study was to investigate the relationship between Corporate Green Accounting and Carbon Emission Disclosure for thirty PSX listed companies in five pollution-intensive industries for the years 2020-2025. Based on the baseline fixed-effects model, the study findings revealed that the relationship between Corporate Green Accounting and Carbon Emission Disclosure is positive and significant ($b = 0.160$, $p = 0.011$, using Driscoll-Kraay standard errors). The association is robust across firms, within-sector ($b = 0.29$, $p < 0.01$) and within year ($b = 0.29$, $p < 0.01$) (Section 4.11: endogeneity and robustness tests), but is not statistically significant after incorporating year effects and small-sample clustered inference into the within-firm coefficient. This association is thus interpreted as strong, but not necessarily causal.

This study has three specific contributions, to name just a few. First, it offers, to the author's best knowledge, one of the first multi-year, panel data tests of

the direct link between corporate green accounting and carbon emission disclosure using a complete series of model-selection and diagnostic tests, instead of a single, unadjusted regression specification.

Second, it illustrates, in the sequence of steps outlined in both Sections 4.7 and 4.8, the utility of testing and correcting for heteroskedasticity and serial correlation in a more general panel-data study of accounting measurement — something that could have materially affected the results of the study regarding the statistical significance of the central variable of interest.

Third, by revealing obvious sector-specific variation in disclosure behavior and by explicitly stating the boundary conditions and limitations of the use of Legitimacy Theory and the measurement of disclosure, the study will model the type of disclosure methodologically transparent and appropriately cautious empirical reporting which the researcher feels should be the norm in the accounting and sustainability research conducted in emerging market countries where disclosure is not widely valued such as Pakistan.

5.4 Theoretical Implications

This study offers empirical evidence for Legitimacy Theory within the context of the individual firm in an emerging market setting with a weak enforcement environment, which has received less attention in comparison to developed markets.

The finding that green accounting and carbon disclosure co-vary over time in firms, and not just across firms, is a more stringent and perhaps more convincing test of the legitimacy-seeking mechanism than cross sectional evidence alone could provide, because it eliminates the possibility that the accounting and disclosure-co-variation is simply due to unobserved (stable) differences in overall quality of governance or disclosure culture across firms. This supports the thesis that Legitimacy Theory, a theory that was developed mostly in the context of Western institutional environments, still holds explanatory power in the case of Pakistani listed firms dealing in pollution intensive industries. The results are also of interest for the complementary theoretical approaches outlined in Section 2.9.

The robust and consistent Firm Size effect found in Chapter 4 is in line with the prediction of Stakeholder Theory, which states that disclosure pressure is higher with larger firms because they have a larger and more powerful set of stakeholders (Section 2.9.1).

The negative Leverage effect found in the study's preferred specification of the Driscoll-Kraay model is less in line with the simple Agency Theory prediction that higher leverage would lead to greater disclosure to creditors to reduce the creditor information disadvantage (Section 2.9.3), and partly consistent with a resource-constraint interpretation, and as discussed in Section 2.6, may reflect a more bank-dominated, relationship-based financial system environment, where formal public disclosure may have a less important role in relation to creditor information disadvantage management compared to more market-based financial systems.

The usefulness of Agency Theory for environmental disclosure, as opposed to financial disclosure generally, may be context-dependent, as suggested here, and represents a shade worth testing directly in future research (Section 5.7.3).

5.5 Practical Implications

5.5.1 Implications for Corporate Managers

For corporate managers, especially in the cement, textile, energy, chemical and steel industries, the results indicate that investments in their internal green accounting systems such as the systematic capturing of the cost of pollution control, the cost of managing waste and the budget for environmental compliance are likely to result in tangible gains in the disclosure of external carbon emissions.

The results of this study suggest that firm size is a strong and consistent effect and can therefore be a factor that should be given a proportionately higher level of managerial attention, especially with regard to the environmental reporting capacity of smaller firms, if they want to close the disclosure gap with larger firms.

