On the Relationship Between Government Subsidies, ESG performance and the Stock Market

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A thesis submitted for the degree of

Doctor of Philosophy in Finance

Essex Business School
University of Essex
July 2025

Acknowledgement

I would like to begin by expressing my deepest gratitude to my family, especially my parents, for the unwavering love and care they have shown me over the past 28 years. Their continuous support and encouragement have been indispensable throughout my academic journey and personal growth.

I am also immensely thankful to my supervisors, Professor Alexandros Kontonikas and Professor Sotirios Kokas, for their invaluable guidance, insightful comments, and constructive criticisms over the past three years. Their mentorship has not only shaped my research but also enriched my understanding of the broader field of finance and economics.

Additionally, I would like to extend my appreciation to all colleagues and administrative staff at the Essex Business School. Their assistance and support have greatly facilitated my work, and their dedication to fostering a collaborative environment has been a significant part of my positive doctoral experience.

Without the collective efforts and generosity of these individuals, this thesis would not have been possible. I am truly grateful for their contributions, and I hope this thesis reflects the care, knowledge, and inspiration they have so generously shared with me.

Abstract

This thesis examines the interactions between government subsidies, firms' environmental, social, and governance (ESG) performance, and stock market reactions. It focuses on how ESG-related subsidies influence corporate behaviour and investor perceptions, subsequently impacting stock market outcomes. Chapter I provides an overview and introduces the research objectives of the thesis. Chapter II demonstrates that higher ESG subsidies lead to significant improvements in firms' ESG performance, particularly after the Paris Agreement. These improvements are more pronounced among larger firms and state-owned enterprises (SOEs) compared to their counterparts. Chapter III employs event study methodology to illustrate that positive stock market reactions to ESG subsidy policy announcements are predominantly observed among firms with robust ESG standings, highlighting investor preferences for sustainable practices. The market impact of ESG subsidies intensifies post-Paris Agreement; however, SOEs experience relatively weaker effects than non-SOEs.Chapter IV introduces Institutional Social Responsibility Concentration (ISRC), showing that stocks receiving larger allocations from socially responsible mutual funds tend to achieve higher future returns, driven by enhanced ESG performance and greater market stability. This relationship further strengthens following the Paris Agreement, underscoring the global shift toward sustainability. Chapter V concludes the thesis and outlines potential directions for future research. Collectively, this work contributes to the sustainable finance literature and provides valuable insights for policymakers, investors, and stakeholders committed to advancing corporate sustainability.

Declaration

I hereby affirm that all materials and results not originally produced in this work have been fully cited and referenced. Unless explicitly credited to others, this thesis represents solely my original research, conducted entirely as my independent solo work under the supervision of my supervisors, and has not been submitted for any other degree at the University of Essex or any other institution.

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Chapter I

Introduction

Over the past decades, climate change risks have shifted from being a niche scientific concern to a central focus of policymaking and business strategy. This heightened awareness underpins the motivation for intensified environmental measures. In 2015, the Paris Agreement was established as a landmark international treaty to limit global warming well below 2°C, galvanizing governments worldwide—including China—to reinforce environmental regulations and foster sustainable development. Meanwhile, the discipline of sustainable finance has grown rapidly, aligning economic activities with broader environmental and social objectives. As a result, Environmental, Social, and Governance (ESG) considerations have become paramount for firms seeking to meet societal expectations.

As the world's largest carbon emitter and a key party to the Paris Agreement, China has pledged to achieve carbon neutrality by 2060. This commitment makes China not only central to global decarbonization efforts but also an ideal empirical context for studying how policy and finance interact to shape ESG outcomes. Unlike developed markets, China features a state-dominated financial system in which state-owned enterprises (SOEs) and politically connected firms play outsized roles. This distinctive institutional setting provides a unique opportunity to examine how government-led ESG interventions function under non-market conditions. Governments around the world, including China, use fiscal incentives—such as direct special financial subsidies[1]—to correct market failures, support certain industries, and achieve their ESG goals. In China's state-dominated financial system, politically connected firms often receive preferential treatment and are expected to undertake more ESG-related activities to meet governmental targets, strengthening their ESG commitment in the process. Furthermore, as global awareness of climate risks

[1] Referred to in this thesis as ESG-related subsidies.

increases, substantial capital flows into ESG-compliant investments reshape investor preferences and influence asset pricing. This trend extends to Socially Responsible Investing (SRI), where investors pursue not only financial returns but also positive social impacts and other non-monetary benefits. With long-term investment horizons, SRI investors focus less on short-term mispricings and more on promoting corporate transparency in climate risk disclosures, thereby driving firms toward more effective climate risk management. The motivation behind this thesis is to examine how government-led ESG subsidy policies and market forces shape corporate behaviours and stock market performances, particularly in emerging economies such as China. China's unique institutional setting, characterized by its state-dominated financial system and the central role of SOEs and politically connected firms, provides a distinct empirical setting to explore how fiscal incentives like ESG-related subsidies influence ESG performance and market behaviour. Unlike market-driven ESG adoption observed in developed economies, China's top-down policy-driven approach introduces a unique pathway through which government interventions directly impact firm-level ESG outcomes, bypassing traditional market mechanisms.

However, the existing literature on ESG and sustainable finance predominantly focuses on developed markets, where corporate sustainability is largely shaped by market-driven mechanisms. Seminal studies by Dyck et al. (2019), Bolton and Kacperczyk (2020), Bolton and Kacperczyk (2021), Bolton and Kacperczyk (2023a), and Bolton and Kacperczyk (2023b) have extensively explored how investor ESG preferences and carbon risk pricing influence market outcomes. Despite these advances, the role of direct government interventions, such as ESG-related subsidies, remains significantly under-explored, especially in emerging economies like China. Given China's unique financial architecture, where SOEs and politically connected firms play dominant roles, understanding the impact of these subsidies on ESG performance and market valuation is crucial. Moreover, the effectiveness of these subsidies in enhancing corporate ESG performance under a state-dominated financial system presents a significant gap in the literature. Furthermore, current ESG performance metrics, which are largely self-disclosed and updated annually, fail to capture

real-time shifts in investor sentiment and firm-level ESG practices. This limitation underscores the need for more granular, investor-driven indicators that reflect both market perceptions and policy-induced changes dynamically. To address these gaps, we introduce novel methodologies to evaluate the effectiveness of ESG subsidies and proposes a new stock-level metric—Institutional Social Responsibility Concentration (ISRC)— designed to capture the degree to which socially responsible investors allocate capital to individual firms, to better capture investor commitment to sustainability in China's distinctive market context. By integrating policy-driven ESG interventions with investor-driven market responses, this research aims to provide a more comprehensive understanding of ESG's role in emerging economies, bridging the gap between policy implementation and market perception.

Overall, we explore three main questions in this thesis: (1) how ESG-related subsidies influence firm-level ESG performance (Chapter II); (2) how ESG-related subsidy policies affect stock market behaviour (Chapter III); and (3) how SRI behaviour impacts stock market performance (Chapter IV). By investigating these dimensions, we demonstrate that the synergy among ESG practices, government interventions, and SRI creates a robust framework essential for building resilient, sustainable economic pathways in practice. This framework not only mitigates the immediate threats posed by climate change but also fosters long-term economic sustainability.

This thesis is organised around a unified policy–performance–pricing mechanism that links the three empirical chapters. Exogenous sustainability policy signals and fiscal instruments—especially ESG-related subsidies and the salience created after the 2015 Paris Agreement—shift firms' incentives and information environments, as shown in corporate finance and market efficiency research (Bond and Goldstein 2015; Carpenter et al. 2021; Bolton and Kacperczyk 2023a; Bolton and Kacperczyk 2023b). Firms respond by upgrading ESG practices that improve transparency, governance quality, and risk management, thereby affecting expected cash flows and perceived risk. Investor preferences then transmit these real adjustments into prices: sustainability-oriented investors derive non-pecuniary utility from greener cash flows and

tilt portfolios accordingly, with implications for discount rates and required returns (Pedersen et al. 2021; Pástor et al. 2021; Pástor et al. 2023; Cornell 2021). Stronger ESG practices also reduce information asymmetry and tail risk, stabilising trading and lowering crash probabilities (Kim et al. 2014; Avramov et al. 2022). These dynamics are amplified in China's state-influenced setting, where policy signals are salient and announcement reactions are sharp (Allen et al. 2024; Connolly and Stivers 2003). Within this framework, Chapter II establishes the policy - performance link by showing that targeted ESG-related subsidies raise firm-level ESG outcomes, strengthened after 2015; Chapter III examines the performance→pricing link using announcement-window returns and turnover; Chapter IV introduces an investor-revealed metric, the Institutional Social Responsibility Concentration, which captures sustainability demand on the ownership side and predicts higher returns and greater market stability (Starks et al. 2017; Pástor et al. 2021). Taken together, the three chapters operationalise a single causal narrative in which policy elevates ESG performance, performance improves information and risk profiles, and investor demand and pricing reflect these improvements more strongly in the post-Paris era (Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2021; Bolton and Kacperczyk 2023b).

In Chapter II, we discover a positive correlation between the size of ESG-related subsidies received and overall ESG performance, with significant effects in the environmental and governance aspects. These effects are notably more pronounced after the 2015 Paris Agreement, suggesting that enhanced global awareness of climate risks has amplified the impact of these subsidies, extending the findings of Dyck et al. (2019), Bolton and Kacperczyk (2020), Bolton and Kacperczyk (2021), Bolton and Kacperczyk (2023a), and Bolton and Kacperczyk (2023b). Furthermore, firm-specific characteristics, such as size and being a state-owned enterprise (SOE), significantly influence the effectiveness of these subsidies in improving ESG performance. Our robust findings, supported by Generalized Method of Moments (GMM) endogeneity tests, indicate that the relationship between ESG-related subsidies and ESG outcomes adheres to the theory of marginal diminishing returns.

The relationship can be explained through two main mechanisms: first, firms perceive ESG-related subsidies as financial incentives that not only provide immediate financial relief but also foster long-term advantages, including enhanced stakeholder relationships, reduced regulatory risks, and stronger brand value. Second, the global focus on sustainability, particularly after the Paris Agreement, has intensified stakeholder expectations, pushing firms to adopt ESG practices beyond mere compliance. Agency theory suggests that ESG-related subsidies can help align the interests of management and shareholders by mitigating conflicts and promoting sustainable growth. Meanwhile, stakeholder theory emphasizes that firms are accountable to a broader range of stakeholders, who increasingly demand responsible business practices. In this context, ESG-related subsidies act as catalysts, enabling firms to meet these expectations and contribute to global sustainability efforts.

Our analysis advances the existing literature by providing a novel, granular measure of ESG-related subsidies, manually distinguishing these from general financial incentives—a level of detail rarely explored in prior studies. We also extend the work of Bolton and Kacperczyk (2020) and Bolton and Kacperczyk (2023a) by demonstrating that international agreements like the Paris Agreement amplify the effectiveness of such subsidies. Finally, our findings reveal that larger firms and SOEs are particularly adept at converting ESG subsidies into tangible ESG improvements, offering new insights into the heterogeneity of subsidy effectiveness across firm types.

Overall, Chapter II reveals that government-led ESG-related subsidies are instrumental in boosting firm-level ESG performance, particularly in the environmental and governance dimensions. These findings bridge a crucial gap in the literature by illustrating how state-directed financial mechanisms in emerging markets not only enhance corporate sustainability but also create a pathway for aligning firm-level ESG practices with global climate commitments under non-market conditions.

In Chapter III, we observe that announcements of ESG-related subsidies predominantly yield positive Cumulative Abnormal Returns (CARs) for firms with higher ESG performances, reflecting

investor confidence in these firms' capacity to meet new sustainability requirements and effectively utilize additional resources. In contrast, low ESG firms generally do not experience significant gains, suggesting market scepticism regarding their ability to comply with evolving ESG standards. We also find that the positive relationship between the value of ESG-related subsidies and CARs becomes more pronounced after the 2015 Paris Agreement, while SOEs exhibit a negative correlation between subsidies and CARs, as investors view these announcements as providing limited new information and expect weaker operational flexibility in SOEs compared with non-SOEs.

Our robustness tests, which incorporate various factor modelling approaches to predict CARs, classify firms based on ESG-related subsidy amounts, and exclude observations overlapping with M&A announcements, collectively reinforce these findings. In addition, our analysis of Cumulative Abnormal Turnover (CAT) reveals distinct investor sentiment patterns: high ESG firms exhibit negative CAT—indicating fewer trades as investors tend to hold these stocks—whereas low ESG firms show positive CAT, reflecting greater uncertainty and speculative trading. This divergence in market behaviour helps explain why high ESG firms achieve higher CARs, as investors display stronger confidence in their prospects.

Moreover, we identify several channels that may drive the positive association between ESG scores, ESG-related subsidy amounts, and CARs. First, larger subsidies provide firms with additional resources to invest in sustainability initiatives, potentially conferring a competitive advantage. Second, higher subsidies serve as a positive signal that national authorities acknowledge a firm's ESG credentials. Finally, firms with robust ESG practices often exhibit strong governance and risk management, enabling them to integrate subsidy-related opportunities into their long-term strategies and attract investors who value sustainable growth. Overall, Chapter III illustrates how government ESG-related subsidies, investor sentiment, and firm-level ESG performance collectively shape stock market outcomes.

In Chapter IV, we first show that SR mutual funds exhibit larger average assets under management (AUM), longer investment horizons, a substantially lower likelihood of stock price crashes,

and a stronger commitment to sustainability than their NSR counterparts, yet they yield lower stock returns. This outcome suggests that SR investors prioritize non-pecuniary social responsibility benefits over purely financial gains. We also find that both SR and NSR funds in China react to short-term stock mispricing signals, although SR funds respond more moderately, aligning with the view that SR investors place greater emphasis on stability and sustainability rather than short-term returns. Moreover, our ISRC metric influences stock pricing efficiency and valuation patterns, indicating that in China, investing in undervalued high-ISRC stocks, often overlooked due to lower reactivity among SR investors, can be a profitable investment strategy.

Next, we provide strong evidence that higher ISRC is positively associated with stock returns, supported by two main mechanisms. The ESG Demand Channel reveals that higher ISRC correlates with superior ESG performance, an enhanced corporate reputation, and increased fund inflows, while the Market Stability Channel highlights that higher ISRC is linked to longer investment horizons, lower turnover rates, diminished selling pressure, and reduced probabilities of stock price crashes. These channels help explain how ISRC contributes to stable and sustainable market performance.

Building on these two channels, we further develop the theoretical foundation for why higher ISRC predicts higher future returns. Concentrated socially responsible ownership operates through multiple reinforcing mechanisms. A high ISRC acts as a credible signal of genuine ESG commitment, attracting additional investor demand and strengthening firm reputation (Lins et al. 2017; Pedersen et al. 2021). By improving transparency and governance, socially responsible investors reduce information asymmetry, lower perceived risk, and enhance pricing efficiency (Kim et al. 2014; Ilhan et al. 2023). A stable investor clientele with long-term horizons mitigates turnover and price volatility, supporting the Market Stability Channel and sustaining long-run valuation premiums (Starks et al. 2017; Cao et al. 2023; Pástor et al. 2021). Moreover, active monitoring by SR-oriented investors improves governance and reduces agency conflicts, which enhances firm efficiency and profitability (Ferreira and Matos 2008; Dyck et al. 2019). High ISRC also captures

collective preferences for hedging non-financial and reputational risks, providing downside protection and improving the risk–return trade-off (Pástor et al. 2021). Finally, alignment with prevailing social norms and ethical values sustains investor loyalty and long-term demand for responsible firms (Bénabou and Tirole 2010; Riedl and Smeets 2017). Together, these theoretical perspectives explain how greater SR concentration strengthens firm fundamentals, stabilises market expectations, and results in higher future stock returns.

Robustness checks, including GMM endogeneity tests and propensity score matching, confirm that the positive ISRC–returns relationship holds consistently. Notably, these effects only emerge following the 2015 Paris Agreement, underscoring the global policy shifts' importance in shaping investor behaviour. Additional tests indicate that ISRC can effectively predict a firm's long-term ESG performance, investment horizon, crash likelihood, and the number of mutual funds experiencing inflow for a stock, with these effects remaining significant and persistent over time. Furthermore, the predictive power of ISRC is particularly pronounced in ESG-sensitive sectors.

Our study builds on prior work that proxies investor preferences using ESG fund flows (Riedl and Smeets 2017), institutional tilts (Dyck et al. 2019), and activist engagements (Dimson et al. 2015). It also extends recent findings by Pástor et al. (2021), who show that ESG fund reallocations influence asset prices. However, we go further by constructing a forward-looking, stock-level metric—ISRC—that directly links SR investor ownership concentration with market outcomes. Unlike traditional firm-level ESG ratings, which are self-reported and backward-looking, ISRC captures dynamic investor preferences and market-recognized ESG value on a quarterly basis. Methodologically, we extend the classification approach of Hwang et al. (2022) and Cao et al. (2023), but shift the analytical focus from how funds are ESG-oriented to how this orientation is reflected in their stock-level holdings.

Overall, Chapter IV demonstrates that ISRC provides a strong, investor-revealed signal of ESG alignment that predicts both stock performance and market stability. It complements and extends existing ESG research by offering a more granular tool to assess how social responsibility is priced

and rewarded in emerging market capital flows.

This thesis advances the literature along four integrated fronts. First, on measurement, we construct a hand-classified measure of ESG-related subsidies from Chinese policy texts and introduce a forward-looking, quarterly, stock-level ISRC that maps fund-level social responsibility to individual holdings, going beyond annual, self-reported firm ESG scores. Second, on identification, we use the Paris Agreement as a plausibly exogenous global policy shock and apply GMM and instrumental-variable strategies—e.g., city-level climate physical risk—to mitigate endogeneity in corporate ESG responses and in return predictability. Third, on pricing mechanisms, we jointly study prices and quantities: CAR and CAT around policy announcements, alongside ISRC-based demand and stability effects, providing a more complete view of how ESG information is incorporated than designs that use returns only. Fourth, on institutional heterogeneity, we open the "black box" of a state-dominated emerging market by contrasting SOEs with non-SOEs and by exploring sector sensitivities, showing when and why ESG policies and investor demand are amplified or attenuated. Collectively, these advances clarify how public policy and investor preferences jointly produce sustainability outcomes and market valuations in settings that differ from the developed-market norm.

To sum up, Chapters II–IV collectively demonstrate how government-led ESG interventions and socially responsible investing jointly shape firm behaviour and market performance in China's unique institutional context. We contribute to the literature by: (1) developing a novel, fine-grained measure of ESG-related subsidies and showing their positive impact on firm-level ESG performance, especially post-Paris Agreement; (2) providing evidence of how capital markets react to state-led ESG policies, using both CAR and CAT to capture stock market reactions and investor sentiments; and (3) introducing the ISRC metric, a forward-looking, stock-level indicator that links fund-level ESG preferences to pricing and stability outcomes. Together, these contributions offer new insights into how policy design and investor behaviour can reinforce each other to support sustainable finance in emerging markets.

Lastly, several implications follow. Targeting and conditionality should be strengthened. Subsidies should be linked to measurable environmental and governance milestones, with staged disbursement and independent third-party verification to prevent slippage and greenwashing. Institutional design also matters. Because SOEs exhibit weaker market responses, reforms such as clearer managerial incentives, stricter disclosure discipline, and reduced administrative frictions are needed to ensure that fiscal support translates into genuine ESG improvements. Sectoral prioritisation can enhance policy effectiveness, as stronger real and pricing effects in industrials and utilities indicate that aligning eligibility thresholds and intensity with sector-specific externalities yields higher returns.

The limited responsiveness of the social dimension calls for a more direct policy approach. To enhance S outcomes, governments could earmark a specific share of ESG-related subsidies for initiatives that improve labour conditions, employee training, workplace safety, and community engagement. Linking a portion of subsidy disbursement to verified social performance indicators such as employee satisfaction, retention, and community investment ratios can help ensure that firms integrate social responsibility into their operational goals. Policymakers may also introduce social impact grants that complement environmental or governance funding, providing financial incentives for firms that demonstrate measurable social improvements. These measures can help strengthen the S pillar while maintaining coherence with broader ESG objectives.

Market infrastructure should continue to promote faster and more transparent information transmission. Regulators can increase the frequency of core ESG metrics in corporate disclosures and promote the adoption of investor-side analytical tools. The ISRC developed in this thesis provides a supervisory and stewardship signal to identify firms with stable ESG-oriented ownership structures and to guide green capital toward its most effective use. International coordination remains essential. Mapping domestic subsidy mechanisms to nationally determined contributions under the Paris framework can enhance policy credibility, attract long-term investors, and reinforce the policy–performance–pricing cycle identified in this research.

Chapter II

Can Government Subsidy Improve Firm's ESG Performance? Evidence From China

II.1. Introduction

Major economies, including China, increasingly face significant risks from climate change. Governments recognize the urgency and intervene actively to mitigate these risks through substantial ESG-related financial subsidies. Firms and investors also increasingly value strong Environmental, Social, and Governance (ESG) practices. Especially in China, with its state-dominated financial system, politically connected firms often receive preferential treatment and thus bear greater ESG responsibilities (Chen et al. 2011; Deng et al. 2020; Cao et al. 2022). China's ambitious goal to achieve carbon neutrality by 2060, combined with its role as the world's largest carbon emitter, makes it an ideal context for examining the impact of ESG subsidies on corporate ESG performance.

Thus, we argue that, in China, government intervention, through ESG-related subsidies, can motivate firms to engage in more environmentally friendly activities, leading to improved ESG performances. We expect that this effect emerges only in the period following the Paris Agreement, as this is the turning point in global consensus on climate change risks.

Our motivation for this study stems from the escalating attention to climate change. Given the importance of the ESG practices, governments are now channelling their interventions towards ESG-related incentives. These incentives are not just financial but also include policy support, tax breaks, and public recognition. The aim is to encourage even more firms to prioritize ESG, especially the environmental pillar, in their operations. As a direct result, there's a noticeable surge in corporate initiatives focused on sustainable energy, waste reduction, and other eco-friendly practices. Moreover, as ESG becomes a benchmark for corporate excellence, investors are also shifting

their investment preferences. They are now more inclined to invest in firms that showcase strong ESG performance, understanding that such firms are better positioned for long-term success in a world increasingly conscious of climate change and its impacts (Giglio et al. 2021; Pedersen et al. 2021; Zerbib 2022). In essence, the synergy between government subsidies, corporate ESG practices, and public recognition is creating a robust framework. This framework not only addresses the immediate threats of climate change but also ensures a sustainable and resilient economic future for all.

Past literature finds that a government subsidy significantly influences firm operations, shaping investment decisions, easing financing costs, and enhancing firm performance; it also stimulates investment in environmentally friendly projects and sustainable practices. ESG performance of a firm also plays a crucial role in its operations. Nevertheless, there remains a significant gap in understanding how government subsidies specifically influence firms' ESG performance.

In this thesis, we fill this gap by formalizing the relationship between government ESG-related subsidies and a firm's ESG performance. The answer to this question is crucial for understanding the effectiveness of government intervention in mitigating global climate risk. If the positive relationship between ESG-related subsidies and the enhancement of a firm's ESG performance is significant, then the government's intervention to mitigate the transition risks under climate change is effective, which aligns with our expectations. Nevertheless, if the relationship is insignificant or even negative, then the government's intervention to mitigate climate risk is ineffective, this would be a scenario envisioned under the classic side effects of government subsidies, characterized by rent-seeking and market distortion. These relationships can be theoretically explained through agency and stakeholder perspectives, suggesting that subsidies mitigate information asymmetry and align managerial incentives toward sustainable outcomes. Considering the critical role of the 2015 Paris Agreement in shaping the global consensus on climate risk, and given China's unique state-dominated financial mechanism, firms with political connections have a greater motivation to enhance their ESG. Furthermore, the decisions of large firms are often under strict scrutiny

by the public and shareholders. This might lead these firms to prioritize investments that improve their public image and shareholder satisfaction (Monsen Jr and Downs 1965), such as ESG practices. Overall, We hypothesize that the relationship between ESG-related subsidies and ESG performance is positive. Furthermore, when examining the roles of the 2015 Paris Agreement, politically connected firms, and large-sized firms separately, we find that each factor independently drives this positive relationship.

Our ESG data is provided by the Sino-Securities Index (SSI) Company, while the government subsidy data is obtained from the China Stock Market and Accounting Research Database (CSMAR). We manually separate the total government subsidies into ESG-related subsidies based on the ESG classification standards provided by SSI. We then match this data with firm-specific characteristics and publicly available data. Finally, our data include nearly all firms listed on the Shanghai and Shenzhen Stock Exchanges from the years 2009 to 2021.

This chapter yields three primary findings. First, according to our baseline results, the value of the ESG-related subsidy a firm receives positively correlates with the firm's overall ESG performance, specifically the effect on the environmental (E) and governance (G) pillars. As expected, only environmental-related subsidies influence the overall ESG performance and the individual environmental and social (S) performances. This is consistent with the objectives of government interventions aimed at mitigating climate risks, confirming the effectiveness of such policies. Specifically, a one-standard-deviation increase in the ESG-related subsidy value a firm receives leads to a 9.6% increase in its ESG performance, a 13.2% rise in the E pillar, and an 11.3% increase in the G pillar, while the S pillar remains insignificant, corresponding respectively to approximately 0.10, 0.13, and 0.11 points of improvement in ESG, E, and G scores per additional $1 million subsidy. Moreover, a one-standard-deviation increase in a firm's environment-related subsidy value results in a 2.2% enhancement in the ESG performance, a 4% rise in the E pillar, and a 3% increase in the S pillar, while the G pillar remains insignificant, equivalent to roughly 0.02, 0.04, and 0.03 points per additional $1 million subsidy.

Second, this positive relationship strengthens considerably following the Paris Agreement period (2015–2021). A one-standard-deviation subsidy increase post-Agreement results in a 25.4% improvement in ESG performance, indicating the Agreement's role as a catalyst for corporate sustainability efforts (Dyck et al. 2019; Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2023a), which translates to about a 0.25-point increase in ESG score for each additional $1 million of ESG-related subsidies during the post-Paris period.

Third, SOEs and large-sized firms leverage ESG-related subsidies more effectively to enhance ESG performance compared with their peers. For instance, SOEs receiving a one-standard-deviation higher subsidy achieve an 8.7% ESG performance increase, predominantly through governance improvements, equivalent to about a 0.09-point gain per additional $1 million subsidy. Similarly, large firms experience a 10.1% increase in ESG outcomes, also driven mainly by governance enhancements, corresponding to roughly a 0.10-point improvement per additional $1 million subsidy.

To address endogeneity concerns, we employ a Generalized Method of Moments (GMM) approach using provincial GDP rankings as an instrumental variable. The results remain robust after adjusting for endogeneity. Additional analyses suggest diminishing marginal returns: the positive effect of ESG subsidies decreases as subsidy amounts increase, eventually becoming insignificant, consistent with economic theory (Marshall 2013).

Taken together, we present strong evidence that firms receiving higher amounts of ESG-related subsidies are associated with elevated overall ESG performances, as well as improved environmental and social performances. Notably, this effect is evident only in the periods following the Paris Agreement, and intriguingly, all pillars also gain significance post the Paris Agreement. This highlights the effectiveness of China's governmental interventions, not just in addressing climate risks, but also in promoting a holistic enhancement of firms' social responsibility and corporate governance. Our study underscores the Paris Agreement as a pivotal moment in forging and reinforcing a global consensus on climate change. Moreover, our findings indicate that SOEs and

large-sized firms are doing better in using ESG-related subsidies to improve their ESG practices compared to their counterparts, with a pronounced focus on enhancing governance performance. Furthermore, we observe that the positive impact of ESG-related subsidies on ESG performance exhibits marginal diminishing returns.

The positive relationship between government ESG-related subsidies and a firm's ESG performance potentially follows two channels. On one hand, firms, acting as rational entities, seek to maximize their value and shareholders' profits (Friedman 2007). ESG-related subsidies present a tangible financial incentive, prompting firms to enhance their ESG performance. This motivation stems not only from immediate monetary benefits but also from the potential for long-term value creation. Firms improving ESG performance foster stronger stakeholder relationships, reduce regulatory risks, and boost brand value.

On the other hand, societal norms and peer pressures introduce a behavioural dimension. The global focus on climate change and sustainability intensifies, placing firms under scrutiny. They face increasing pressure from stakeholders, such as customers, employees, and investors, to adopt sustainable practices. As discussed above and studies by Bolton and Kacperczyk, the Paris Agreement of 2015 plays a turning point in shaping this global consensus (Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2023a). Thus, firms strive to improve their ESG performance to meet these societal norms and expectations, beyond solely the attraction of subsidies. However, the social (S) dimension tends to exhibit weaker responsiveness, as its outcomes are often long-term, qualitative, and less directly tied to measurable financial performance. Consequently, firms face weaker incentives to allocate limited subsidy resources toward S-oriented initiatives that yield diffuse or delayed returns. To strengthen the S dimension, policymakers could link a portion of ESG-related subsidies to verified social outcomes—such as employee welfare improvements, community development projects, or supplier diversity targets. Establishing matching-grant schemes or reward multipliers for firms that demonstrate measurable social contributions, supported by third-party audits or social impact reports, could enhance the effectiveness of subsidies in promoting sustained

S improvements.

Established theories further illuminate these potential channels. The agency theory indicates potential discord between management and shareholders due to differing interests (Meckling and Jensen 1976). Yet, ESG-related subsidies bring these interests together, aiming for improving ESG performance. Management pursues the direct financial rewards from ESG-related subsidies, while shareholders anticipate long-term value creation from ESG performance improvements. In the meantime, stakeholder theory emphasizes a firm's responsibilities to all its stakeholders. With rising global sustainability awareness, stakeholders expect firms to embrace sustainable practices. Here, ESG-related subsidies act as catalysts, encouraging firms to fulfil these expectations.

Our study makes three key contributions. First, we manually separate total government subsidies into ESG-related and non-ESG-related components, providing a novel, fine-grained measure rarely seen in prior work. Second, we show that ESG-related subsidies significantly improve firms' ESG performance, and this effect strengthens post–Paris Agreement, highlighting how global climate commitments enhance policy efficacy, which extends the studies by Bolton and Kacperczyk (2020) and Bolton and Kacperczyk (2023a). Third, we uncover heterogeneous effects across politically connected (SOE) and large firms, revealing that these groups are more adept at converting ESG subsidies into tangible ESG improvements. Collectively, these findings extend existing literature by pinpointing the mechanisms of how targeted subsidies foster corporate sustainability in a state-dominated financial system, offering actionable insights for policymakers and investors alike.

The remainder of this chapter is structured as follows: Section II.2 provides a literature review, while Section II.3 develops the research hypotheses. Section II.4 introduces the framework of government ESG-related subsidies in China, and Section II.6 describes the data. Section II.5 outlines the research methodology, followed by Section II.7, which presents the baseline findings and discussions. Section II.8 examines the role of the 2015 Paris Agreement, while Section II.9 reports the heterogeneity analysis. Section II.10 provides additional tests, and finally, Section II.11 concludes the chapter.

II.2. Literature Review

II.2.1. Government Subsidies and Firm Behaviour

Government subsidies have long been regarded as a central policy instrument for correcting market failures, stimulating innovation, and promoting industrial upgrading (Innes 1991; Harrison and Rodríguez-Clare 2010; Busom et al. 2014). In general, subsidies influence firm behaviour through three major channels: investment incentives, financing costs, and performance outcomes.

First, subsidies can effectively encourage firms to invest in R&D and innovation. Empirical studies show that public funding helps overcome underinvestment problems, especially in risky or long-term projects (Almus and Czarnitzki 2003; Busom et al. 2014). In China, subsidies have been found to promote innovation and technology upgrading among listed firms (Gao et al. 2021). However, there remains debate regarding the efficiency of subsidy allocation. Some scholars argue that excessive intervention may distort competition and reduce market discipline (Harrison and Rodríguez-Clare 2010). This indicates that while subsidies stimulate innovation, their effectiveness depends critically on implementation quality and targeting efficiency.

Second, subsidies improve firms' external financing conditions by sending positive signals to the market and reducing information asymmetry (Jaffe 2002; Meuleman and De Maeseneire 2012). This "certification effect" expands credit access and lowers financing constraints (Lim et al. 2018; Busom et al. 2014). Yet, subsidies might also create moral hazard if firms become reliant on state support rather than market discipline. Hence, subsidies can simultaneously strengthen financial flexibility and introduce allocative inefficiency, which motivates closer examination in ESG contexts.

Third, numerous studies demonstrate that government support enhances firm performance by fostering growth, innovation, and employment (Colombo et al. 2011). Nevertheless, not all subsidies generate positive spillovers; their impact varies depending on firm characteristics, governance quality, and the degree of political connection. In China, the presence of politically connected

firms adds complexity to this relationship.

II.2.2. ESG-Related Subsidies and Sustainable Development

In recent years, subsidy policy has evolved from general industrial support to targeted sustainability promotion. ESG-related subsidies, which are explicitly linked to environmental, social, and governance objectives, have emerged as a critical instrument for facilitating the green transition (Acemoglu et al. 2016; Jaffe et al. 2005). They complement carbon taxes by reducing firms' costs of adopting cleaner technologies and accelerating innovation in renewable energy sectors. Empirical evidence confirms that combined fiscal and regulatory measures yield superior results compared to stand-alone taxation (Acemoglu et al. 2016).

In China, ESG-related subsidies serve a dual role: stimulating corporate ESG practices and supporting national carbon neutrality targets (Martin et al. 2014; Flammer 2021). These subsidies channel capital into green industries, enhance environmental disclosure, and encourage firms to align with government sustainability agendas. However, recent studies also caution that such subsidies may produce diminishing marginal effects, as firms achieving high ESG levels rely less on financial incentives for further improvement (Zhang et al. 2023). This underscores the need to assess whether the positive effects of ESG subsidies persist across varying levels of subsidy intensity and firm characteristics.

II.2.3. Political Connections and Subsidy Allocation in China

China's state-dominated financial system and centralized political structure play a crucial role in shaping subsidy allocation (Allen et al. 2005; Boyreau-Debray and Wei 2005). Political connections, often proxied by state ownership or the presence of politically connected directors, enhance firms' access to government resources (Chen et al. 2011; Lin et al. 2015). Studies consistently show that SOEs and politically connected firms receive preferential treatment in subsidy distribution, particularly in strategic sectors such as energy, infrastructure, and technology (Cao et al. 2022; Hsu et al. 2018).

While such connections may ensure policy compliance and facilitate the achievement of governmental objectives, they can also weaken efficiency and crowd out more deserving private firms. Therefore, examining whether politically connected firms, proxied by SOEs, translate ESG-related subsidies into superior ESG performance offers critical insights into the interaction between political economy and sustainability outcomes.

II.2.4. ESG Performance, Transition Risk, and Firm Size

The transition toward a low-carbon economy introduces significant risks and opportunities for firms. Transition risk, stemming from policy changes and technological shifts, threatens the value of carbon-intensive assets and raises compliance costs (Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2021; Bolton and Kacperczyk 2023b). Firms with greater access to capital and government support can better navigate these challenges by investing in cleaner technologies and improving ESG performance (Jondeau et al. 2023). In this sense, government subsidies act as a buffer, mitigating transition risks and accelerating sustainable transformation (Aghion et al. 2016).

Furthermore, the Paris Climate Agreement of 2015 represents a global institutional shift that redefined corporate ESG priorities. Following the Agreement, both investors and regulators intensified their scrutiny of environmental and governance practices, creating stronger market incentives for ESG improvement (Dyck et al. 2019; Giglio et al. 2021). Thus, the relationship between ESG-related subsidies and ESG performance is likely to strengthen in the post-Paris Agreement era.

Firm size also influences ESG outcomes. Larger firms face greater public visibility and reputational pressure, prompting stronger ESG commitments (Monsen Jr and Downs 1965). Their abundant resources and professional management teams further enable effective use of subsidies for sustainability enhancement. Hence, firm size is expected to moderate the subsidy and ESG relationship, with large firms achieving more substantial performance gains.

II.2.5. Agency and Stakeholder Perspectives

The relationship between government subsidies and ESG performance can be interpreted through agency and stakeholder theories, which help explain why subsidies may influence the E, S, and G dimensions differently.

From the agency theory perspective, managers act as agents of shareholders and may not always align with long-term sustainability objectives (Meckling and Jensen 1976). Government subsidies can mitigate information asymmetry and financial constraints, reducing agency costs by signalling governmental endorsement of ESG investment (Meuleman and De Maeseneire 2012). However, the effectiveness varies across dimensions. E initiatives often involve tangible and measurable outcomes such as emission reduction or energy efficiency, making them easier to monitor by investors and regulators. S activities, such as employee welfare or community engagement, are more qualitative and discretionary, allowing managers greater flexibility to pursue symbolic rather than substantive actions. G improvements, in contrast, directly address internal control and oversight mechanisms, reducing agency problems but requiring persistent institutional commitment (Cao et al. 2022). Therefore, subsidies may generate stronger effects on E and G than on S.

From the stakeholder theory perspective, firms must balance the expectations of multiple stakeholders, including governments, investors, employees, and communities, to sustain legitimacy and long-term performance (Meckling and Jensen 1976; Liang and Renneboog 2017). Government ESG-related subsidies signal policy priorities and reshape stakeholder salience by amplifying pressure on firms to meet environmental and governance standards (Flammer 2021). E improvements respond directly to social and regulatory concerns about climate risks, while G reforms reassure investors and regulators about accountability and transparency. In contrast, S initiatives often produce diffuse or delayed benefits and are less sensitive to subsidy incentives. As a result, stakeholder pressures and government interventions interact to create heterogeneous impacts across the E, S, and G pillars.

In summary, agency and stakeholder perspectives together suggest that government subsidies are most effective in areas with clearer accountability and measurable outcomes, such as E and G, while their influence on S tends to be weaker. This reasoning forms the conceptual foundation for the empirical analysis and hypotheses developed in the following section.

II.3. Hypothesis Developments

Government subsidies can provide firms with critical financial resources to invest in sustainability-oriented projects, such as adopting cleaner technologies and strengthening corporate governance (Innes 1991; Jaffe 2002; Meuleman and De Maeseneire 2012). By reducing financing constraints and lowering the cost of debt, subsidies enable firms to allocate more funds toward ESG-enhancing practices (Lim et al. 2018). Moreover, these subsidies can elevate a firm's external reputation, attracting socially conscious investors and thereby fostering a virtuous cycle that reinforces ESG improvements (Cornell 2021). In economies like China, where the government emphasizes strategic industries and climate-related goals, the initial infusion of subsidies is likely to have a strong positive impact on ESG engagement (Acemoglu et al. 2016; Jondeau et al. 2023; Cao et al. 2022).

H1: The government subsidy value is positively related to firms' ESG performances.

The pivotal global climate accord—the Paris Agreement—highlights the escalating urgency of climate risk and sets ambitious targets for reducing carbon emissions (Dyck et al. 2019; Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2021; Bolton and Kacperczyk 2023a; Bolton and Kacperczyk 2023b). Since signing the Agreement in 2015, China has intensified policy measures to facilitate green transitions, including offering more robust government subsidies to promote renewable energy, emissions reduction, and other ESG-related efforts. Consequently, enterprises face growing market and regulatory pressures to conform to higher ESG standards. We therefore anticipate that the Paris Agreement serves as a catalytic event that enhances the effectiveness of ESG-related subsidies. In other words, while government subsidies generally foster ESG perfor-

mance, this effect should be particularly pronounced in the post-Paris era, when both policy drivers and social norms have become more ESG-focused.

H2: The positive effect of ESG-related subsidies on ESG performance is mainly driven by the period following the 2015 Paris Agreement.

In China's state-dominated financial system, political connections exert a significant influence on resource allocation, including the distribution of government subsidies (Chen et al. 2011; Cao et al. 2022; Xiao and Shen 2022). Firms with strong ties to government bodies or officials—often manifested as SOEs—are more likely to secure preferential access to subsidies and may also experience heightened regulatory oversight. In turn, these subsidies can be channelled into ESG projects, such as cleaner production, community development, or corporate governance improvements. Additionally, politically connected firms may be under greater pressure to meet policy goals, including environmental standards, given their close alignment with governmental objectives (Chen et al. 2011). We thus posit that the beneficial linkage between subsidies and ESG performance is stronger for firms enjoying political connections.