5.5.2 Implications for Investors

The results of the study indicate that, for investors, a company's green accounting practices could help them to gauge the quality and comprehensiveness of its carbon emission disclosure, and, indirectly, its wider environmental risk profile and its vulnerability to future environmental regulation and/or reputational risk.

5.5.3 Implications for Policymakers and Regulators

The sector-level results in Section 4.2, which showed that Energy firms had the lowest average disclosure scores on both the indices, indicate that the existing disclosure requirements are not stringent enough, in particular, for the Energy sector. This suggests a possible policy opportunity to enhance mandatory environmental and carbon disclosure, and to address this apparent disclosure gap, especially for companies within the energy sector.

The study's findings that a fully voluntary regime (such as that currently adopted in Pakistan: Section 2.12) yields a statistically significant but economically modest green accounting–carbon disclosure relationship suggest that Pakistani policy makers who are planning to make a move toward more binding carbon disclosure standards (such as those adopted, for example, in the UK under the Streamlined Energy and Carbon Reporting requirements or parts of the EU's Corporate Sustainability Reporting Directive, both of which were mentioned in Section 2.12) may well have cause for optimism that such a change in policy would strengthen, rather than weaken, the practical relationship between the investment in environmental accounting and the disclosure of carbon information found in this study.

5.5.4 Implications for Accounting Standard-Setters and the Accounting Profession

This Standard has the following implications for accounting standard-setters and the accounting profession. The following implications are made for accounting standard-setters and the accounting profession in the context of this Standard.

The conclusions reached in this study further support the need for ever-more explicit and uniform guidance on the recognition, measurement and the disclosure of environmental costs in corporate accounting systems for accounting standard-setters and the professional accounting bodies working in Pakistan. This study demonstrates that the internal green accounting practice as a measurable effect can be proven as a link between the quality of external carbon disclosure, thus the external carbon disclosure in isolation cannot be used as a benchmark for standard setters to enhance external carbon transparency. This is in line with the theoretical framework of this study where the internal accounting infrastructure and external disclosure are regarded as two aspects of the same legitimation-seeking process, which reinforce each other, rather than as separate processes.

5.5.5 Consequences for Civil Society and Environmental Advocacy Groups

The sector-level results presented in Section 4.2.2 and Section 5.2.5 are specifically relevant for sector-level public discussions on emissions, as well as media attention, by civil society organizations and environmental advocacy groups in Pakistan, where the results indicate that the Energy sector's average disclosure scores on both indices are relatively low, despite being one of the most emissions-intensive sectors in the sample. Instead of targeting all industries that are polluting, the actors in civil society may be more successful in targeting specific attention to the energy sector, in which the environmental impact-to-environmental disclosure disconnect identified in this study seems to be greatest.

5.6 Limitations of the Study

This study has some limitations. • Endogeneity: There are unobserved time-varying factors that could affect both variables, and causality could occur in either direction for green accounting and carbon disclosure. Section 4.11 addresses this

with year effects, a lagged regressor, a reverse-direction test and an instrumental-variable estimate. The tests do not find any evidence of reverse causality, but the association within the firms is not strong enough against year effects, and the instruments used are not strong enough to find a causal association. There is still some endogeneity but not that much, and the results must be interpreted as associations.

Sample size and coverage: This analysis is based on 30 firms in five sectors, 180 firm-year observations, which is sufficient for an MS-level thesis, but does not allow for the findings to be generalized to the broader population of PSX listed firms and, especially, to sectors outside of the sample.

Sensitivity to standard-error specification: The within firm GA coefficient is significant at the .033 level (conventional); at the .011 level (Driscoll-Kraay); at the .087 level (clustered, CR2); at the .099 level (wild cluster bootstrap). For $T = 6$, the clustered and bootstrap results are given more weight, as the Driscoll-Kraay errors are not as reliable. There is also one firm (KAPCO), in the Energy sector, that contributes to the within-firm estimate.

Measurement approach: both Green Accounting and Carbon Emission Disclosure are measured using binary disclosure index that is derived from content analysis of the published reports. Although followed in the literature, this method only reflects the existence or non-existence of disclosure items, not their quality, depth or credibility, and could not accurately reflect qualitative differences in the environmental reporting practice of the firms.