H3: The positive effect between ESG-related subsidy and ESG performance is stronger for firms with political connections compared to their peers.

Beyond political connections, firm size plays an important role in ESG decision-making and performance. Larger firms typically have more resources, broader organizational structures, and greater public exposure, which can amplify both the scrutiny they receive and the benefits they derive from ESG enhancements (Monsen Jr and Downs 1965). Because they face higher reputational stakes, large firms often adopt more proactive measures to demonstrate corporate responsibility. Moreover, their extensive capital and managerial capacity can help them make effective use of government subsidies targeted at ESG improvement. Consequently, large firms are likely to show a more pronounced ESG performance gain per unit of ESG-related subsidy relative to smaller counterparts.

H4: The positive effect between ESG-related subsidy and ESG performance is stronger for large firms compared to their peers.

II.4. Government ESG-Related Subsidies Framework in China

II.4.1. Discussions in Government ESG-related Subsidy Application Steps

This subsection provides an overview of the government ESG related subsidy application process in China and detailing the accounting treatment for subsidies in financial statements.

In general, firms to apply a subsidy comprises seven stages and details show in Table II.1 and below [2].

Step 1: Online Submission In the initial stage, firms must actively apply rather than being automatically selected. Applications are submitted voluntarily through designated online platforms operated by the relevant ministry or local government, such as the Ministry of Finance, the National Development and Reform Commission, or provincial Development and Reform Commissions. Firms are required to complete an electronic application form and upload supporting documents such as tax certificates, business licence, legal representative identification, project proposal, financial statements, and any required permits or environmental compliance documents. In some cases, applicants must also submit hard copies or verify materials on site after the online submission.

Applications are voluntary in the sense that firms self-select to apply, but there is potential selection bias since only projects meeting specific eligibility criteria are considered. These criteria commonly include firm size, industry classification, technology type, or strategic importance to national or regional development goals. Certain projects, especially in energy conservation, pollution control, and innovation, are prioritised under central and local policy frameworks.

Funding is generally partial rather than full. Most programmes cover between 20% and 50% of total project investment or provide cost-sharing mechanisms, such as interest rebates or equip-

[2] We systematically collate and organize information from official websites related to government ESG subsidies, enabling a clear comprehension of the subsidy application procedure.

ment purchase subsidies, rather than covering 100% of the investment cost. Firms may also face restrictions based on size, ownership type, or region. Subsidy programmes operate at both national and provincial or municipal levels, with local governments often adding co-funding arrangements or additional evaluation criteria.

During this submission phase, the online system automatically checks the completeness and format of materials and may prompt firms to correct errors or upload additional documents. Applications that pass preliminary screening proceed to expert review and on-site inspection in subsequent stages.

Steps 2-4: Preliminary Review, Expert Evaluation, and On-site Investigation Governments provide subsidies to firms to encourage improvements in targeted areas and require firms to meet particular criteria. These stages ensure that the firms and their proposed projects align with the objectives of the subsidy program and improve related aspects by using subsidy, eventually contributing to their ESG performance improvement. Step 2): Preliminary Review - Conducted by the funding agency, this stage involves an initial assessment of the submitted application and documents to ensure that the firm meets the required qualifications. For example, a firm seeking a subsidy from the "Air Quality Improvement Subsidy Policy Notice" must demonstrate the requisite qualifications and propose a project targeting nitrogen oxide emission reduction. Step 3): Expert Evaluation - An expert committee reviews the application, assessing the project's feasibility, potential impact, and consistency with subsidy objectives. Firms may receive feedback and be asked to revise and resubmit their proposals if necessary. Subsidies can be sought for either prospective projects or as compensation for completed projects aligned with policy objectives. 4) On-site Investigation - Government or third-party inspectors visit the firm's facility to verify the information provided in the application, assess the project's implementation capability, and ensure compliance with relevant regulations and industry standards. Inspectors may also interview key personnel involved in the project to gain more insights.

Step 5: Public Announcement At this juncture, funding agencies disclose the approved projects

and associated funding amounts, ensuring transparency and providing stakeholders with an opportunity to raise concerns or objections.

Step 6: Subsidy Issuance Following the success of public announcement, funds are disbursed to the approved firms, enabling them to implement their projects and enhance their ESG practices.

Step 7: Post-subsidy Reporting and Evaluation Firms are required to submit comprehensive reports detailing the project's outcomes and performance. This stage enables the government to oversee the appropriate use of subsidies, leading to improved ESG performance in targeted areas. Firms must furnish project completion reports, financial reports, performance evaluation reports, intellectual property reports, and any other documents mandated by the funding agency or government. Additionally, firms may be subject to post-project evaluations or audits carried out by funding agencies or independent third-party organizations.

In summary, the seven-stage subsidy application process is strategically structured to guide and monitor the proper use of subsidies and motivate firms to achieve the objectives of government subsidy policies, eventually improve their ESG performance. By understanding and following this process, firms can effectively receive subsidies that support innovation and growth in targeted areas, ultimately enhancing ESG practices.

Overall, from the discussion above, we can see the government ESG related subsidy intends to push development and improvement on a specific project/target of a firm. Therefore, we argue that the ESG-related subsidy helps to contribute to a better ESG practice of a firm.

II.4.2. Mechanisms and Structures of ESG-related Subsidy

The foundation for government ESG-related subsidies in China is deeply rooted in various political, economic, and social factors. Central to its approach is the emphasis on long-term economic growth, technological advancement, and self-sufficiency. This strategy is intended to elevate China's global position and decrease its dependence on foreign technology and resources. This focus is shaped by China's centralized political structures and the government's significant

role in guiding the country's economic direction.

Strategic industries such as renewable energy, high-speed rail, and technology, including ESG-related subsidies, are of high priority due to their correlation with political stability and economic security (Brandt et al. 2013). China's subsidy policies tend to favour politically connected firms and sectors, including SOEs. These policies underscore China's commitment to enhancing ESG activities (Cao et al. 2022). In our study, we find that SOEs are more effective than non-SOEs in utilizing ESG-related subsidies to improve their ESG practices.

II.4.3. Accounting Treatment of ESG-Related Government Subsidies in Financial Statements

This subsection addresses how firms should account for subsidies in their financial statements. Based on China's Accounting Standard for Business Enterprises No. 16[3] - Government Subsidies (Riccardi and Riccardi 2016), the accounting treatment of subsidies is contingent upon the nature of economic activities and the conditions associated with them.

From the firm's annual reports, ESG reports and the study by Laınez and Callao (2000), the government ESG-related subsidies can cover both already incurred expenses and projected future expenses for firms. For incurred expenses, if the government subsidy is related to the firm's daily activities and explicitly intended to compensate for already incurred related expenses or losses, the subsidy directly offsets the corresponding costs and expenses, and is recorded as a current period gain/loss. For projected future expenses, if the government subsidy is related to the firm's daily activities and explicitly intended to compensate for related expenses or losses in future periods, the subsidy is recognised as deferred revenue. These two types of subsidy accounting treatments are dependent on the firm's accounting policies and do not impact the firm's net profit or shareholder equity.

[3] See $http://www.gov.cn/gongbao/content/2017/content_5237716.htm$.

II.5. Research Methodology

II.5.1. The relationship between government ESG-related subsidy and ESG performances

To examine the relationship between government ESG-related subsidies and ESG performances, we employ *Eq.* (*II*.1) for the regression analysis.

$$Y_{i,t+1} = \alpha + \beta X_{i,t} + \gamma^{\top} X'_{i,t} + \varepsilon_{i,t}, \tag{II.1}$$

where $Y_{i,t+1}$ is a vector set that includes the ESG performance and the separated E/S/G performances of firm i in year t. The vector $X_{i,t}$ consists of the natural logarithm of total ESG-related subsidy (ESGSUB) and non-ESG-related subsidy (NONSUB)[4] received by firm i in year t. We apply a logarithmic transformation to manage heteroscedasticity and mitigate the influence of outliers, thereby improving the robustness and interpretability of our model. The ESG-related subsidy is lagged by one year to address potential reverse causality, ensuring that our model captures the influence of prior-year subsidies on the current year's ESG performance. By lagging the ESG-related subsidy by one year, we aim to clearly observe its impact on ESG performance. $\gamma^{\top} X'_{i,t}$ represents a vector of control variables. To mitigate the impact of outliers, we winsorize all variables at the 1% and 99% levels. Additionally, we account for firm and year fixed effects and cluster standard errors at both the firm and year levels, and further include industry and year and region (province) and year fixed effects for robustness.

II.5.2. The exogenous shock of the Paris Agreement 2015 on ESG

To examine the relationship between government ESG-related subsidies and ESG performances following the Paris Agreement 2015, we employ *Eq.* (*II*.2) for the regression analysis.

$$Y_{i,t+1} = \alpha + \beta\, ESGSUB_{i,t} + \theta \left(ESGSUB_{i,t} \times Paris_t\right) + \gamma^{\top} X'_{i,t} + \varepsilon_{i,t}, \tag{II.2}$$

[4] We define NONSUB as the total subsidy minus ESGSUB.

where the interaction term $Paris_t$ is a time dummy variable that indicates the timing of the Paris Climate Agreement 2015, set to 1 for the years following 2015 (2015 to 2021) and 0 otherwise.

To delve into the year-on-year effects of ESG-related subsidies on ESG performances at a more granular time resolution, we perform an interaction analysis using $Eq.$ (*II*.3).

$$Y_{i,t+1} = \alpha + \sum_{m=2009}^{2020} \beta_m \left(ESGSUB_{i,t} \times Year_m \right) + \gamma^\top X'_{i,t} + \varepsilon_{i,t}, \tag{II.3}$$

where $Year_m$ is an indicator variable that equals one in calendar year m and zero otherwise; thus β_m captures the year-specific association between ESGSUB and the outcome.

II.5.3. The Impact of Firm Characteristics on the Relationship between ESG Subsidy and ESG performances: Firm Size and Firms with political connections

To examine the relationship between politically connected firms and ESG performances, in line with Cao et al. (2022) and Hsu et al. (2023), we use SOEs to proxy firms with political connections and employ $Eq.$ (*II*.4).

$$Y_{i,t+1} = \alpha + \beta\, ESGSUB_{i,t} + \theta \left(ESGSUB_{i,t} \times SOE_i \right) + \gamma^\top X'_{i,t} + \varepsilon_{i,t}, \tag{II.4}$$

where the interaction term SOE_i is a dummy variable set to 1 if the firm is a State-Owned Enterprise, and 0 otherwise.

To examine the relationship between firm size and ESG performances, we employ $Eq.$ (*II*.5).

$$Y_{i,t+1} = \alpha + \beta\, ESGSUB_{i,t} + \theta \left(ESGSUB_{i,t} \times Size50_i \right) + \gamma^\top X'_{i,t} + \varepsilon_{i,t}, \tag{II.5}$$

where the interaction term $Size50_i$ is a dummy variable set to 1 if the firm's size is larger than the median size of all firms, and 0 otherwise.

II.5.4. Additional Test

Finally, we investigate the diminishing marginal effect of ESG-related subsidies on ESG performances by dividing ESG-related subsidies into ten groups based on ESG performance deciles and estimating Eq. (II.6).

$$Y_{i,t+1} = \alpha + \sum_{m=1}^{10} \beta_m \left(ESGSUB_{i,t} \times Group_m \right) + \gamma^{\top} X'_{i,t} + \varepsilon_{i,t}, \tag{II.6}$$

where $Group_m$ is an indicator for the m-th decile bin of ESGSUB (with $m = 1$ the lowest decile and $m = 10$ the highest), so that β_m traces how the ESGSUB–outcome association varies across the subsidy distribution.

II.6. Data and Sample

II.6.1. Description on Subsidy Data

Our primary database is the CSMAR. Since 2006, the Chinese Accounting Standards Committee has mandated that listed firms disclose the government cash subsidies they receive (Riccardi and Riccardi 2016; Han et al. 2019). We gather the annual government subsidy data for firms from CSMAR, which provides comprehensive subsidy details for Chinese firms listed on the Shanghai and Shenzhen stock exchanges. This data includes information regarding the related projects and subsidy amounts each listed firm receives annually.

One significant aspect of our research is the meticulous process of data collection and classification. For our study, we use the ESG indicator system provided by the SSI company as the benchmark. We classify ESG-related subsidies based on a structured keyword-matching approach, identifying key terms that align with Environmental (E), Social (S), and Governance (G) categories according to the ESG standards set by the SSI[5] (See Appendix A). These classifications are derived

[5]This classification process is based on a keyword-matching method. Specifically, if a subsidy project's name includes the term 'Environment' or other related keywords, it is categorized as an Environmental-related subsidy. Similarly, subsidies containing terms such as 'Technology' are classified under Social-related subsidies. However, we prioritize Environmental subsidies; for instance, if a project's name includes both 'Environment' and 'Technology', it

from the total government subsidies spanning the period of 2009 to 2021. By relying on keywords as the primary classification criterion, this method ensures a systematic and objective allocation of subsidies into ESG categories. While time-consuming, this keyword-driven matching process enhances the accuracy and consistency of our dataset, which is critical for the validity of our research findings.

Our dataset shows that the aggregate value of ESG-related subsidies is approximately 55.38 billion USD, constituting about 32% of the overall subsidy value (approximately 169.81 billion USD), and exhibiting an upward trend annually, we present the trends in the changes of total subsidy and ESG-related subsidy value over time in Figure II.1, and Figure II.2 presents the changes over time in the values of individual E/S/G -related subsidy value.

Furthermore, our findings indicate that the magnitude of S-related subsidies (approximately 39.55 billion USD) consistently exceeds that of E-related subsidies (approximately 15.83 billion USD) and G-related subsidies annually, with the latter being almost inconsequential (as presented in Figure II.2). Overall, S-related subsidy constitutes about 72% and E-related subsidy 28%. This can be associated with China's emphasis on long-term economic development, technological advancement, and self-sufficiency, which are integral components of the country's strategic vision.

As we find that, most of the S-related subsidies are allocated to technological and patent-related initiatives, reflecting the government's commitment to fostering innovation and technological advancement as a key aspect of corporate social responsibility. E-related subsidies primarily support environmental and green initiatives, emphasizing China's pledge to encourage sustainable business practices. Despite not exhibiting a consistent upward trend, E-related subsidies have remained stable.

Interestingly, our subsequent analysis revealed a more pronounced impact on E performances following the Paris Agreement in 2015, suggesting the significant influence of this global environmental policy. Further, a potential reason for the negligible number of G-related subsidies could

is still classified as an E-related subsidy.

be that the government has little incentive to subsidize firms for improving corporate governance, as this responsibility primarily falls on the firms themselves to ensure transparency, accountability, and ethical practices (Jiang and Kim 2020). Overall, these findings align with China's strategic vision emphasizing long-term economic development, technological advancement, self-sufficiency, and environmental sustainability.

Panel A of Table II.3 presents the descriptive statistics for the total subsidies (TOTSUB), ESG-related subsidies (ESGSUB), non-ESG subsidies (NONSUB), and the environmental, social, and governance pillars related subsidies (ESUB, SSUB, GSUB). On average, each firm in our dataset receives about 7.04 million USD in total subsidies annually, with ESG-related subsidies accounting for approximately 2.29 million USD. Non-ESG subsidies, which are measured as the total subsidy minus ESG-related subsidy, make up the remaining 4.75 million USD. Among the ESG-related subsidies, S-related subsidies (approximately 1.64 million USD) significantly outweigh E-related subsidies (approximately 0.68 million USD), while G-related subsidies are practically non-existent. This aligns with our earlier observation about China's strategic emphasis on social and environmental aspects of sustainability.

II.6.2. Description of ESG Data

Our ESG dataset covers the widest range of listed firms over an extensive time span. The SSI Company evaluates a firm's ESG performance based on 16 topics and 44 key indicators, assigning a nine-grade rating from 'AAA' to 'C' across the three main ESG pillars during regular review. For example, the Environmental (E) pillar comprises key indicators relating to environmental pollution, environmental friendliness, and environmental management. The Social (S) pillar encompasses elements such as human capital, product liability, and employee health and safety. Lastly, the Governance (G) pillar includes governance risk, external sanctions, and business ethics among its key considerations. This system provides a holistic and detailed assessment of a firm's ESG practices.

Panel B of Table II.3 provides the descriptive statistics for the ESG performances, as well as its E, S, G pillars. The ESG performances range from a minimum of 39.98 to a maximum of 92.38, with the SSI's ESG performance scale fluctuating $0-100$. The mean value of 72.80 is on the higher end of this scale, indicating that on average, firms in our dataset have relatively high ESG performance. This high mean ESG performance suggests that the average firm in the dataset performs well in terms of ESG, which could reflect effective ESG policies, responsible management, or a commitment to sustainable practices.

For Paris Agreement 2015, Figure II.3 presents the box plots of ESG performances conditional on the Paris Agreement periods. From this figure, we can see that both E and S performances in the post-Paris period tend to be slightly higher than those in the before Paris period, while G performance exhibits a declining trend. However, the overall ESG performances consistently show similar medians across both periods.

II.6.3. Description on Control Variables

Further, we gather data on the firms' fundamentals for control variables from the CSMAR database. Panel C provides detailed statistics on control variables. Our Controls variable following the study by Xiao and Shen (2022), include Sales growth rate (Growth), Market to Book Ratio (MB), Return on Assets (ROA), leverage ratio (LEV), cash flow from operations to firm size (Cash), total capital expenditure amount (CAPEX), Firm market capitalisations (SIZE), since they also study the environmental performances of China's listed firms.

These control variables allow us to account for various firm-specific characteristics that may influence ESG performances and subsidies. For instance, larger firms (SIZE) or those with better performance (ROA) may receive more subsidies or have higher ESG performances due to their higher visibility and resources. Similarly, firms with more investments in capital expenditure (CAPEX) may be more likely to engage in ESG activities, hence receiving higher ESG performances and subsidies. Meanwhile, the cash flow from operations (Cash) can affect a firm's liquidity and thus

its ability to carry out ESG initiatives.

We use SOEs as a proxy for firms with political connections, as these entities are directly controlled by the government. This is in line with Hsu et al. (2023) and Cao et al. (2022), who suggest that political connections can affect firm behaviour, including their ESG practices. In our dataset, SOEs constitute 37.47%.

Finally, our dataset for analysis includes 3,270 unique firms with 24,137 observations in total, spanning the period from 2009 to 2021. In line with mainstream papers, we exclude firms marked with $*ST$ (delisting), as these firms may have unique characteristics or circumstances that can distort the results. We provide the definitions of these variables in Table II.2.

II.7. Empirical Results and Discussions

II.7.1. Predicative Power of ESG-related subsidy on Firm's ESG performance

This subsection presents the findings of the relationship between government ESG-related subsidies and ESG performances, we report the results in Table II.4.

II.7.2. Baseline results

Panel A in Table II.4 reports our baseline results on the predictive power of ESG-related subsidy value for firms' subsequent ESG performance. Overall, ESG-related subsidies are found to significantly and positively predict future ESG scores.

Specifically, Column (1) shows that a one-unit increase in ESGSUB is associated with an average increase of 0.096 units in a firm's ESG performance in the following year, significant at the 1% level when controlling for firm and year fixed effects, which corresponds to roughly a 0.10-point increase in ESG score per additional $1 million of ESG-related subsidies. Column (2) presents results that incorporate industry–year fixed effects, where the coefficient rises to 0.283 and remains highly significant, equivalent to approximately a 0.28-point improvement in ESG score for every $1 million of ESG-related subsidies. Column (3), which adds region (province)–year fixed effects,

also yields a positive and significant coefficient of 0.175, indicating that an additional $1 million in ESG-related subsidies is associated with about a 0.18-point increase in ESG score. Column (4) replaces ESGSUB with non-ESG-related subsidies (NONSUB) and shows that these generic subsidies have no significant impact on ESG performance, with the coefficient on NONSUB (0.739) being statistically insignificant, suggesting that non-targeted subsidies, even at comparable dollar magnitudes, do not lead to measurable improvements in firms' ESG scores. This result supports the validity of our data classification and indicates that only ESG-targeted subsidies drive improvements in corporate ESG outcomes.

II.7.3. Endogeneity Testing

To address potential endogeneity concerns arising from unobserved variables that may simultaneously influence both ESG performance and ESG-related subsidies, we employ the Generalized Method of Moments (GMM) approach. In addition to lagging the explanatory variable to mitigate risks of reverse causality, the GMM framework further addresses simultaneity bias, ensuring more robust and reliable estimates. This method also allows us to control for firm-specific and year-specific fixed effects while clustering standard errors at both the firm and year levels.

We select the provincial GDP rank (GDPRANK) in 2021[6]—where the firm is listed—as the instrumental variable (IV), ranking provinces from 1 (lowest GDP) upwards.[7]

For instrument relevance, the selection of GDPRANK is grounded in Armellini and Basu (2010), which document a strong positive association between regional economic development and government subsidy levels across countries. In line with this evidence, it is reasonable to expect that provinces with higher GDP levels in China tend to allocate greater fiscal resources, including ESG-related subsidies, to local firms. This implies a negative relationship between GDP rank (where a lower rank corresponds to a wealthier province) and the volume of subsidies firms receive. Moreover, China's decentralized fiscal system, particularly after the 1980s fiscal reforms,

[6] As the expiration date of our dataset is 2021.

[7] Local governments in China distribute government subsidies and possess significant autonomy in allocation decisions since the 1980s (Lim et al. 2018).

has granted substantial autonomy to provincial governments in setting and implementing subsidy policies, further strengthening the plausibility of this channel.

For instrument exogeneity, although provincial GDP is a determinant of local fiscal capacity and subsidy availability, it should not directly influence firm-level ESG performance. According to Ioannou and Serafeim (2012), ESG practices are primarily shaped by internal firm characteristics—such as governance structures, corporate strategies, and environmental initiatives—as well as by overarching national institutions including political, legal, and educational systems. Provincial economic prosperity may exert indirect effects by enhancing regional infrastructure, regulatory capacity, or public pressure; however, these effects are mediated through government actions and are unlikely to systematically bias firm-level ESG ratings independent of subsidy allocation. Therefore, GDPRANK satisfies the exclusion restriction required for instrumental variable validity, as its principal channel of influence operates through government subsidy distribution rather than direct alteration of corporate ESG practices.

Panel B presents the results of our first-stage and second-stage GMM instrumental variable estimations using GDPRANK as the instrument. In the first-stage results, we observe a significant positive relationship between GDP rank and ESG subsidy value, with the coefficient of GDPRANK being 0.007 and statistically significant at the 1% level across all specifications. The weak identification test (F-statistic) yields a value of 17.324, which exceeds the recommended threshold of 10 as per Stock et al. (2002), suggesting that our chosen instrument satisfies the relevance condition. In the second-stage results, we continue to find a positive and statistically significant relationship between ESG subsidies and ESG performance. The consistency of these findings with our baseline results further indicates that employing GDPRANK as an instrument effectively addresses endogeneity concerns and enhances the credibility of our estimates.

II.7.4. Predictive Power of ESG-related Subsidy Value on Individual E/S/G Performance

Next, Panel C shows that one-unit increase in ESGSUB leads to an average increase of 0.132 units in a firm's E performance, significant at the 1% level, which corresponds to approximately a 0.13-point improvement in environmental performance per additional $1 million of ESG-related subsidies. One-unit increase in ESGSUB leads to an average increase of 0.033 units in a firm's S performance, but not statistically significant, implying an economically small effect of about 0.03 points per $1 million subsidy. One-unit increase in ESGSUB leads to an average increase of 0.113 units in a firm's G performance, significant at the 5% level, equivalent to roughly a 0.11-point increase in governance performance per additional $1 million subsidy. These results suggest that government ESG-related subsidy policy positively influences firms' E and G dimensions but does not appear to exert the same influence on the S dimension.

Panel D presents the results examining the joint impact of separated E, S, and G subsidies on the overall ESG and respective E, S, and G performances for firms. Our findings suggest that E-related subsidies (ESUB) have a significantly positive impact on firms' overall ESG performance and individual E and S performances, while the impact of S- and G-related subsidies (SSUB and GSUB) is not statistically significant.

Specifically, Column (1) shows that the estimated coefficient of ESUB on $ESG_{i,t+1}$ is 0.022, significant at the 1% level, which implies that each additional $1 million in E-related subsidies increases the firm's overall ESG score by about 0.02 points. Column (2) reveals that the estimated coefficient of ESUB on $E_{i,t+1}$ is 0.040, also significant at the 1% level, corresponding to an approximate 0.04-point improvement in environmental performance per additional $1 million subsidy. Column (3) demonstrates that the estimated coefficient of SSUB on $S_{i,t+1}$ is -0.048, but it is not statistically significant, indicating no meaningful economic impact of S-related subsidies on social performance. However, ESUB is significantly positively related to $S_{i,t+1}$, with a coefficient of 0.030 significant at the 5% level, which translates to an approximate 0.03-point increase

in social performance per $1 million of E-related subsidy. Column (4) indicates that the estimated coefficients of GSUB, ESUB, and SSUB on $G_{i,t+1}$ are not statistically significant, with a value of 0.000 for GSUB.

These results suggest that only *E* subsidies significantly contribute to a firm's overall ESG performance and individual *E* and *S* performances, whereas *S* and *G* subsidies do not seem to have a similar impact. The lack of statistical significance for *G* subsidies is attributed to their relatively small volume, which is almost negligible, suggesting government intervention is not motivated to help firms improve their governance aspect. This finding suggests that environmental subsidies play a pivotal role in enhancing ESG performance, and the positive relationship between ESG-related subsidies and ESG performances is driven only by *E*-related subsidies. Our findings suggest the critical role of environmental related subsidies in enhancing firms' ESG performance. These findings carry significant implications for policymakers, suggesting that if the government intends to leverage subsidy policies to improve corporate ESG performance, concentrating these subsidies on environmental initiatives may prove more effective.

II.7.5. Why Government Subsidies Fail to Enhance Social (S) Performance?

The empirical evidence indicates that government ESG-related subsidies significantly improve firms' E and G performance, whereas their impact on S remains largely insignificant. This divergence can be interpreted through institutional and theoretical perspectives.

Institutionally, China's subsidy system is primarily designed to promote environmental protection and governance enhancement. Subsidies are usually tied to quantifiable outcomes—such as emission reduction, energy efficiency, or compliance improvements—allowing for transparent evaluation by regulators and firms alike. Governance-related measures also align with state objectives that emphasize transparency, accountability, and internal control. By contrast, S activities—such as community welfare, labour conditions, or diversity programs—are less subject to direct regulation or measurable benchmarks, leading firms to allocate fewer resources to them

when using subsidy funds.

From a theoretical standpoint, both agency and stakeholder perspectives explain why S responds weakly to subsidies. S investments often yield diffuse, long-term benefits that are difficult to monitor and monetise, increasing managerial discretion and the risk of symbolic rather than substantive engagement (Meckling and Jensen 1976; Friedman 2007). Subsidies therefore may not sufficiently constrain opportunistic behaviour or align incentives in the S dimension. Furthermore, stakeholder attention in China tends to prioritise environmental compliance and governance quality—areas that are politically salient and publicly observable—while S concerns receive comparatively limited scrutiny (Flammer 2021; Cao et al. 2022).

Taken together, these patterns suggest that subsidies are most effective when linked to tangible and auditable outcomes in E and G, while the softer and qualitative nature of S limits responsiveness to financial incentives. To better integrate the social dimension, ESG-related subsidies could incorporate explicit social performance criteria such as employee welfare, occupational safety, or community engagement as part of the eligibility or disbursement conditions. Governments may adopt tiered reward structures that provide incremental subsidies for firms achieving verified improvements in S metrics and introduce tax incentives or procurement advantages tied to demonstrated social responsibility. In addition, mandatory third-party social impact audits could ensure that reported S outcomes are credible and measurable. Addressing this policy gap may therefore require complementary measures such as enhanced social disclosure standards, labour protection regulation, and independent evaluation to strengthen the social pillar of corporate sustainability.

II.8. The Role of Paris Agreement 2015

This section provides the findings of the relationship between government ESG-related subsidies and ESG performances following the periods of the Paris Agreement. Results are presented in Table II.5. We find that the effect observed from $H1$ becomes significant only after the Paris Agreement (2015–2021) but not before, which is consistent with and extends the studies by Dyck et

al. (2019), Bolton and Kacperczyk (2020), Bolton and Kacperczyk (2021), Bolton and Kacperczyk (2023a), and Bolton and Kacperczyk (2023b).

Panel A presents the results examining the relationship between ESG-related subsidies and firms' ESG performance, as well as individual E, S, and G performances, following the Paris Climate Agreement in 2015. Our findings indicate that ESG-related subsidies have influenced firms' overall ESG performance and individual E and G scores after 2015, whereas these subsidies did not have the same influence before the Paris Agreement or on S performance.

Column (1) shows that the estimated coefficient of the interaction term Paris × ESGSUB on $ESG_{i,t+1}$ is 0.254, significant at the 1% level, which corresponds to approximately a 0.25 point increase in the firm's overall ESG score for each additional $1 million of ESG-related subsidies after 2015. Column (2) indicates that the estimated coefficient of Paris × ESGSUB on $E_{i,t+1}$ is 0.265, also significant at the 1% level, equivalent to roughly a 0.27 point improvement in environmental performance per $1 million subsidy. Column (3) reveals that the estimated coefficient of Paris × ESGSUB on $S_{i,t+1}$ is 0.176, significant at the 10% level, which translates to about a 0.18 point rise in social performance per $1 million subsidy. Column (4) demonstrates that the estimated coefficient of Paris × ESGSUB on $G_{i,t+1}$ is 0.298, significant at the 5% level, corresponding to nearly a 0.30 point increase in governance performance per $1 million subsidy. The estimated coefficients of ESGSUB alone are not significant, confirming that the Paris Agreement period amplified the impact of ESG-related subsidies.

These results suggest that government ESG subsidy policy positively influences the improvement of firms' overall ESG performance and their individual E, S, and G dimensions following the Paris Agreement, but not before. Compared with the baseline results, the S performance becomes significant after 2015, indicating an economically meaningful strengthening of the subsidy–performance link in the post-Paris period. This finding reflects China's carbon neutrality and carbon peaking policies introduced after the Agreement and demonstrates their effectiveness in driving corporate ESG engagement.

Panel B presents the results of our year-by-year interaction effects of ESG-related subsidies on ESG performances, and results are visually represented in Figure II.4. Our findings show that only starting from 2015, the year of the Paris Agreement, a clear and significant positive relationship emerges between ESG-related subsidies and ESG performances. The interaction terms from 2015 to 2020 for $ESG_{i,t+1}$, $E_{i,t+1}$, $S_{i,t+1}$, and $G_{i,t+1}$ all present statistically significant coefficients, confirming a strengthened link between ESG subsidies and ESG performance following the Paris Agreement. Collectively, these results highlight the Paris Agreement as a pivotal turning point in aligning policy incentives and corporate ESG outcomes.

II.9. Heterogeneity Analysis: Firm Size and State-Owned Enterprises (SOEs)

Table II.6 presents our analysis of the relationship between ESG-related subsidies and ESG performance across firms with different characteristics, focusing on SOEs and large-sized firms. Our study reveals a mixed response from SOEs to ESG-related subsidies. While these subsidies significantly boost their overall ESG and governance performances, SOEs do not exhibit notable improvements in environmental or social pillars compared with non-SOEs. This observation aligns with our hypothesis and previous findings by Cao et al. (2022).

Specifically, Column (1) displays the estimated coefficient of $ESG_{i,t+1}$ on the interaction term SOE × ESGSUB as 0.087, significant at the 10% level, which corresponds to approximately a 0.09 point increase in overall ESG performance per additional $1 million subsidy for SOEs. Columns (2) and (3) show that the estimated coefficients of $E_{i,t+1}$ and $S_{i,t+1}$ on SOE × ESGSUB are 0.031 and 0.021 respectively, but neither is statistically significant, implying economically negligible effects in the environmental and social dimensions. Column (4) reveals that the estimated coefficient of $G_{i,t+1}$ on SOE × ESGSUB is 0.166, significant at the 5% level, equivalent to around a 0.17 point rise in governance performance per $1 million subsidy for SOEs.

Columns (5) to (8) present the results for large-sized firms. Column (5) shows that the estimated coefficient of $ESG_{i,t+1}$ on Size50 × ESGSUB is 0.101, significant at the 5% level, which

corresponds to roughly a 0.10 point increase in overall ESG score for every $1 million of ESG subsidy among large firms. Columns (6) and (7) show that the estimated coefficients of $E_{i,t+1}$ and $S_{i,t+1}$ on Size50 × ESGSUB are -0.027 and 0.091 respectively, but neither is statistically significant, suggesting no economically material effect in the environmental or social pillars. Column (8) reveals that the estimated coefficient of $G_{i,t+1}$ on Size50 × ESGSUB is 0.178, significant at the 5% level, indicating that each additional $1 million in ESG subsidies is associated with about a 0.18 point increase in governance performance for large firms.

In summary, while SOEs show a mixed response to ESG-related subsidies, both SOEs and large firms derive the most benefit through improved governance. The economic magnitude of these effects, approximately 0.1 to 0.2 ESG points per $1 million subsidy, demonstrates that governance-oriented outcomes represent the primary channel through which state-linked and large firms translate financial support into measurable ESG advancements.

II.10. Additional Testing

In this section, we delve into the marginal diminishing returns of ESG subsidies on ESG performance by segmenting the ESG subsidy into deciles as our additional test.

The law of diminishing marginal returns, a fundamental economic concept, suggests that as ESG-related subsidy levels increase, the subsequent boost to a firm's ESG performance lessens. We separate ESG-related subsidies into ten groups based on their decile value, with a higher decile of ESG-related subsidy indicating a higher ESG-related subsidy value. The results are presented in Figure II.5 and Table II.7.

Specifically, the estimated coefficient of the interaction between ESGSUB and $ESG_{i,t+1}$ starts at 0.290 for the 0th decile of ESGSUB, as shown in the first row, which implies that each additional $1 million of ESG-related subsidy is associated with about a 0.29-point increase in ESG performance for firms in the lowest subsidy group. As we move to higher deciles of ESGSUB, the coefficient gradually decreases. For instance, it is 0.261 for the 1st decile, 0.236 for the 2nd decile,

and so on, until it reaches 0.196 for the 9th decile, corresponding to approximately a 0.20-point increase per additional $1 million subsidy at the upper end of the distribution. However, these coefficients are not statistically significant from the 8th decile onwards, indicating that this effect disappears in such cases. The reduction from 0.29 to 0.20 points per $1 million subsidy represents an approximate 30% decline in the marginal economic effect, consistent with the theoretical prediction of diminishing returns. Our findings underscore that with rising ESG-related subsidy values, their positive effect on ESG performances diminishes and eventually disappears, following the law of diminishing marginal returns.

II.11. Conclusion

II.11.1. Summary

In summary, our study provides compelling evidence that government ESG-related subsidies, especially those targeting environmental initiatives, positively influence firms' ESG performance. This positive relationship between ESG-related subsidies and ESG performance is driven exclusively by the periods following the Paris Agreement and is accompanied by a marginal diminishing effect.

This finding aligns with and extends the studies by Dyck et al. (2019), Bolton and Kacperczyk (2020), Bolton and Kacperczyk (2021), Bolton and Kacperczyk (2023a), and Bolton and Kacperczyk (2023b), underscoring the pivotal role of the Paris Agreement as a catalyst and turning point in global ESG practices, due to the stronger global consensus toward an achievement of a green environment. This insight is significant for policymakers, highlighting the profound influence of global policy landmarks in shaping corporate behaviour toward sustainable and environmentally friendly practices.

Furthermore, our study reveals that politically connected firms, especially SOEs, and large-sized firms are more effective in utilizing these subsidies to enhance their ESG performance compared to their peers (Monsen Jr and Downs 1965; Cao et al. 2022). This finding underscores the importance of firm characteristics, particularly size and political connections, in shaping ESG per-

formance. However, the S pillar remains largely unaffected by subsidy incentives, consistent with agency and stakeholder perspectives suggesting that social initiatives yield less measurable, long-term benefits and receive weaker policy prioritization. This divergence across E, S, and G pillars highlights that subsidies are most effective when targeting quantifiable and auditable outcomes.

II.11.2. Policy Implications

Our findings highlight the critical role of environmental subsidies in driving the positive relationship between ESG-related subsidies and ESG performance. This carries significant implications for various stakeholders.

For policymakers, the success of the Paris Agreement underscores the efficacy of global climate agreements. Policymakers should therefore harness the potential of such international frameworks to promote a greener future. Recognising the pivotal role of the Paris Agreement, they should consider its implications when designing future policies. Furthermore, by channelling resources and attention toward environmental-related subsidies, policymakers can foster a more sustainable corporate landscape and incentivize companies to adopt practices that align with global environmental standards.

At the same time, the limited impact of subsidies on the S pillar suggests that fiscal incentives alone cannot effectively internalize the social externalities of corporate activities. To address this gap, policymakers could integrate explicit social performance criteria into subsidy frameworks, such as indicators of employee welfare, occupational safety, and community engagement. Linking a portion of subsidy eligibility or disbursement to verified social outcomes would create a stronger alignment between fiscal support and genuine social progress. Governments could also establish outcome-based reward schemes or tax incentives for firms that demonstrate measurable improvements in social responsibility, and introduce independent social audits to enhance credibility and accountability. Complementing fiscal support with enhanced social disclosure standards and labour protection mechanisms would ensure that subsidies contribute more directly to inclusive

and equitable development.

Policymakers also need to encourage firms without political ties to make better use of ESG-related subsidies by introducing targeted incentive programmes. Such initiatives can help ensure a more balanced and inclusive improvement in ESG performance across the corporate sector.

For corporate decision-makers, particularly in large firms, our findings emphasize the importance of strategic investments in both environmental and social initiatives. Such investments not only enhance ESG performance but also attract government subsidies and strengthen market recognition. Decision-makers should therefore prioritise ESG-oriented investments, actively pursue relevant subsidies, and clearly communicate the long-term financial and reputational value of these initiatives to shareholders. ESG-related subsidies can also help mitigate the agency conflicts described by Meckling and Jensen (1976), as management seeks immediate financial benefits while shareholders recognise the long-term value of improved ESG performance.

However, firms should acknowledge that social improvements rely less on direct fiscal support and more on sustained engagement with internal and external stakeholders. Incorporating social objectives into corporate strategy, aligning managerial incentives with social outcomes, and embedding these targets within governance structures can yield durable benefits in employee relations, reputation, and community trust. Firms may also leverage partnerships with local governments or NGOs to amplify the reach and credibility of their social initiatives.

For other stakeholders, such as investors and consumers, our study provides a valuable analytical basis for decision-making. By closely monitoring firms' investments in environmental and social[8] initiatives, stakeholders can gain a predictive advantage. Insight into forthcoming ESG performance, coupled with an understanding of associated risks and returns, enables more informed decisions. Whether seeking investments that reflect ethical values or purchasing products from companies that prioritise sustainability, stakeholders can rely on robust empirical evidence to align their choices with both risk preferences and desired outcomes. Moreover, investors should recog-

[8]Such as technological advancements and patent acquisitions.

nise that environmental and governance indicators respond more directly to fiscal interventions, while social progress depends more on long-term strategic behaviour and stakeholder collaboration. Integrating this understanding into portfolio decisions may enhance both return stability and social impact. Consequently, further exploring the relationship between ESG performance and ESG-related subsidies, particularly in conjunction with stock market performance, presents an interesting direction for future research.