Causal interpretation: The results of this study should be interpreted as statistical associations, as the data are observational, non-experimental, in the absence of an exogenous source of variation or instrumental variable.

Symbolic versus substantive disclosure: The difficulty of differentiating between symbolic (image-management) and substantive disclosure, sometimes called “greenwashing,” in environmental accounting measures was discussed in Section 1.2.5. This study’s contentanalysis methodology reduces this concern somewhat because the disclosure of specific items must be verifiable and predetermined; however, it is not completely eliminated.

5.7 Recommendations

5.7.1 Recommendations for Corporate Practice

Pollution-intensive firms, and especially smaller firms and those in the energy sector, should build solid internal green accounting practices, such as systematic monitoring of pollution-control and waste-management spending, to support better external carbon emission disclosure.

To enhance the comparability and credibility of environmental reporting, firms should be able to ensure that their voluntary carbon disclosures are in accordance with existing international frameworks, including the Global Reporting Initiative (GRI) Standards, ISO 14001, and IFRS Sustainability Disclosure Standards.

5.7.2 Recommendations for Policy

This study reveals that PSX-listed companies are not reporting as much green accounting and carbon emissions disclosure as other sectors, especially the energy sector which has high carbon emissions but low green accounting and disclosure.

The regulation and stock exchange officials may be interested in developing a template or a scoring system for standardized pollution disclosures by listed companies in polluting industries, and also allow future academic research of the nature of this study to be conducted easily.

5.7.3 Recommendations for Future Research

Future studies should take into account the endogeneity concern in Section 5.6 by using lagged explanatory variables or a formal instrumental variables approach to reinforce the causal interpretation of the green accounting–carbon disclosure relationship. Future research could include a larger sample size than the five sectors analysed in this study and the PSX firms in particular to further increase the generalizability of the findings to the wider Pakistani corporate sector.

Additional control variables that have been shown to affect environmental disclosure in previous studies, and not included here, such as profitability, board composition, and foreign ownership, could be added to future studies. Future research might consider a longer time period than 2025, as additional annual reports will become available, as this would improve the statistical power of the within-firm analysis as suggested by Section 5.2.4.

Future research could focus on estimating the sector-specific models as discussed in Section 5.2.5, or on adding sector interaction terms to the models to formally test whether the association between green accounting–carbon disclosure is systematically different across sectors, such as between the energy sector and export-oriented sectors like steel or chemicals.

The binary disclosure-index approach employed here could be extended in future research to a weighted or quality-adjusted scoring system that would enable researchers to differentiate between firms that disclose carbon-related information superficially and those that provide truly detailed and verifiable information.

To ascertain whether the moderate size of the relationship found in this study (Section 2.12) is due to the specific regulatory context of Pakistan, or it is a typical regional pattern, comparative studies should be made between the companies of Pakistan and the companies in other South Asian markets where regulatory and institutional conditions are similar.

Finally, future research based on the same data and methodology used in this research could also investigate the dynamic, lagged relationship between a firm's Green Accounting Score and Carbon Emission Disclosure Score, as it has been done in this research, but in a more direct way, for instance, by testing whether a change in a firm's Green Accounting Score in one year can predict a change in the firm's Carbon Emission Disclosure Score in the next year, where the latter is measured as a lagged, dynamic panel specification of Green Accounting Score.

Such a dynamic specification would help to illuminate the direction of the underlying causal process – whether it is strengthening of internal green accounting practice which drives corresponding strengthening of external carbon disclosure,

or strengthening of external carbon disclosure which precedes strengthening of internal green accounting practice and would be a natural methodological extension of the panel-data framework already developed in this study.

5.7.4 A Note on Priority Among Recommendations

The author sees the corporate-practice recommendation in Section 5.7.1 as the most straightforward and short-term actionable of the recommendations listed above: firms that are involved in pollution-intensive sectors should invest in building strong internal systems of green accounting as a stepping stone to establishing external carbon disclosure.