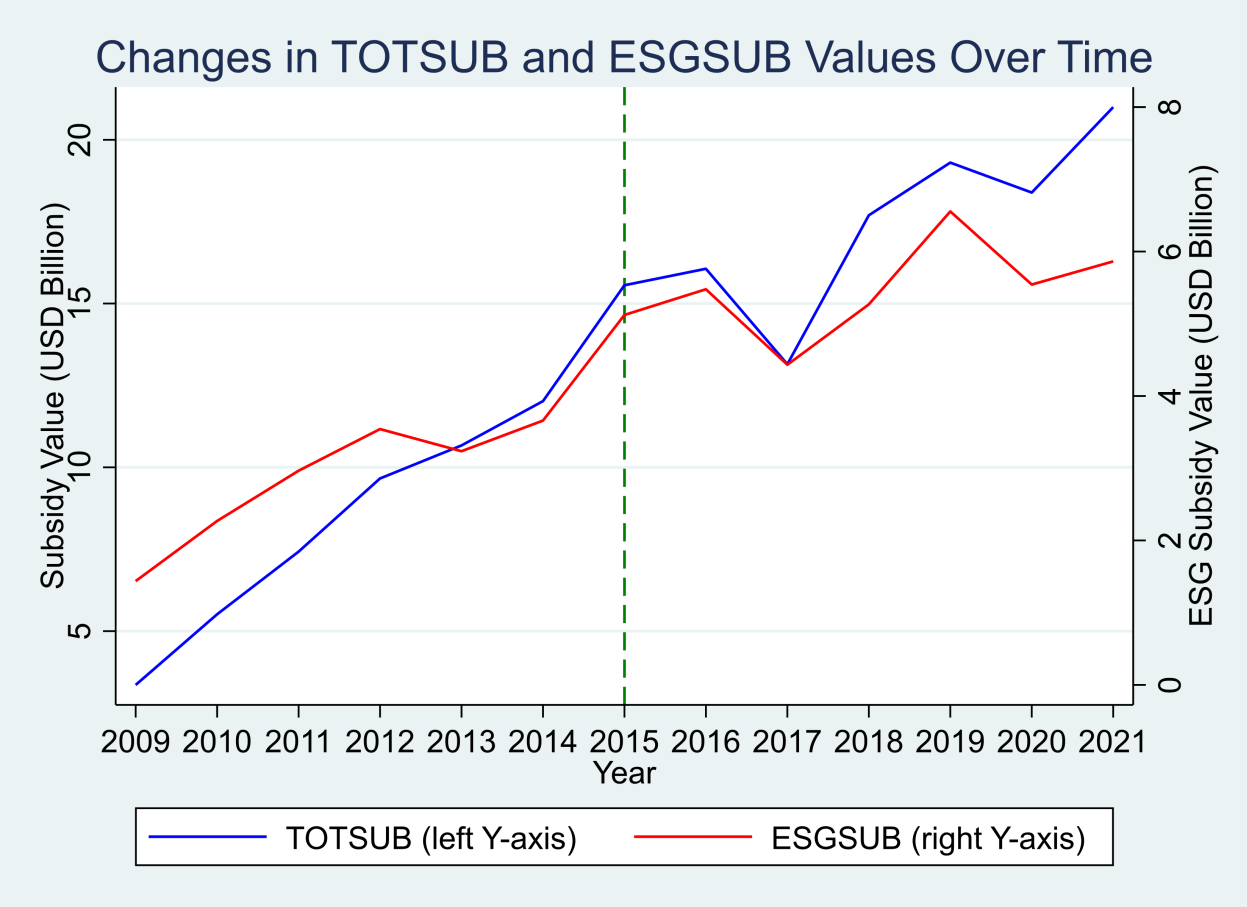
II.11.3. Further Research Directions

An interesting extension of our findings would be to explore their implications for stock market performance. How do the dynamics between government subsidies, firm characteristics, and ESG performance influence stock market outcomes? This can offer a richer perspective on the broader financial and economic implications of our findings (See Chapter III). Second, understanding the cost to the government of providing the subsidies versus the societal benefit of improved ESG performance would be an interesting extension of the current work.

Nevertheless, it is important to note that while our study provides valuable insights, there are potential caveats associated with the basic assumptions of our analysis. For instance, ESG performances could potentially be manipulated to appear better than they are in reality, namely, greenwashing (Zhang 2022), especially in the case of politically connected firms. This is an area that warrants further investigation.

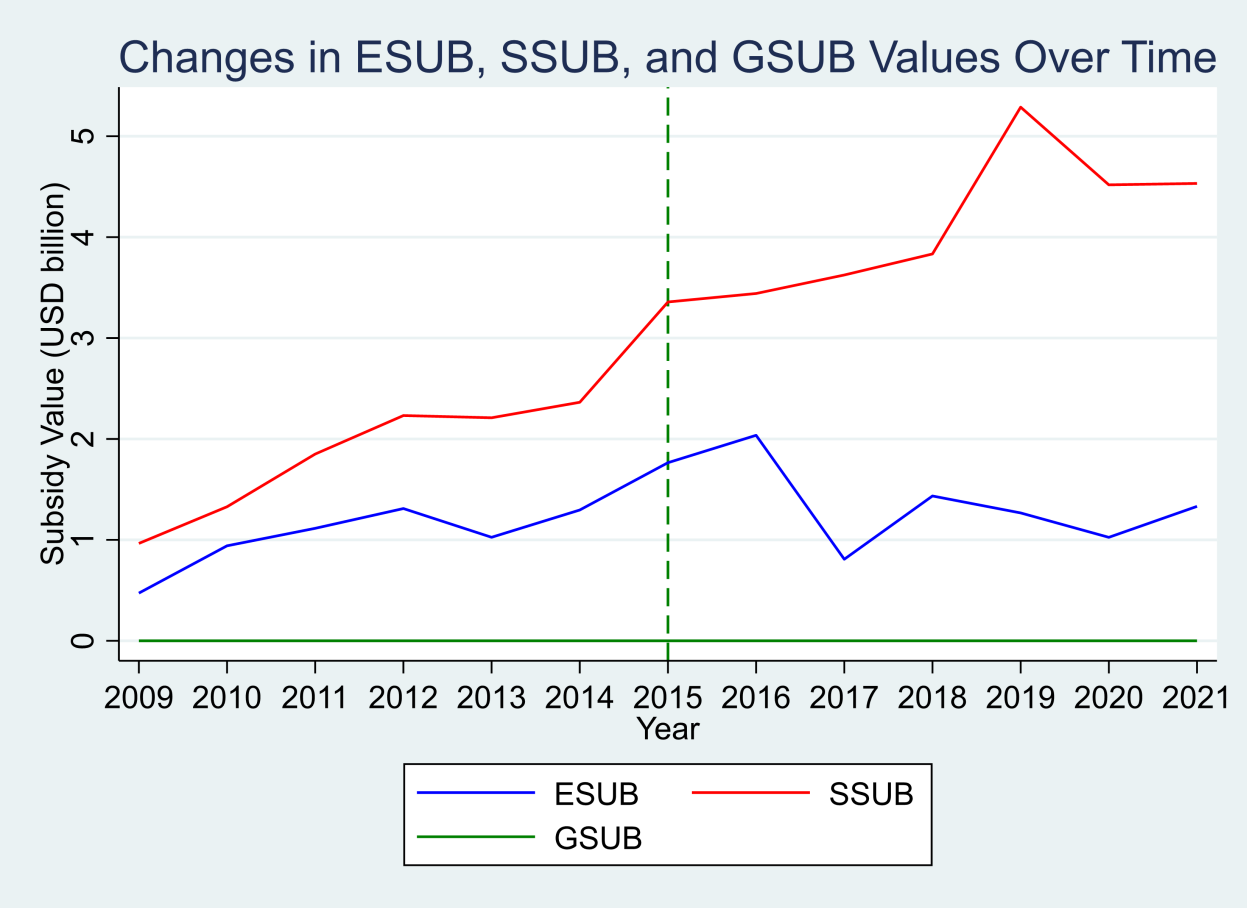
In conclusion, our study underscores the significant role of government subsidies, the Paris Agreement, and firm characteristics in shaping firms' ESG performance, providing valuable insights for future research and policymaking in this area.

Figure II.1: **The Trend of ESG-Related and Total Government Subsidies (2009–2021)**



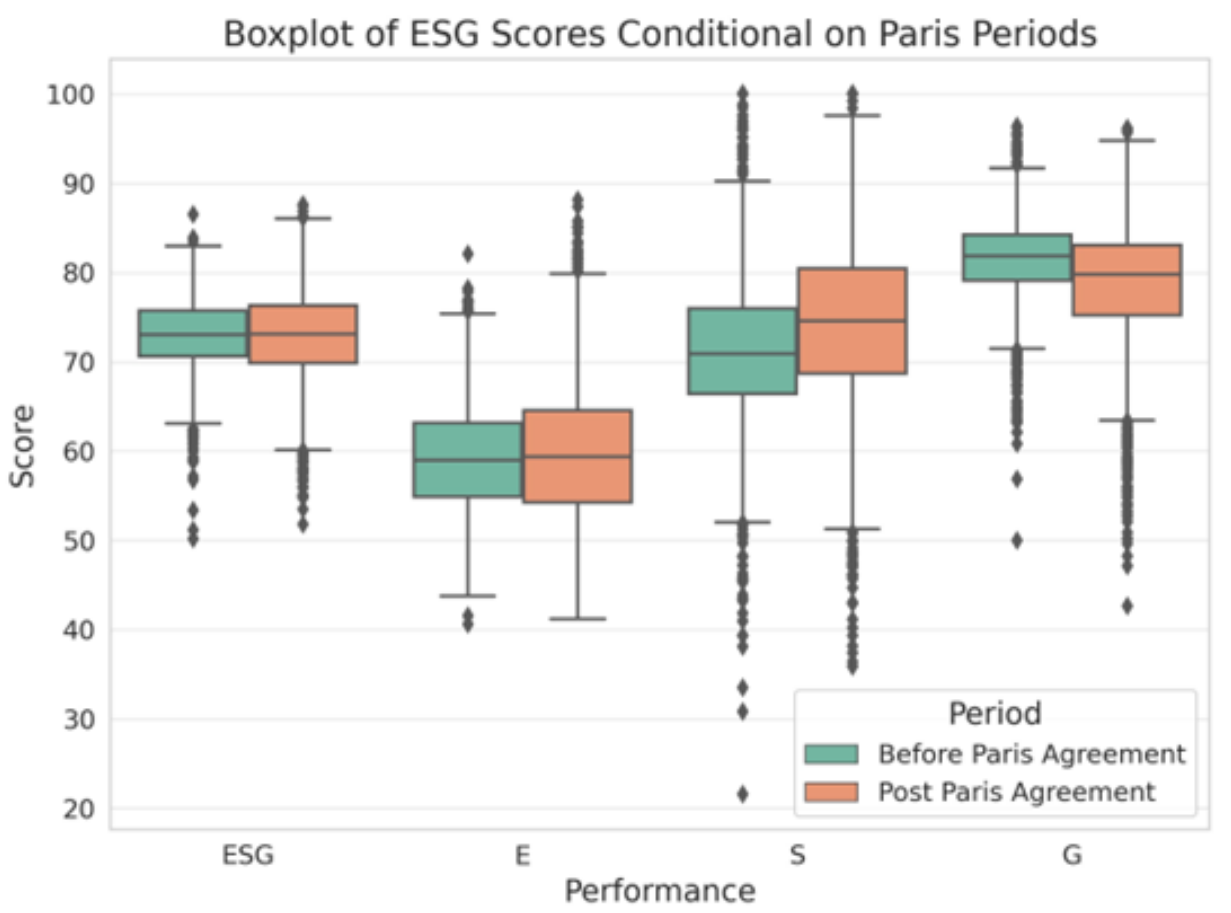
Note: This figure presents the trends in changes in total government subsidy and ESG-related subsidy over time. The blue line indicates the trend of the total government subsidy, while the red line represents the ESG-related subsidy. The left Y-axis corresponds to the total subsidy, and the right Y-axis corresponds to the ESG-related subsidy.

Figure II.2: **The Trend of Separated E/S/G-Related Subsidies (2009–2021)**



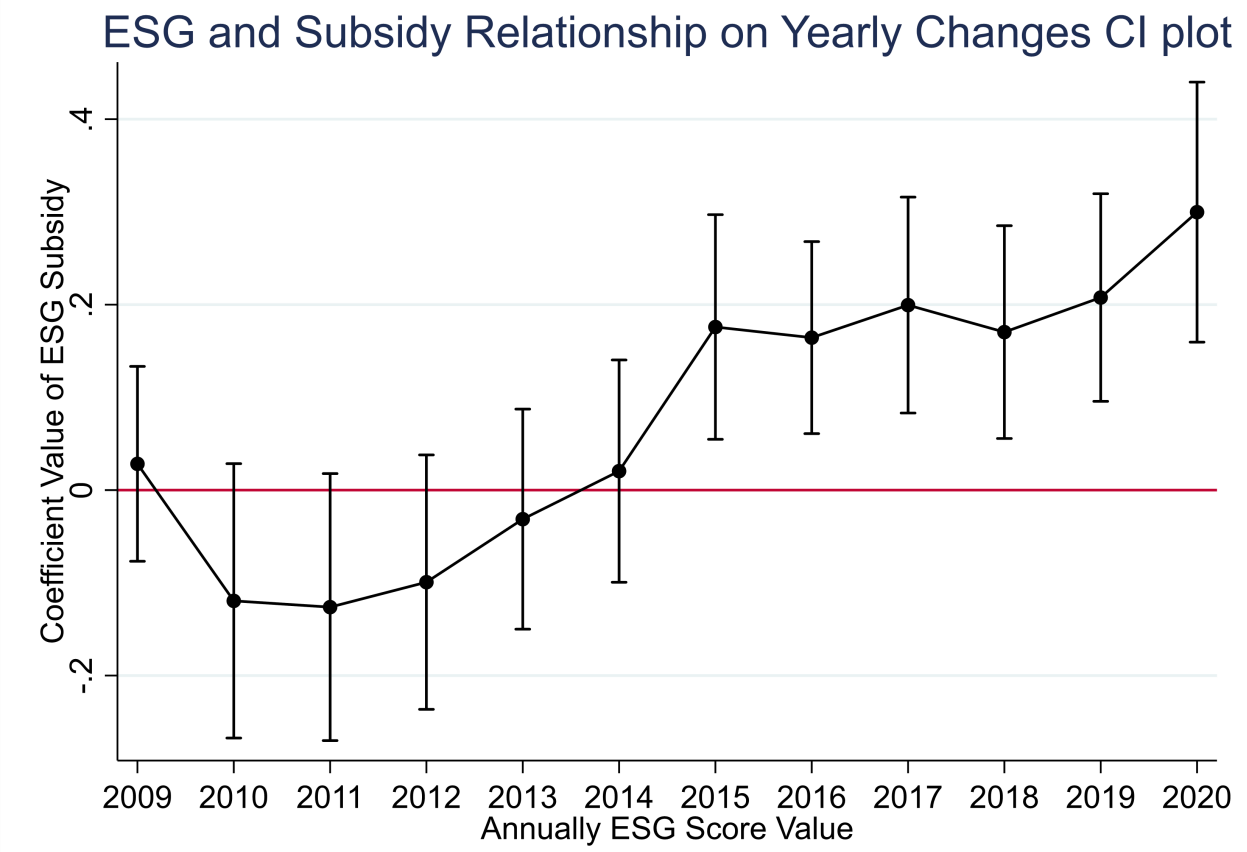
Note: This figure presents the trends in the changes of the separated Environmental, Social, and Governance related subsidies over 2009 to 2021.

Figure II.3: **Boxplots of ESG Performance Before and After the Paris Agreement**



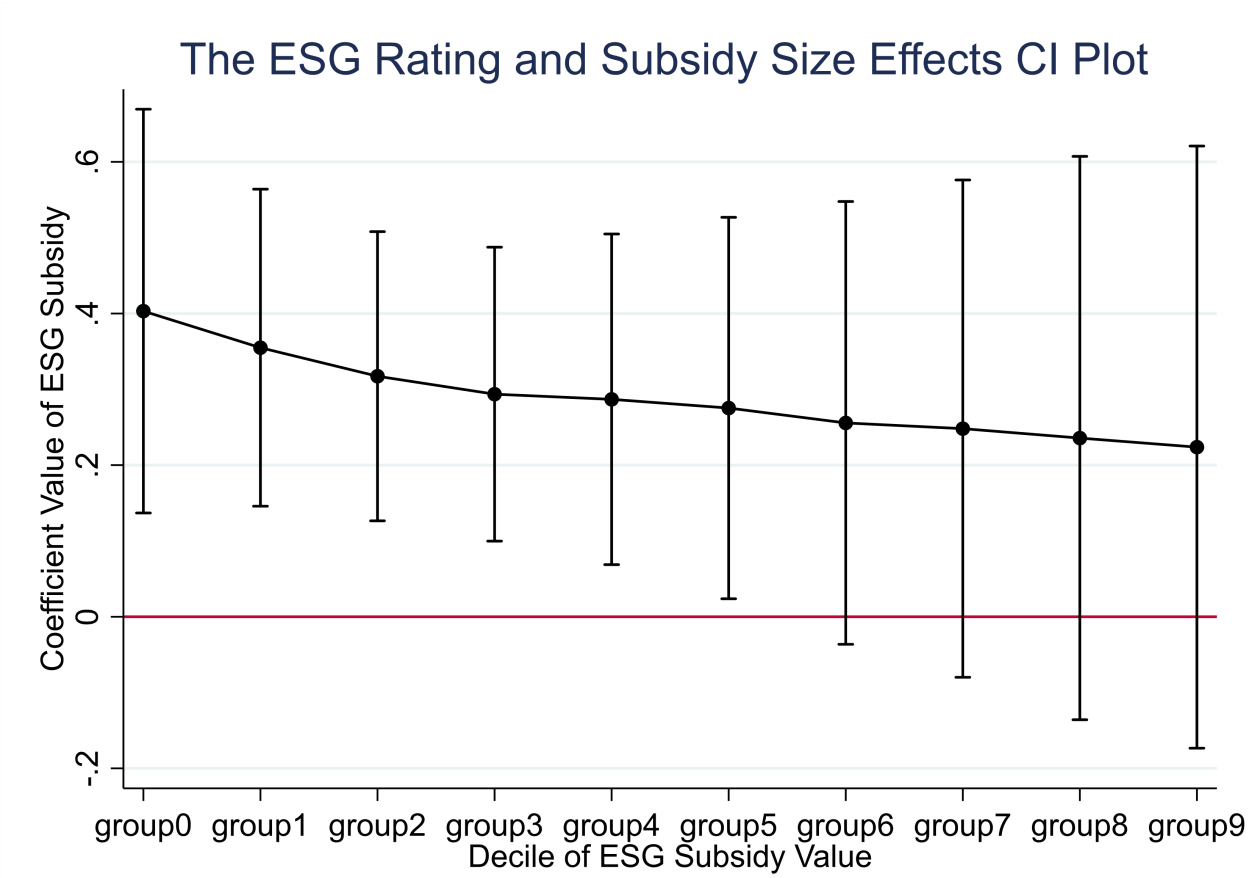
Note: This figure compares the distributions of overall ESG, Environmental, Social, and Governance scores before and after the Paris Agreement period.

Figure II.4: **Annual Confidence Interval Analysis of ESG and ESG Subsidies (2009–2020)**



Note: This figure presents the yearly trend and confidence intervals of the ESG rating and subsidy size effect. The line plot represents the coefficient values over the years, the scatter points correspond to these values for each specific year, and the capped lines show the 95% confidence intervals.

Figure II.5: **Diminishing Marginal Effect of ESG Subsidies on ESG Performance**



Note: This figure presents a Confidence Interval (CI) plot of the diminishing marginal analysis on ESG ratings and the ESG subsidy value size. The line plot represents the coefficient values for different groups, with each group representing a decile of the ESG subsidy value. The scatter points correspond to these values for each specific group, and the capped lines or indicate the 95% confidence intervals. The x-axis labels '*group*0' to '*group*9' represent the deciles of the ESG subsidy value.

Table II.1: **Government Subsidy Application and Evaluation Process in China**

Progress Steps	Details/Requirements
(1)Online Submission	Application form Supporting documents (e.g., tax payment certificates, annual reports, business licenses, etc.)
(2)Preliminary Review	Conducted by the funding agency
(3)Expert Evaluation	Expert committee review Feedback and possible revisions
(4)On-site Investigation	Verification of information Assessment of project implementation capacity Compliance with regulations and industry standards
(5)Public Announcement	List of approved projects Subsidy amounts
(6)Disbursement of Subsidies	Distribution funds to firms
(7)Post-Subsidy Reporting and Evaluation	Project completion report Financial report Performance evaluation report Intellectual property report Post-project evaluations or audits

Note: This table presents the results of a comprehensive analysis of the government subsidy application processes which posts on government-related websites, which details the process and requirements for a firm to apply for and obtain government subsidies. The gathered information has been systematically organized and consolidated to provide a clear understanding of the subsidy application process.

Table II.2: **Variable Definitions**

Variables	Full Name of Variable	Description
Dependent Variables		
ESG	Firm's ESG Performance	A measure of a firm's overall ESG Performance.
E	Firm's E Performance	A measure of a firm's performance in environmental aspect.
S	Firm's S Performance	A measure of a firm's performance in social aspect.
G	Firm's G Performance	A measure of a firm's performance in governance aspect.
Independent Variables		
ESGSUB	ESG-related Subsidy	The natural logarithm of total ESG-related subsidy.
NONSUB	Non-ESG-related Subsidy	The natural logarithm of total non-ESG-related subsidy.
ESUB	E-related Subsidy	The natural logarithm of total E-related subsidy.
SSUB	S-related Subsidy	The natural logarithm of total S-related subsidy.
GSUB	G-related Subsidy	The natural logarithm of total G-related subsidy.
Control Variables		
Size	Market Capitalization	The natural logarithm of total market capitalization.
MB	Market to Book Ratio	The ratio of market value to book value of a firm.
CAPEX	Capital Expenditure	The total capital expenditure value.
ROA	Return on Asset	The total net income divided by total book value of assets.
CASH	Operating Cash Flow to Asset Value	The total operating cash flow divided by total assets.
Growth	Operating Revenue Growth	The rate of growth of operating revenue of a firm.
LEV	Leverage Ratio	The total value of debt divided by the total book value of assets.
Instrumental Variable		
GDP RANK	Rank of Gross Domestic product	A rank indicating the province's GDP (1 = lowest GDP province).
Dummy Variables		
Paris	Paris Agreement 2015	1 if the year is from 2015 onward, 0 otherwise.
SOE	State-Owned Enterprise	1 if the firm is state-owned, 0 otherwise.
SIZE50	Big size firm	1 if the firm's size is above the median, 0 otherwise.

Table II.3: **Summary Statistics of Variables**

Panel A: Subsidy Values (Winsorized at 99%)

	N	Mean	SD	Min	p25	Median	p75	Max
TOTSUB ($million)	24137	7.04	22.76	0.00	0.73	1.92	5.17	674.00
ESGSUB ($million)	24137	2.29	10.87	0.00	0.15	0.50	1.54	544.43
NONSUB ($million)	24137	4.74	17.75	0.00	0.28	0.97	3.04	653.57
ESUB ($million)	24137	0.68	6.57	0.00	0.00	0.01	0.18	510.57
SSUB ($million)	24137	1.64	8.48	0.00	0.08	0.34	1.07	544.43
GSUB ($million)	24137	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Panel B: ESG Performances

	N	Mean	SD	Min	p25	Median	p75	Max
ESG	24137	72.80	5.49	39.98	69.76	73.14	76.43	92.38
E	24137	59.82	7.65	33.82	54.24	59.49	64.88	93.34
S	24137	73.07	10.39	0.00	66.61	73.28	79.75	100.00
G	24137	79.34	7.61	19.33	76.73	81.00	83.95	97.33

Panel C: Control Variables (Winsorized at 99%)

	N	Mean	SD	Min	p25	Median	p75	Max
GROWTH (%)	24137	0.36	0.92	-0.72	-0.03	0.14	0.42	6.44
MB	24137	4.82	56.87	0.11	1.89	2.94	4.64	7049.63
ROA	24137	0.03	0.04	-0.61	0.01	0.02	0.04	0.36
CASH ($million)	24137	38.67	100.60	-1000.43	3.21	23.54	58.02	3322.37
CAPEX ($million)	24137	68.77	173.23	0.16	6.40	17.89	49.33	1296.71
LEV	24137	0.43	0.21	0.01	0.27	0.42	0.59	1.76
SIZE ($million)	24137	1.679	4.796	0.069	0.446	0.79	1.55	367.887

Note: This table presents the statistical summary for variables utilized in our study from 2009 to 2021. Panel A shows the subsidy values, while Panel B shows the ESG and E/S/G performances, while . Panel C shows summary statistics for the main control variables. All continue variables (except the ESG and E/S/G performance) are winsorized at the 1% and 99% levels to mitigate the impact of extreme outliers.

Table II.4: **Baseline Results: ESG-Related Subsidies and ESG Performance**

Panel A: Predictive Power of ESG-Related Subsidies on ESG Performances

	(1)	(2)	(3)	(4)
	ESG (T+1)	ESG (T+1)	ESG (T+1)	ESG (T+1)
ESGSUB	0.096***	0.283***	0.175***	
	(0.027)	(0.038)	(0.035)	
NONSUB				0.739
				(0.955)
Growth	0.212***	0.115*	0.283***	0.213***
	(0.044)	(0.059)	(0.069)	(0.043)
MB	0.000	-0.001	-0.001	0.000
	(0.000)	(0.001)	(0.001)	(0.000)
ROA	25.722***	33.879***	32.108***	25.589***
	(2.172)	(3.191)	(3.081)	(2.156)
LEV	0.001**	0.002***	0.002***	0.001**
	(0.000)	(0.001)	(0.001)	(0.000)
Cash	0.000***	0.000***	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
CAPEX	-4.409***	-3.574***	-2.822***	-4.401***
	(0.629)	(0.415)	(0.421)	(0.622)
Size	0.471*	0.811***	1.092***	0.480*
	(0.229)	(0.107)	(0.104)	(0.231)
Constant	61.373***	50.291***	45.212***	60.552***
	(5.153)	(2.309)	(2.296)	(5.457)
R-sq	0.640	0.195	0.162	0.640
N	18171	18546	18546	18171
Firm FE	Y	N	N	Y
Industry FE	N	Y	N	N
Region FE	N	N	Y	N
Year FE	Y	Y	Y	Y

Panel B: Endogeneity Tests (GMM 2SLS)

Step 1: Regression of GDPRANK on ESGSUB		Step 2: Regression of ESGSUB on ESG	
Instrumented Variable: GDPRANK	(1)		(2)
	ESGSUB (T+1)		ESG (T+1)
GDRRANK	0.007***	ESGSUB	6.639***
	(0.003)		-2.915
Controls	Y		Y
R-sq	-		-3.979
N	18546		18546
Firm FE	Y		Y
Year FE	Y		Y
Weak Identification test (F-Stat)		17.324	

Panel C: Predictive Power of ESG-Related Subsidies on E/S/G performances

	(1)	(2)	(3)
	E(T+1)	S(T+1)	G(T+1)
ESGSUB	0.132***	0.033	0.113**
	(0.042)	(0.056)	(0.043)
Controls	Y	Y	Y
R-sq	0.733	0.632	0.569
N	18171	18171	18171
Firm FE	Y	Y	Y
Year FE	Y	Y	Y

Panel D: Separated E/S/G-Related Subsidies on ESG and E/S/G performances

	(1)	(2)	(3)	(4)
	ESG(T+1)	E(T+1)	S(T+1)	G(T+1)
ESUB	0.022***	0.040***	0.030**	0.004
	(0.006)	(0.011)	(0.013)	(0.008)
SSUB	0.005	0.004	-0.048	0.047
	(0.014)	(0.020)	(0.034)	(0.028)
GSUB	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Controls	Y	Y	Y	Y
R-sq	0.640	0.733	0.633	0.569
N	18171	18171	18171	18171
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Note: This table provides our baseline results. Panel A presents the predictive power of ESG-related subsidy value (*ESGSUB*) and non-ESG-related subsidy value (*NONSUB*) on a firm's future ESG performance. Coefficients reflect the expected change in ESG scores associated with a one-unit increase in the respective subsidy value, holding other variables constant. Our control variables include Growth (sales growth rate), MB (market-to-book ratio), ROA (return on assets), LEV (leverage ratio), Cash (cash flow from operations to firm size), CAPEX (total capital expenditure amount), and SIZE (firm market capitalization). Panel B presents the endogeneity tests using a GMM 2SLS approach. The instrumented variable is GDP RANK, which measures the rank of the firm's provincial GDP (where the province with the lowest GDP is assigned rank 1, followed by 2, and so on). Panel C presents the predictive power of ESG-related subsidy value (*ESGSUB*) on a firm's separated E/S/G performances. Panel D presents the predictive power of the speared E/S/G related subsidy on ESG and individual E/S/G performances. We apply firm and year fixed effects, and additionally include industry and region (province) fixed effects for robustness. We winsorize all non-binary variables at the 1% and 99% levels and cluster standard errors at the firm and year level. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively, with standard errors shown in parentheses.

Table II.5: **The Role of the 2015 Paris Agreement**

Panel A: Paris Agreement Interaction Baseline

	(1)	(2)	(3)	(4)
	ESG (T+1)	E(T+1)	S(T+1)	G(T+1)
ESGSUB	-0.050	-0.020	-0.068	-0.058
	(0.056)	(0.063)	(0.079)	(0.068)
Paris × ESGSUB	0.254***	0.265***	0.176*	0.298**
	(0.052)	(0.055)	(0.085)	(0.098)
Controls	Y	Y	Y	Y
R-sq	0.641	0.733	0.633	0.570
N	18171	18171	18171	18171
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Panel B: Yearly Interaction Effects (2009–2020)

	(1)	(2)	(3)	(4)
	ESG (T+1)	E(T+1)	S(T+1)	G(T+1)
2009 × ESGSUB	0.028	0.017	0.291***	-0.120
	(0.048)	(0.063)	(0.084)	(0.068)
2010 × ESGSUB	-0.119	-0.104	-0.180	-0.095
	(0.067)	(0.081)	(0.101)	(0.077)
2011 × ESGSUB	-0.126*	-0.083	-0.159*	-0.143
	(0.065)	(0.072)	(0.076)	(0.089)
2012 × ESGSUB	-0.099	0.013	-0.196**	-0.106
	(0.062)	(0.065)	(0.085)	(0.085)
2013 × ESGSUB	-0.031	-0.012	-0.101	-0.007
	(0.054)	(0.060)	(0.074)	(0.073)
2014 × ESGSUB	0.020	0.019	0.050	0.012
	(0.054)	(0.060)	(0.075)	(0.072)
2015 (Paris) × ESGSUB	0.176***	0.183**	0.168**	0.169**
	(0.055)	(0.065)	(0.075)	(0.073)
2016 × ESGSUB	0.164***	0.299***	0.022	0.202***
	(0.047)	(0.067)	(0.063)	(0.063)
2017 × ESGSUB	0.200***	0.338***	0.203**	0.115
	(0.053)	(0.071)	(0.074)	(0.066)
2018 × ESGSUB	0.170***	0.260***	0.105	0.167**
	(0.052)	(0.073)	(0.091)	(0.073)
2019 × ESGSUB	0.208***	0.230***	0.085	0.272***
	(0.051)	(0.057)	(0.085)	(0.068)
2020 × ESGSUB	0.300***	0.194***	0.047	0.499***
	(0.064)	(0.059)	(0.087)	(0.098)
Controls	Y	Y	Y	Y
R-sq	0.642	0.734	0.633	0.571
N	18171	18171	18171	18171
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Notes: This table examines how the 2015 Paris Agreement shapes the relationship between ESG-related subsidies and ESG performance. Panel A reports baseline interactions. Panel B provides a detailed year-by-year analysis from 2009 to 2020. All regressions include firm and year fixed effects. Standard errors are clustered at the firm and year levels. All continuous variables are winsorized at the 1% and 99% levels. Coefficients represent the marginal effect of ESG-related subsidies on firm ESG performances, conditional on the post-Paris Agreement interaction. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively, with standard errors shown in parentheses.

Table II.6: **Heterogeneity Analysis: SOEs and Large Firms**

	SOEs				Large Firms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ESG (T+1)	E(T+1)	S(T+1)	G(T+1)	ESG (T+1)	E (T+1)	S (T+1)	G (T+1)
ESGSUB	0.057	0.119**	0.023	0.039	0.046	0.145***	-0.012	0.024
	(0.035)	(0.050)	(0.066)	(0.057)	(0.031)	(0.038)	(0.071)	(0.050)
ESGSUB × SOE	0.087*	0.031	0.021	0.166**				
	(0.046)	(0.073)	(0.095)	(0.071)				
Size50					-1.738**	0.046	-1.307	-2.978***
					(0.655)	(0.816)	(1.177)	(0.944)
ESGSUB × Size50					0.101**	-0.027	0.091	0.178**
					(0.043)	(0.055)	(0.078)	(0.061)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
R-sq	0.640	0.733	0.632	0.569	0.643	0.733	0.633	0.573
N	18171	18171	18171	18171	18171	18171	18171	18171
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Notes: This table presents heterogeneity analysis focusing on State-Owned Enterprises (SOEs) and large firms, defined as those with size above the annual median. All regressions include firm and year fixed effects. Standard errors are clustered at the firm and year levels. All continuous variables are winsorized at the 1% and 99% levels. Coefficients on the interaction terms capture how the relationship between ESG-related subsidies and ESG performance varies for SOEs and large firms. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively, with standard errors shown in parentheses.

Table II.7: **Marginal Diminishing Returns of ESG-Related Subsidies on ESG**

	(1)
	ESG(T+1)
Group0 × ESGSUB	0.290***
	(0.086)
Group1 × ESGSUB	0.261***
	(0.072)
Group2 × ESGSUB	0.236***
	(0.068)
Group3 × ESGSUB	0.222***
	(0.069)
Group4 × ESGSUB	0.224**
	(0.078)
Group5 × ESGSUB	0.219**
	(0.089)
Group6 × ESGSUB	0.206*
	(0.101)
Group7 × ESGSUB	0.205*
	(0.113)
Group8 × ESGSUB	0.203
	(0.128)
Group9 × ESGSUB	0.196
	(0.133)
Group	0.031
	(0.294)
Controls	Y
R-sq	0.642
N	18171
Firm FE	Y
Year FE	Y

Notes: This table presents the results of an additional test examining the marginal diminishing returns of ESG-related subsidies on ESG performance. To assess this, we divide ESG subsidy values (ESGSUB) into deciles, forming ten distinct groups. Each row in the table corresponds to one decile of ESGSUB, allowing us to capture non-linear effects across different subsidy levels. Regression include firm and year fixed effects. All continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm and year levels. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively, with standard errors shown in parentheses.

Chapter III

The Capital Market Responses to ESG-related Subsidy Policy Announcements: Evidence from China

III.1. Introduction

Climate change is a global concern, not just for major economies like China. Many governments implement subsidy policies to support firms tackling climate change, offering financial aid and correcting market failures. In China, such subsidies promote growth in ESG-focused sectors like clean energy vehicles (Liu et al. 2022). These ESG-related subsidies also influence how markets interpret financial data. Research from both the US and China shows that government subsidies impact stock prices and market behaviour, enhancing information efficiency (Lee et al. 2014; Bond and Goldstein 2015; Carpenter et al. 2021). Market reactions often spike after macroeconomic news, such as subsidy announcements (Connolly and Stivers 2003).

The Paris Agreement marked a global turning point in climate action. Studies highlight its role in raising awareness and influencing policies, including China's pledge to achieve carbon neutrality by 2060 (Bolton and Kacperczyk 2023a; Bolton and Kacperczyk 2023b; Bolton and Kacperczyk 2024). In China's state-controlled system, politically connected firms often gain preferential access to ESG subsidies. These firms align with national goals, but State-Owned Enterprises (SOEs) often face bureaucratic drag—inefficiencies that weaken market responses and hinder the effectiveness of ESG subsidies in improving corporate performance (Allen et al. 2005; Chen et al. 2011; Fan et al. 2020; Cao et al. 2022; Allen et al. 2024).

Our motivation for research arises from a growing worldwide emphasis on ESG actions, which are progressively drawing attention from investors and policymakers because of increasing worries about climate change risks. Governments respond to this by offering subsidies that aim to encourage greener practices among firms. These firms' stock prices react not only when there are

announcements about new subsidy policies (Bond and Goldstein 2015), but also when the abnormality in stock turnover can become extreme at such times (Connolly and Stivers 2003). Investors are also changing their investment orientations as they take ESG as a measure of corporate excellence (Dyck et al. 2019; Pedersen et al. 2021; Pástor et al. 2021; Pástor et al. 2023).Previous studies show that government subsidies significantly impact various aspects of firm operations, including investment decisions, cost of capital, performance improvement, and the stimulation of green investments and sustainable initiatives, as environmental projects require more funding than others.

Besides, stock markets may also react significantly through different firms' rationalisation levels on ESG issues or policies based on past findings. But what is still not known is how exactly a government's announcement regarding its subsidies relating to ESG affects returns earned by corporations listed in the stock exchange market. While Chapter II finds that the amount of ESG-related subsidy positively relates to a firm's ESG performance, there are still gaps in the literature concerning reactions shown by share prices when similar events occur within a firm.

We employ an event study to examine how ESG-related subsidy policy announcements in China affect stock returns, using data from all listed Chinese firms between 2010 and 2022. Firms are grouped into 'high' and 'low' ESG categories based on the median ESG score. We analyse variations in market response using Cumulative Abnormal Returns (CARs) over event windows $[-2:+2]$, $[-2:+3]$, and $[0:+1]$, with $[-2:+2]$ as the baseline for regression analysis.

Firms with high ESG ratings are expected to show positive CARs and lower Cumulative Abnormal Turnover (CATs), indicating that the market values such announcements and rewards sustainable practices. In contrast, low-ESG firms may exhibit insignificant CARs and higher CATs, suggesting weaker market efficiency and scepticism towards their ESG efforts. These outcomes have implications for both policymakers and investors in designing subsidies and forming ESG-based investment strategies.

In addition to the baseline CAR analysis based on firms' ESG performance, we further in-

corporate institutional ownership as an additional dimension through which market reactions may vary. Examining how firms with high and low ownership concentration respond to subsidy announcements allows us to capture differences in investors' capacity, information processing, and monitoring intensity, providing a complementary test of the mechanisms behind the announcement effects.

We anticipate stronger positive CARs for firms that publicly commit to sustainability-related subsidies, as such signals may boost investor confidence in management's capacity to drive long-term, sustainable growth. However, firms with weak ESG performance may not benefit as much, due to doubts over their ability to manage sustainability risks. Further, SOEs, often closely tied to political elites, may suffer from bureaucratic drag that reduces their responsiveness to ESG subsidies, despite policy support (Allen et al. 2024). Their constrained flexibility and implementation inefficiencies contrast with non-SOEs, which tend to attract more interest from ESG-focused investors and exhibit better stock performance following subsidy announcements.

Our ESG data is sourced from SSI Company, and subsidy policy data from CSMAR. ESG-related subsidies are identified via keyword matching, following the method outlined in Chapter II and Appendix A. These are then linked with firm characteristics, stock returns, and other public data for the full study period.

Our chapter presents three key findings. First, our baseline result shows that ESG-related subsidy announcements yield significantly positive CARs for high ESG firms across event windows $[-2:+2]$, $[-2:+3]$, and $[0:+1]$, while low ESG firms show no significant reactions. This suggests investor confidence in high ESG firms' capacity to leverage subsidies for sustainable growth. The CARs observed are 0.028%, 0.038%, and 0.016%, respectively. Notably, the CAR of 0.028% over the $[-2:+2]$ window is approximately four times larger than the average five-day return of the Shanghai Composite Index (0.0074%) during the sample period, suggesting that investors could earn considerably higher short-term returns by reacting to ESG-related subsidy announcements compared to simply holding the market portfolio.Second, we find that both ESG scores and

the amount of ESG-related subsidies are positively associated with CARs. A one-unit increase in ESG scores corresponds to a 0.023% CAR rise in $[-2:+2]$ and 0.026% in $[-2:+3]$, though insignificant in $[0:+1]$. Similarly, subsidy amount increases are linked to CAR rises of 0.020%, 0.023%, and 0.009% across the three windows. Sector analysis shows stronger effects in industrial and utility sectors, which are more sensitive to environmental regulations. Third, the CAR-subsidy relationship changes after the 2015 Paris Agreement. Post-agreement, subsidies are associated with a 0.085% CAR increase, whereas pre-agreement the effect is negative (-0.062%). The relationship also differs by ownership: non-SOEs see a 0.027% CAR increase per subsidy unit, while SOEs see a decrease of 0.017%, likely due to bureaucratic drag and limited flexibility (Fan et al. 2020; Allen et al. 2024).