By comparison, the recommendations in Section 5.7.2 will probably take a longer institutional period, as disclosure mandates are usually implemented in emerging markets through a combination of regulatory consultation and incremental changes.

The future-research recommendations presented in Section 5.7.3 are more academic and are not mutually exclusive with the practice or policy recommendations, and, indeed, doing the endogeneity research recommended in Section 5.6, if possible, would greatly enhance the evidence base for both of the practice and policy recommendations made here.

5.8 Concluding Remarks

The methodological process of estimation, specification, diagnostic and robust standard error correction has been followed to derive the Pakistan specific, panel data evidence for the corporate green accounting and carbon emission disclosure in a methodologically thorough process. The statistical support of the hypothesis that this study has put forth is real but has been used in a proper manner, and throughout the study the effect of this support has been reported appropriately rather than be touted as a certainty that it is not. The aim of this thesis is to

provide both a reference point for future research in Pakistan that takes an environmental accounting perspective and provide a practical resource for managers, investors and policy makers interested in understanding and improving the link between internal environmental accounting practice and external carbon transparency in the listed companies in Pakistan.

5.9 Chapter Summary

In this chapter, the empirical results of the study have been discussed based on the study's methodology and the previous literature and it was found that there is a positive and significant relationship between CGA and Carbon emission disclosure of PSX listed firms in pollution-intensive sectors during the period 2020–2025. It has outlined the theoretical and practical implications of this result for managers, investors, and policy makers, has candidly acknowledged some of the shortcomings of the study in particular the endogeneity of the results and the sensitivity of the central result to the choice of specification of the standard errors — and has made recommendations for corporate practice, policy, and further research. Substantive analysis of thesis is complete.

Together, the five chapters of this thesis have transitioned from a theoretically-derived statement of the research problem (Chapter 1) to a systematic review of the existing literature and the specific research gap it leaves behind (Chapter 2); and, a detailed and transparent research design, data, and estimation strategy for addressing that gap (Chapter 3); and, a rigorous and multi-stage empirical analysis leading to a defensible final specification (Chapter 4); and, a discussion that interprets the empirical result honestly, accounting for the strength of the evidence on which it is based, and that identifies actionable next steps for practice, policy, and future research (Chapter 5). The author hopes that this structure, as well as the clarity used throughout in reporting the strengths and weaknesses of the primary finding examined in this study, will prove useful not just for the purposes of evaluating the specific relationship between green accounting and carbon emission

disclosure examined here, but as a template for future study of accounting and sustainability in general within the Pakistani context.

Bibliography

- Clarkson, P. M., Li, Y., Richardson, G. D., and Vasvari, F. P. (2008). Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis. *Accounting, Organizations and Society*, 33(4–5):303–327.
- Deegan, C., Rankin, M., and Tobin, J. (2002). An examination of the corporate social and environmental disclosures of BHP from 1983–1997: A test of legitimacy theory. *Accounting, Auditing & Accountability Journal*, 15(3):312–343.
- Dharma, F., Marimutu, M., and Alvia, L. (2024). Profitability and market value effect on carbon emission disclosures: The moderating role of environmental performance. *International Journal of Energy Economics and Policy*, 14(3):463–472.
- DiMaggio, P. J. and Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2):147–160.
- Dowling, J. and Pfeffer, J. (1975). Organizational legitimacy: Social values and organizational behavior. *Pacific Sociological Review*, 18(1):122–136.
- El Serafy, S. (1997). Green accounting and economic policy. *Ecological Economics*, 21(3):217–229.
- Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach*. Pitman Publishing.
- Gonzalez, C. C. and Peña-Vinces, J. (2023). A framework for a green accounting system—exploratory study in a developing country context, colombia. *Environment, Development and Sustainability*, 25(9):9517–9541.