Robustness checks using alternative models (Sharpe 1964; Carhart 1997; Fama and French 2015; Liu et al. 2019) confirm these patterns. Additionally, sorting firms by median subsidy levels shows that even low ESG firms experience CAR gains when receiving high subsidies—though to a lesser extent—highlighting the role of financial incentives. Further, our results remain robust after excluding firm-day observations where ESG-related subsidy announcements coincide with the firm's own M&A disclosures, suggesting that the observed market reactions are not driven by overlapping corporate events. For additional test, we also examine investor sentiment via CATs. High ESG firms show negative CATs (e.g., -0.021% in $[-2:+2]$), indicating stable holding behaviour, while low ESG firms show positive CATs (e.g., 0.023%), reflecting speculative trading. This aligns with prior findings on turnover and speculative behaviour in China's markets (Pan et al. 2016).

Taken together, we find strong evidence that market responses to ESG-related subsidy announcements lead to high positive CARs only for high ESG firms but no significant benefit among low ESG firms. This implies that such announcements are only of interest to the former. Higher levels of ESG scores and more funds allocated by the Chinese government result in higher CARs. Particularly, a positive link between subsidies amount provided by ESG and CAR only exists dur-

ing post-2015 periods of the Paris Agreement; before that period it is negative, meaning that it indicates how effective China's government interventions at climate risk mitigation are as well as how they manage to boost investor confidence and valuations in favour of highly scored ESG firms. Moreover, the Paris Agreement is a turning point in global efforts towards combating climate change through international cooperation, further extending the study by Bolton and Kacperczyk (2023a), Bolton and Kacperczyk (2023b), and Bolton and Kacperczyk (2024). For non-SOEs, the relationship is positive while negative for SOEs. In contrast to non-SOEs that have relatively greater autonomy, SOEs suffer from bureaucratic rigidity thus leading to lower stock market returns in China (Fan et al. 2020). Consistent with these findings, additional tests based on institutional ownership show that firms with higher ownership concentration experience more favourable announcement returns, reinforcing the role of investor composition in shaping market reactions to ESG related subsidies. Besides this, we argue that investor sentiment may explain why high ESG firms display superior CARs relative to low ESG ones. Belief about the firm's prospects drives share prices up or down. We observe that CATs fall as firms become more compliant with corporate governance requirements - typically associated with higher ESG ratings. But for less-scoring ESG firms whose confidence weakens due to uncertainty about these firms' compliance with new rules. This lack of confidence prompts investors to sell off their shares, and as trading volumes increase, it results in insignificant CARs.

High ESG firms tend to experience positive CARs following ESG-related subsidy announcements due to several factors. Strong governance and transparency enhance investor confidence, as these firms are better positioned to utilise subsidies effectively for sustainable growth. Their superior risk management and long-term strategic planning further support the efficient integration of subsidies, making them more attractive to sustainability-oriented investors. Positive relationships among ESG scores, subsidy amounts, and CARs may stem from effective resource allocation, signalling effects (Meuleman and De Maeseneire 2012), or competitive advantages. Larger subsidies signal government endorsement, allowing firms to invest more in sustainability initiatives, gain

market share, and potentially outperform peers.

Our chapter contributes to the literature by examining investor reactions to state-led ESG subsidy announcements, an area under-explored compared to firm-level ESG actions such as corporate sustainability announcements (Flammer 2013; Flammer 2021), green bond issuances (Tang and Zhang 2020), and carbon regulation expectations (Ilhan et al. 2021). We shift the focus to direct government interventions in emerging markets, providing novel evidence on how state-driven ESG policies influence market perceptions, which is an aspect that has received limited attention in existing studies. Moreover, we uniquely integrate CARs and CATs to capture both price impacts and trading behaviour, allowing for a richer interpretation of investor sentiment—an approach rarely combined in ESG event studies. This extends existing research on ESG information processing and pricing (Krueger et al. 2020). Finally, by manually identifying and categorizing ESG-related subsidies from China's policy dataset, we provide a detailed assessment of how such announcements influence stock performance in state-led financial systems. While focused on China, our findings likely generalize to other emerging markets.

The structure of this chapter is as follows: section III.2 contains a literature review, section III.3 discusses our hypotheses, section III.4 describes our research methodology, section III.5 details our data, section III.6 presents our empirical findings, and section III.7 provides the conclusion.

III.2. Literature Review

III.2.1. Government Subsidy Policy and Stock Pricing Information Efficiency

Government subsidies are necessary tools in fiscal policy used to correct market failures, promote economies of scale in strategic sectors, and attain goals such as even distribution of wealth, and reducing joblessness (Innes 1991; Schwartz and Clements 1999; Lim et al. 2018), they can also be utilised to manipulate the stock market (Han et al. 2019). Governments influence stock markets by initiating objectives and providing funding support using policies. According to Bond and Goldstein (2015), these adjustments play a key role in price efficiency information, which is consistent

with Fama's Efficient Market Hypothesis (1970) that holds that stock prices take into account all available information including governmental actions. According to Connolly and Stivers (2003), the U.S. Stock Market experiences abrupt changes at times coinciding with significant macroeconomic news such as subsidy announcements which indicate that markets are particularly responsive to this kind of news. Such as, a mathematical model developed by Bond and Goldstein (2015) based on an established model of information aggregation was used to analyse how government subsidies affected the U.S. financial markets during the 2007-2008 financial crisis. In this period, major bailouts were provided by the government to large financial institutions like American International Group (AIG) as well as Citigroup, and big firms within the auto industry. The authors' findings indicate that market players traded differently due to different types and amounts of these government subsidies, consisting mainly of grants or high-interest loans, thereby affecting the set information contained in the equity prices at that particular time.

In China, it is common for public firms to be given financial support by the government. Lee et al. (2014) had discussions with several Chinese finance experts. They confirmed that knowledge of these subsidies has a significant effect on earning expectations, target prices, and stock recommendations leading to improvement in the market's skill in absorbing subsidy policy information. Using panel regression analysis from 1995 to 2016, Carpenter et al. (2021) noticed that since 2004 information aggregation efficiency has been at par with that of the U.S., which indicates how well the market prices in future firm profits imply that it can efficiently combine other policies like government subsidies.

Overall, these investigations reflect that both US and Chinese stock markets have efficiently priced government subsidies' information.

III.2.2. The Relationship Between Government Subsidy Policy and Stock Market Performance

The correlation between prices in the stock market and government subsidies is complex due to how they influence market efficiency. It involves both a positive stimulus as well as potential

negative effects.

Impact of Government Subsidies on Firm Value

Lee et al. (2014) introduced an advanced accounting valuation model by combining Ohlson (1995) and Ohlson (1999)'s models using a large sample of time series analysis to examine the effect of government subsidies on firm value. In China, they found that there is a significant relationship between government subsidies and firm value supported by the use of linear information systems as well as variables such as book values and abnormal earnings.

Moreover, Jiang et al. (2018) employed Chinese stock prices to perform empirical regression analyses after collecting subsidy data manually from Chinese firms between 2004 and 2014. The authors conclude that there is a positive association between stock market price and government subsidies; thus, signifying that the market considers it favourably when stocks are subsidised. The research has demonstrated that stock market prices are positively related to government subsidies. This implies that subsidising a firm's shares could enhance its value within various avenues in the markets; for example through stock markets. Several factors account for this positive relationship including changes in the fundamentals of the firm as well as macroeconomic externalises among others.

Additionally, different types of government subsidies can also have varying effects on a firm's stock market returns

i. Various Types of Government Subsidy

   As regards environmental-related subsidies, Liu et al. (2022) divide the subsidies in China's new energy vehicle (NEV) sector into three categories: fiscal policies, tax incentives, and government procurement. To investigate the impact of China's NEV subsidy policies on the stock prices of NEV firms from 2010 to 2019, Liu et al. (2022) used daily stock data for NEV firms and conducted a vent study. The abnormal returns were calculated to determine the impact of these policies on stock prices. Their findings indicate that targeted subsidies

– especially those with regard to tax incentives and government procurement – have positive future effects on the stock price of NEV firms. Nonetheless, this research focuses only on the NEV sector, there is still a gap in knowledge about how ESG-related subsidies impact future stock returns in a broader range of firms.

Meanwhile, Government Research and Development (R&D) Subsidy is also important for the IPO performance of the firm. Chen et al. (2018) do this by dividing government subsidies into R&D or non-R&D-based programs. The measure for IPO performance was done using two major indicators: Net Proceeds from IPO (NetPro) which shows better performance as it increases; and pre-money Market Valuation(PreVal). Better performance is indicated by larger values for these indicators.

For example, Chen et al. (2018) indicate that an inverted U-shaped relationship exists between a firm's IPO performance and R&D subsidy. This means that while initial R&D subsidies positively influence IPO performance, after they reach certain levels their benefits will reduce. On the contrary, non-R&D subsidies exhibit a U-shaped effect indicating their benefits increase with higher amounts following an initial limited impact. Also, it presents that when firms are SOEs or high level patenting intensity then R&D subsidies have smaller effects on IPO performance. This implies that stock market returns can be influenced by different types of subsidies in distinct ways, thus underlining the relevance of subsidy-specific nature in stock market research.

Further, government subsidies on firm stock market performance have diverse impacts while external macro factors and internal firm fundamentals are major conduits through which these subsidies affect market value and attractiveness.

ii. External Macro Factors

In China, the central government is the highest decision-making authority and controls the entire financial system (Allen et al. 2005; Boyreau-Debray and Wei 2005; Megginson et al.

2014). However, in recent years, economic reforms in China have focused on decentralising administrative powers since the 1980s (Chen et al. 2014; Jiang et al. 2018; Lim et al. 2018). Using competition to promote economic growth, local governments adopt national laws to fit regional needs, and based on their enhanced flexibility, these municipalities can direct central government funds toward preferred firms within their jurisdictions (Ayyagari et al. 2010). Political connectedness is a common characteristic of firms that are favoured by the government and are often recipients of more subsidies (Johnson and Mitton 2003; Jiang et al. 2018; Cao et al. 2022). It has been revealed that subsidies sometimes affect the market value of a firm according to its politically connected (PC) status.

Thus PC firms as described by Johnson and Mitton (2003) are those having links with government officials. These business stocks initially performed poorly after the loss of these grants during Malaysia's Asian financial crisis saw an upswing when capital controls were imposed leading to more support. This demonstrates how subsidies could increase market values for PC firms during periods of crisis. As Bond and Goldstein (2015) state, stock market information efficiency improves with subsidy policies.

For this reason, local governments subsidise public firms to avoid being delisted may raise corruption concerns. That said, such entities are often seen as endorsed by authorities thereby making them attractive investments and hence enhanced access to financing (Jaffe 2002; Meuleman and De Maeseneire 2012; Lim et al. 2018). For example, Jacob et al. (2016) explore the effects of withdrawing subsidies in Ontario using a difference-in-differences approach that shows subsidies boost firm value by decreasing investment risks and enhancing returns. And if subsidies are taken away, it increases investment risks and lowers market value. Thus, firms with government support through subsidies end up attracting more private money thus enabling them to grow (Kleer 2010; Ferreira and Matos 2008).

iii. Firm's Fundamental Factors

In China, government grants significantly boost corporate cash flow, as predicted by the Discounted Cash Flow (DCF) model (Allen et al. 2005; Chen et al. 2014; Lim et al. 2018), which in turn results in higher stock prices. Such increased cash flows decrease financial constraints and investment-cash flow sensitivity according to Jiang et al. (2018), with relatively smaller firms being more limited in terms of finance (Colombo et al. 2013; Busom et al. 2014). It is important to note that Chinese private firms experience greater financial constraints compared to SOEs (Chen et al. 2014).

On a different note, Lamont et al. (2001) used the arguments of Kaplan and Zingales (1997) for their analysis of stock returns from 1968-1997 using the KZ index which measures the level of financial constraint. These results provide evidence that stock returns are affected negatively by financial constraints, which supports the notion that subsidies help ease financing limitations; thus, positively affecting both the market value and performance of stocks for this firm.

According to the Pecking Order Theory (Myers and Majluf 1984), firms with low internal funds seek external finance. However, listed firms in China often face copious legal and regulatory barriers to obtaining debt or equity financing. This scenario makes it better than seeking loan facilities as an alternative to government subsidies since there are many issues concerning legal restrictions on borrowing practices through banks or other channels. State-granted funds are in most cases considered cheaper. However, Lim et al. (2018) indicate a contrary result where non-tax subsidy increases a firm's leverage. The data from Chinese-listed firms between 2007 and 2011 shows that these subsidies act as implicit guarantees by the government according to debt investors meaning they minimise the likelihood of defaulting.

Furthermore, the Trade-off Theory advanced by Myers (1984) opinion that firms with lower debt levels have a lower probability of bankruptcy and thus higher value. Fama and French (2002) also found a negative relationship between a firm's debt and its value hence subsidies

can alleviate a firm's debt obligations to boost its financial status, and stock market returns.

Negative Impact

The impact of government subsidies on stock market returns can be intricate and is not always positive. Research indicates that the uncertainty from policies on government subsidies often results in a decrease in a firm's stock market returns. Pastor and Veronesi (2012) analysed how US stock prices react when there are changes in the U.S. administration. The authors observe that after policy change announcements, there is usually a general drop in stock prices due to the discount rate effect which outweighs the cash flow effect caused by policy uncertainty. As a result, this leads to a decline in their share values averagely.

Similarly, Liu et al. (2022) comment that while China's NEV policy initially increases NEV firms' stock returns, continuous changes in policies and withdrawal of local government incentives may finally hurt these firms' share prices. On the other hand, Han et al. (2019) reveal that firms receiving subsidies tend to exhibit lower future equity return rates compared to non-subsidised ones as well as having lower valuations, especially among those paying significant amounts of cash dividends. Nonetheless, this indicates that while a firm's financial standing can be improved through grants, increasing investor confidence and leading to a rise in stock prices. Uncertainties surrounding such policies may result in a negative outcome that affects investors' perception of long-term stock value.

Government subsidies could have both positive and negative impacts on stock prices. In some cases they increase the firm's financial strength and enhance investors' confidence, thus making them experience favourable movement of share prices upwards. Conversely, such dependence or unpredictability about these allowances could be dangerous to equity markets overall; this means that lack of clarity would reduce public opinion as regards investments made for more than half-years ahead into the future.

III.2.3. The Relationship Between ESG Practices and Stock Market Performance

The Role of the Paris Agreement 2015

The Paris Agreement 2015, signed under the United Nations Framework Convention on Climate Change, has set global goals for fighting climate change by promoting low-carbon economies. This important agreement led to a significant increase in worldwide recognition and investment in ESG practices; thereby changing stakeholders' mindsets so that they consider ESG factors more and more when they make decisions. (Dyck et al. 2019; Bolton and Kacperczyk 2023a; Bolton and Kacperczyk 2023b; Bolton and Kacperczyk 2024). Post-agreement, there has been a remarkable increase in investor awareness as well as firms' ESG actions particularly in Asia indicating a transition towards a more responsible investing approach.

China is one country that is continuously employing ESG-oriented subsidies as part of its commitment to the Paris Accord with its intention to become carbon-neutral by 2060. This development crucially influences investor preferences and sentiments, emphasising the importance of ESG impacts in evaluating stock market performance.

ESG and Stock Market Return

An increasing body of research and consensus consistently demonstrates that investing in ESG proves profitable (Financial Times 2017). For instance, Kempf and Osthoff (2007) implement a long short trading strategy based on socially responsible (SR) ratings in the U.S. stock market and discover that portfolios long on stocks with high SR ratings and short on those with low ratings substantially outperform, delivering abnormal returns of up to 8.7% annually.

Additionally, Lins et al. (2017) investigate the impact of investor trust on stock returns during the 2008 financial crisis using data from US stocks. They find that firms with higher ESG scores significantly outperform during the crisis, linking this performance to the enhanced trust these firms inspire in investors and stakeholders, which proves critical during periods of market instability. This evidence suggests that high ESG ratings not only boost investor confidence but also protect

against negative market shocks, offering substantial protective benefits for firms during economic downturns.

Furthermore, Pástor et al. (2021) develop an equilibrium model to analyse how investors' consideration of ESG standards influences asset prices and corporate behaviours. They observe that while green assets generally yield lower expected returns due to widespread investor preference, their performance relative to brown assets improves as consumer and investor awareness of ESG issues grows. This indicates that under certain conditions, firms with strong ESG performance can excel in the stock market, particularly when market awareness of these risks increases.

Likewise, Avramov et al. (2022) initially reported a negative impact of ESG rating uncertainty. However, as this uncertainty diminishes, the positive effects of ESG performance on firm returns become evident. Kim et al. (2014) also examine the relationship between ESG and stock price crash risk in the U.S. stock market from 1995 to 2009, finding that robust ESG practices significantly reduce the likelihood of price crashes due to increased transparency and reduced information asymmetry. Institutions that prefer investing in ESG typically opt for low volatility stocks among high ESG stocks (Pástor et al. 2023), which further enhances their stock market performance. This preference aligns with the protective effects of ESG investments, suggesting that ESG compliance contributes to stabilising stock prices and reducing market volatility.

In summary, ESG performance significantly enhances firm resilience, boosts stock returns, and reduces the likelihood of stock price crashes, particularly under economic stress or when market sensitivity to sustainability issues intensifies. As the understanding and valuation of ESG factors improve, the positive impact of high ESG scores on firm valuations and market stability becomes increasingly evident.

ESG and Investor Preference and Sentiments

i. Investor Preferences

Higher ESG scores not only mitigate climate change and transition risks but also attract sig-

nificant investments from risk-averse investors who value stability and sustainable practices. Since ESG investing offers both profitable actual returns and non-pecuniary benefits (Pedersen et al. 2021), there is an increasing trend in investor preference for ESG. Cornell (2021) noted that the shift toward sustainability is an outstanding feature in recent investment strategies. It goes along with the trends observed under green finance as highlighted by (Giglio et al. 2021; Pástor et al. 2023; Cao et al. 2023).

According to Pástor et al. (2021), assets with high ESG scores tend to perform better after positive policy changes due to the preference of investors for green holdings. Lins et al. (2017) also discovered during the period of the financial crisis in 2008 that firms attracting robust stocks were those that had impressive ESG performance even when there was a bet against greener firms. Additionally, Choi et al. (2020) find that during periods of unusual warmth, stocks of carbon-intensive firms, which represent low ESG performance, underperform compared to those with lower carbon footprints in the U.S. stock markets. This underperformance largely stems from retail investors' preference to sell off these stocks due to environmental concerns associated with extreme climate events.

ii. Investor Sentiments

According to Connolly and Stivers (2003), significant policy announcements are accompanied by extremely abnormal turnover that underlines the significance of investor trading behaviour at that time.

Since Pástor et al. (2023) found that institutions prefer holding high ESG assets, this preference results in a lower turnover rate for stocks of high ESG firms. Starks et al. (2017) use low stock turnover rates to identify long-term investors, showing that long-term institutional investors favour firms with robust ESG performance and adjust their portfolios in response to new ESG information. Further, Cao et al. (2023) analyse how Socially Responsible Investing (SRI) institutions respond to quantitative mispricing signals. They find that institutions

adhering to Socially Responsible Investing principles react less to these mispricing signals compared to non-SRI institutions, further suggesting that high ESG firms are more likely to attract long-term holdings by institutions that prefer high ESG, rather than short-term arbitrage.

Conversely, low ESG firms are less attractive to investors, and experience increased turnover due to policy uncertainties and the potential stock price declines (Pastor and Veronesi 2012). As a result, during these times there is often an increase in turnover.

We anticipate low abnormal turnover for high ESG firms as we approach ESG-related subsidy announcements due to stable investor interests and lower-risk assets favoured by long-lived owners of equities. On the contrary, Pan et al. (2016)'s study provides evidence that low ESG firms record higher rates of turnover because investors are anxious about them or they trade speculatively. Trading can lead prices up, resulting in market correction as reflected by the negative correlation between speculative trading and future stock returns in China's A-share market found by them. In addition, Allen et al. (2024) also found out that events promoting speculative activities cause an increase in turnovers leading to decreased stock returns.