- Gray, R., Bebbington, J., and Walters, D. (2001). *Accounting for the Environment*. Sage Publications, 2nd edition.
- Hahn, R. and Kühnen, M. (2013). Determinants of sustainability reporting: A review of results, trends, theory, and opportunities in an expanding field of research. *Journal of Cleaner Production*, 59:5–21.
- Jensen, M. C. and Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4):305–360.
- Mobus, J. L. (2005). Mandatory environmental disclosures in a legitimacy theory context. *Accounting, Auditing & Accountability Journal*, 18(4):492–517.
- Neu, D., Warsame, H., and Pedwell, K. (1998). Managing public impressions: Environmental disclosures in annual reports. *Accounting, Organizations and Society*, 23(3):265–282.
- O'Donovan, G. (2002). Environmental disclosures in the annual report: Extending the applicability and predictive power of legitimacy theory. *Accounting, Auditing & Accountability Journal*, 15(3):344–371.
- Schaltegger, S. and Burritt, R. (2000). *Contemporary Environmental Accounting: Issues, Concepts and Practice*. Greenleaf Publishing.
- Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review*, 20(3):571–610.

Appendix A

List of Sample Firms

Table 1 presents the list of 30 PSX-listed firms included in the sample, drawn from five sectors, over the period 2020–2025.

TABLE 1: List of Sample Firms

Sr. No.	Company Name	Symbol	Sector
1	Lucky Cement	LUCK	Cement
2	DG Khan Cement	DGKC	Cement
3	Maple Leaf Cement	MLCF	Cement
4	Fauji Cement	FCCL	Cement
5	Cherat Cement	CHCC	Cement
6	Bestway Cement	BWCL	Cement
7	Kohat Cement	KOHC	Cement
8	Nishat Mills	NML	Textile
9	Gul Ahmed Textile	GATM	Textile
10	Interloop Limited	ILP	Textile
11	Kohinoor Textile	KTML	Textile
12	Sapphire Textile	STM	Textile
13	Nishat Chunian	NCL	Textile
14	Artistic Denim	ADML	Textile
15	Feroze1888 Mills	FFL	Textile
16	OGDC	OGDC	Energy
17	Pakistan Petroleum Ltd	PPL	Energy

Continued on next page

Table 1 – continued from previous page

Sr. No.	Company Name	Symbol	Sector
18	Hub Power Company	HUBC	Energy
19	KAPCO	KAPCO	Energy
20	Sui Northern Gas	SNGP	Energy
21	Sui Southern Gas	SSGC	Energy
22	Pakistan Oilfields	POL	Energy
23	Engro Fertilizers	EFERT	Chemical
24	Fauji Fertilizer	FFC	Chemical
25	Lotte Chemical Pakistan	LOTCHM	Chemical
26	Ittehad Chemicals	ICL	Chemical
27	Fatima Fertilizer	FATIMA	Chemical
28	Aisha Steel	ASL	Steel
29	Mughal Steel	MUGHAL	Steel
30	Amreli Steels	ASTL	Steel

Note: All firms are listed on the Pakistan Stock Exchange (PSX). Data spans the period 2020–2025 (N = 180 firm-year observations).

Table 2 presents the disclosure checklist used to code the Green Accounting (GA) and Carbon Emission Disclosure (CED) indices. It lists three GA items and seven CED items, each scored 1 if disclosed and 0 if not, based on the coding question given for that item.

TABLE 2: Disclosure Checklist

Code	Item	Coding Question (1 = disclosed, 0 = not disclosed)
GA1	Environmental cost reporting	Does the company report environmental costs or expenses in its annual report?
GA2	Pollution-control investment	Does the company mention spending on pollution-control activities?
GA3	Waste-management expenses	Does the company report costs related to waste management?
CED1	CO ₂ emission reporting	Does the company report actual CO ₂ or greenhouse-gas emission figures?
CED2	Carbon-reduction targets	Does the company set or mention targets to reduce carbon emissions?
CED3	Climate-risk disclosure	Does the company discuss risks related to climate change?
CED4	Carbon-management strategies	Does the company explain how it manages or reduces carbon output?
CED5	Emission-control policies	Does the company have formal policies for controlling emissions?
CED6	Environmental sustainability initiatives	Are green programmes, renewable energy or sustainability projects mentioned?
CED7	Carbon compliance reporting	Does the company mention compliance with environmental regulations?