In summary, high ESG-scoring firms exhibit lower announcement-related turnovers, signifying strong investor faith and stability associated with higher CARs while low CARs usually witnessed more turnover due to uncertainty-driven speculation among weakly rated ones.

III.3. Hypothesis Development

This chapter is based on evidence from the Efficient Market Hypothesis (Fama 1970), which argues that stock prices rapidly reflect all available information, and on Carpenter et al. (2021) who established that the efficiency of China's capital market is on par with that of the US, and Bond and Goldstein (2015) demonstrate that policy changes can trigger immediate reactions in stock market prices. We investigate the extent to which the Chinese market reacts to ESG-related subsidy policy

announcements, our interest arises due to greater emphasis on sustainability and differential effects of ESG subsidies depending on the firm's level of commitment to ESG principles.

We anticipate that ESG-related subsidy announcements enhance investor confidence and lead to higher valuations, resulting in positive CARs. Regarding the aspect of general government subsidies, market reactions are generally favourable when firms receive these supports Lee et al. (2014), partially due to a halo effect from perceived government backing Meuleman and De Maeseneire (2012). Such subsidies can increase cash flows, reduce financial constraints, and lower debt levels, thereby boosting stock market performance Myers (1984), Fama and French (2002), and Lim et al. (2018). Focusing on the ESG aspect, improved ESG metrics correlate with lower capital costs, better financial outcomes, and higher market prices (Gillan et al. 2021). Our Chapter II indicates that higher ESG-related subsidies specifically enhance a firm's ESG performance. Additionally, subsidies for NEVs positively impact the stock prices of NEV companies Liu et al. (2022). Firms with robust ESG frameworks often outperform in the stock market, even in bearish conditions (Lins et al. 2017). ESG-related subsidy policies also reduce uncertainty regarding ESG ratings and policy implementation, leading to superior stock market performance for firms with high ESG ratings (Pastor and Veronesi 2012; Avramov et al. 2022).

Moreover, we hypothesise that firms with low ESG scores will not yield significant CARs from policies related to ESG-related subsidies. This stems from the more profound environmental, social, and governance-related risks that surface following such announcements. These firms often lack substantial investment in ESG practices, leading investors to continue doubting their sustainability and risk management capabilities. With the increasing emphasis on ESG investments and growing investor demand for sustainable practices, firms performing poorly on ESG may encounter difficulties when accessing finance. Moreover, there are concerns that low ESG firms, once obtaining ESG-related subsidies, will face high costs to improve their ESG attributes sufficient to comply with such subsidies' conditions. Furthermore, because share prices do tend to go down when subsidies are announced, there is no interest from investors in these low ESG firms, and

there is hardly any change in share prices or in the functioning of the market as a whole following the announcement of the policy (Bond and Goldstein 2015; Giglio et al. 2021).

Additionally, we expect that various components of a firm's ESG attributes such as total ESG score and size of ESG-related subsidies have notable impacts on its CARs. This takes place because: 1) there is a perception by the market about high-ESG performing firms being more adept at the utilisation of these subsidies as well as the incorporation of principles concerning environmental-social governance into their activities; 2) Furthermore, it also depends on the amount of subsidy received by a firm. If it is large, investors pay more attention and have higher expectations. These stock reactions become more sensitive compared with small ones.

Therefore, our first hypothesis (H1) is:

> *H1a: ESG-related subsidy policy announcements result in positive CARs for high ESG firms and no significant reactions for low ESG firms.*
>
> *H1b: ESG performance and ESG-related subsidy amount are positively related to such CARs.*

Next, since the 2015 Paris Agreement is a major milestone in the global effort to promote ESG practices (Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2023a; Bolton and Kacperczyk 2023b). Based on this, we expect that the positive relationship between ESG-related subsidy amounts and CARs largely occur after the agreement. In China, political connections make it easier for SOEs to list on the stock market than private firms even with weak profitability. This makes SOEs less efficient due to bureaucratic inefficiencies (Fan et al. 2020; Allen et al. 2024). Conversely, non-SOEs benefit greatly from these subsidies as they receive necessary financial support without extensive government backing, thus facing fewer government restrictions and having more flexibility in using these funds. This freedom allows them to innovate faster than their counterparts and reduce costs associated with wastage of resources. Consequently, this contributes to improving investors' trust in their operations as well as the competitiveness of various markets in which they

operate rendering them operationally competent. Thus H2 is:

> *H2a: The positive relationship between ESG-related subsidies and CARs is driven only in the post-Paris Agreement period.*
>
> *H2b: The positive relationship between ESG-related subsidy and CARs is positive for non-SOEs and negative for SOEs.*

Moreover, it is necessary to note that examining how ESG-related subsidy announcements affect CARs requires consideration of the significance of investor sentiment about a firm's ESG performance. Connolly and Stivers (2003) reveal that significant policy announcements often result in extremely abnormal turnover, pointing to shifts in investor sentiment. Our study contributes to this literature by investigating how trading turnover as a reflection of investors' perceptions about ESG-related subsidy programs affects stock CARs.

Cornell (2021), Giglio et al. (2021), Pástor et al. (2021), and Pástor et al. (2023) discuss institutional investors' increasing preference for ESG-compliant assets, these studies find that high ESG firms—seen as less volatile and more sustainable—experience decreased trading activity during subsidy announcements. This is an indicator of stable investor interest and positive sentiment towards firms with robust ESG credentials. This stability is attributed to the fact that investors in ESG are often long-term institutional investors, who focus on long-term investments rather than exploiting short-term pricing errors for arbitrage (Starks et al. 2017; Cao et al. 2023).

In contrast, firms with lower ESG scores encounter higher turnover due to negative sentiment fuelled by uncertainties and speculative trading after these announcements. This negative view stems from doubts about these firms' commitment to ESG standards and their risk management, suggesting such firms do not see CAR benefits from policy announcements. Pastor and Veronesi (2012) and Bond and Goldstein (2015) further illustrate that policy changes can introduce market volatility and depress stock prices, causing investors to react more strongly.

With this in mind, we can draw on Pan et al. (2016), pointing out the fact that the announcement

of a subsidy related to an ESG criterion would normally lead to speculative activities followed by increased turnover rate with a reduction in stock returns in Chinese market thus making our 3rd hypothesis valid:

> *H3: For high ESG firms, positive investor sentiment during ESG-related subsidy- announcement leads to lower CATs. Conversely, for low ESG firms, negative sentiment leads to higher CATs.*

III.4. Methodology and Model Design

III.4.1. Event Study Analysis of Cumulative Abnormal Returns (CARs)

In our event study, we follow MacKinlay (1997) and condense the process into four major steps. First, we choose the event of interest, describe the event window, and define it by selecting the sample for analysis. After that, we would then predict the expected return over the event window under the assumption that there was no event. Then we find abnormal returns which are differences between actual returns in the event window minus predicted expected returns. Finally, we conduct a statistical test to determine if these abnormal returns significantly differ from zero.

We define the event in our study as the announcement date of China's national policies on ESG-related subsidies. We treat the policy announcement day as the event day. However, if the announcement does not align with a trading day, following Lyon et al. (2013) and Liu et al. (2022), we consider the first trading day after the announcement as the event day. Regarding the event and estimation windows, we adhere to the principle of not overlapping the estimation window with the event window, as advocated by Campbell et al. (1998).

Predicting the Expected Return

For predicting the expected returns (ER) of all firms in our study, following Ang and Zhang (2004), we utilise the Fama-French three-factors model (Fama and French 1993). We define the expected return of firm i on trading day i as *Eq.* (III.1):

$$ER_{i,t} = r_{f,t} + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{i,t}, \quad t = -6, -7, \ldots, -85, \tag{III.1}$$

where $r_{f,t}$ is the daily equivalent of the annual three-month deposit rate at China's bank in year t[9], MKT_t represents the excess return of the value-weighted (VW) market portfolio over the risk-free rate on trading day t; SMB_t, standing for "Small Minus Big," measures the expected additional return from investing in firms with smaller market capitalisation's compared to those with larger market capitalisation's on trading day t; HML_t, representing "High Minus Low," quantifies the return spread between stocks with high and low book-to-market ratios on trading day t. The error term captures the idiosyncratic risk not explained by the market, size, or value factors. Alternatively, we utilise the CAPM (Sharpe (1964)), Carhart's Four Factors (Carhart (1997)), China's Three Factors (Liu et al. (2019)), and Fama-French Five Factors (Fama and French (2015)) to predict the ERs for our robustness check.

Furthermore, following the methodology of Liu et al. (2022), we set our estimation window to 85 days before the event, ranging from day -85 to day -6, marked as $[-85, -6]$. This approach references their research on China's New Energy Vehicle (NEV) subsidy and its impact on stock market reactions, which closely aligns with our study.

Based on the definitions provided above, we define the abnormal return (AR) for firm i on day t as *Eq.* (III.2):

$$AR_{i,t} = R_{i,t} - ER_{i,t}, \tag{III.2}$$

where $R_{i,t}$ represents the actual return for firm i on trading day t.

Calculating the Cumulative Abnormal Return (CARs)

Next, to assess the cumulative impact of government ESG-related subsidy policy announcements on stock market return, we employ *Eq.* (III.3) to calculate the CAR for firm i on trading day t

[9]Since major banks in China are effectively controlled by the government, the bank rates in China are essentially considered as risk-free rates.

during the event window we set:

$$CAR(\tau_1, \tau_2) = \sum_{\tau_1}^{\tau_2} AR_{i,t}, \tag{III.3}$$

where $CAR(\tau_1, \tau_2)$ is calculated to measure the cumulative impact of the event on firm i 's stock abnormal return within the event window. Here, τ_1 and τ_2 represent the bounds of the event window, where τ_1 and τ_2 is the end of the window.

For measuring the CAR, we established three event windows commonly adopted in the event study literature. The primary window is CAR $[-2: +2]$, covering a five-day span from two days before to two days after the event. This window captures potential information leakage prior to the announcement and immediate market reaction thereafter. This specification is widely used in policy event studies, especially in emerging markets where news diffusion may not be immediate due to lower market efficiency. We further extend the window to $[-2: +3]$ to explore whether the market response persists slightly longer beyond the event day. Additionally, a shorter window $[0: +1]$ is used to isolate the immediate reaction. These multiple windows help us evaluate both short-term and slightly lagged investor responses, following standard practice in the event study literature (e.g., Liu et al. (2022) and Lyon et al. (2013)).

Finally, we evaluate if the CARs resulting from ESG-related subsidy policies are statistically significant from zero. We winsorize all CARs at the 1% and 99% levels in our analysis to effectively address outliers.

III.4.2. Regression on CARs

Since ESG performance can influence stock market reactions, and Chapter II finds that receiving ESG-related subsidies enhances a firm's ESG performance, we further investigate whether ESG performance affects cumulative abnormal returns (CARs). Following the approach of Chaudhry

et al. (2022) and Fiordelisi and Ricci (2016), we examine this relationship using an event window of $[-2,+2]$ as the baseline.

To test this relationship, and consistent with Fiordelisi and Ricci (2016), we estimate the following regression model:

$$CAR_{i,t} = \alpha + \beta X_{i,T-1} + \gamma^{\top} \mathbf{X}'_{i,T-1} + \varepsilon_{i,t}, \tag{III.4}$$

where $CAR_{i,t}$ represents the cumulative abnormal return of firm i during the event window around the announcement date. To mitigate potential reverse causality, all independent variables are lagged by one year. $X_{i,T-1}$ denotes a vector that includes ESG performance and the ESG-related subsidy amount received by firm i in the year $T-1$, corresponding to the subsidy policy announcement year. $\gamma^{\top} \mathbf{X}'_{i,T-1}$ represents a vector of control variables following Bolton and Kacperczyk (2023b), which include firm size (SIZE), leverage (LEV), Tobin's Q ratio (TobinQ), operating cash flow (CFO), revenue growth (Growth), capital expenditure (CAPEX), and return on assets (ROA). We control for both industry and year fixed effects. To address the influence of outliers, all non-binary variables are winsorized at the 1% and 99% levels.

Heterogeneity Analysis of the Regression on CARs

i. Paris Agreement and SOEs

To examine whether the effect of ESG-related subsidies on CARs varies with the Paris Agreement of 2015 and with state ownership, we estimate the following models:

$$CAR_{i,t} = \alpha + \beta (ESGSUB_{i,T-1} \times Paris_t) + \gamma^{\top} \mathbf{X}'_{i,T-1} + \varepsilon_{i,t}, \tag{III.5}$$

$$CAR_{i,t} = \alpha + \beta (ESGSUB_{i,T-1} \times SOE_i) + \gamma^{\top} \mathbf{X}'_{i,T-1} + \varepsilon_{i,t}, \tag{III.6}$$

where $ESGSUB_{i,T-1}$ represents the amount of ESG-related subsidy received by firm i in year $T-1$. $Paris_t$ is a dummy variable equal to 1 for the years 2015 and after, and 0 otherwise. SOE_i is a dummy variable equal to 1 if the firm is state-owned and 0 otherwise. These interaction terms capture whether the market reacts differently to ESG subsidies after the Paris Agreement or for politically connected (SOE) firms.

ii. Sectoral Heterogeneity

We further explore whether the effect of ESG performance and ESG-related subsidies on CARs varies across different sectors, including Industry, Public Utility, Real Estate, Finance, and Comprehensive sectors. The Comprehensive sector[10] is used as the baseline group. The following model is estimated:

$$CAR_{i,t} = \alpha + \beta_{\text{base}} X_i + \sum_{j=1}^{J} \beta_j (X_i \times I_{j,i}) + \gamma^\top \mathbf{X}'_{i,T-1} + \varepsilon_{i,t}, \tag{III.7}$$

where X_i includes ESG performance or ESG-related subsidies. β_{base} captures the baseline effect for the Comprehensive sector, and β_j captures the additional impact of sector j (Industry, Public Utility, Real Estate, Finance) relative to the baseline. $I_{j,i}$ is a sector indicator variable equal to 1 if firm i belongs to sector j and 0 otherwise. These interaction terms allow us to assess how the market's response to ESG factors and subsidies varies across industries.

III.4.3. Measuring Investor Sentiments

We measure investor sentiment changes after the release of ESG-related government grants and examine varying impacts on CARs between firms with high versus low ESG ratings by using cumulative abnormal turnover as an indicator. We follow Connolly and Stivers (2003) who used

[10]The comprehensive sector includes firms that do not clearly fall into traditional categories such as industry, utilities, real estate, or finance. These firms often operate across multiple industries or adopt diversified business models.

this approach in determining if these announcements affect investors' trading behaviour and market sentiment surrounding the announcement date. This technique shows how investor reactions to such announcements impart differences in CARs through different channels.

Calculating the Abnormal Turnovers Rates

In our study, we predict abnormal turnover (AT) shocks across all firms by adopting the approach of Connolly and Stivers (2003), who use residuals from a regression model to represent market-adjusted relative turnovers(MRTO).These residuals are a measure of the abnormal turnover rate that indicates unexpected changes in turnover, net of expected impacts arising from stock returns' size and direction. This method helps us differentiate between particular firm-specific trading responses to ESG-related subsidy policy announcements and general market movements. We use *Eq.* (III.8) to test this, as shown below:

$$AT_{i,t} = \gamma_0 + \sum_{k=1}^{6} \gamma_k AT_{i,t-k} + \gamma_7 R_{i,t} + \gamma_8 D^- R_{i,t} + \gamma_9 |R_{i,t-1}| + \gamma_{10} D^- |R_{i,t-1}| + \mu_{i,t}, \tag{III.8}$$

where $AT_{i,t}$ is the natural logarithm of the turnovers for firm i on trading day t, using the natural logarithm helps to normalise the data, reducing the impact of extreme values or outliers in turnovers, which is common in trading data. $R_{i,t}$ is the excess return of firm i on trading day t, D^- equals 1 if $R_{i,t}$ is negative and 0 otherwise, and the γ_s are the estimated coefficients. The excess return equals the nominal return minus the annual three-months deposit rate of China's bank in year t. The residual $\mu_{i,t}$ represents the abnormal turnover rates.

Calculating the Cumulative Abnormal Turnovers (CATs)

Next, to assess the cumulative impact of government ESG-related subsidy policy announcements on stock abnormal turnovers, we calculate the CAT for each firm i over the designated event win-

dow. This is done by summing the calculated residuals (abnormal turnover rates) across the event window as *Eq.* (III.9) follows:

$$CAT(\tau_1, \tau_2) = \sum_{\tau_1}^{\tau_2} \mu_{i,t}, \tag{III.9}$$

where $CAT(\tau_1, \tau_2)$ is calculated to measure the cumulative impact of the event on firm i's stock abnormal turnovers within the event window. Here, τ_1 and τ_2 represent the bounds of the event window, where τ_1 is the start and τ_2 is the end of the window.

For our analysis, we outline the data used in this study based on our methodological framework and event study parameters, and we begin with the ESG-related subsidy policy data.

III.5. Data Description and Processing

III.5.1. Description on ESG-Related Subsidy Policy Data

In line with Liu et al. (2022), our study covers the period from 2010 to 2022. All relevant government policy announcement data are collected from the CSMAR Database. We categorised these policies into three subcategories: Environmental (E), Social (S), and Governance (G) which further fall under ESG-related subsidies by using ESG benchmarks as keywords. In our dataset, around 12% of all government policies are ESG-related, among which approximately 33% relate to environmental issues and 67% to social issues.

Subfigure *a* of Figure III.1 demonstrates shifts in ESG-related subsidy policies of all government subsidies between 2010 and 2023. Particularly worth noting is a surge in ESG-related policies post-2015 when the Paris Agreement was made. This massive upsurge has been referred to as a change towards better global ESG performance by Bolton and Kacperczyk (2023a) and Bolton and Kacperczyk (2024). China's dedication to the climate goals set out in The Paris Agreement is consistent with these findings plus a growing emphasis on ESG pillars.

Additionally, subfigure *b* demonstrates trends of ESG, E, S, G related subsidy policies be-

tween 2010 and 2023 Following the Paris Agreement in 2015 there is a discernible sharpening focus on environmental and social pillars that culminated into a conspicuous peak in ESG related policies. The graph shows an enormous jump in a number of E+S related subsidy policies following the agreement hence indicating increased commitments. Notably, however, E-subsidies have witnessed remarkable growth highlighting escalated priorities given to the environment through enhanced attention on global climate agreements while Governance -related subsidies hardly ever grow because good corporate governance is a firm's duty while governments mainly go for other fields.

III.5.2. Identification and Validation of ESG-Related Subsidy Policy Announcements

ESG-related subsidy policy announcements are identified from the CSMAR policy database, which records the official public release dates of central and local government policy documents. We define the announcement date as the first disclosure date reported in CSMAR. When policy announcements occur on non-trading days, the event date is aligned to the next trading day to ensure consistency with stock market data.

To identify ESG-related subsidy policies, we apply a keyword-matching procedure using the ESG benchmarks provided by the SSI classification system, following the approach described in Chapter II. Policies containing ESG-related keywords associated with environmental protection, social responsibility, or governance improvement are classified as ESG-related subsidies.

To assess whether the estimated abnormal returns are affected by confounding firm-specific events, we conduct robustness checks in which firm-day observations are excluded when ESG-related subsidy announcements overlap with major corporate disclosures, such as mergers and acquisitions. In addition, sensitivity checks using alternative event windows are conducted to ensure that the results are not driven by the choice of announcement date or window length. These validation procedures help confirm that the estimated abnormal returns primarily reflect market reactions to ESG-related subsidy policy announcements rather than unrelated information shocks.

III.5.3. Data Sample Processing Methods

To evaluate the impact of ESG subsidy policies on CARs to daily returns and ensure our event study is correct, we use a secondary screening process for target ESG-focused firms. This is aimed at eliminating firms whose shares were suspended during our period of analysis designated by '*ST' for special treatment as they suffered from financial distress. The purpose of this step is to reduce the extent to which unrelated financial events affect our analysis.

This study examines how differently subsidy announcements affect firms with high and low ESG scores. We separate these filtered firms into two groups according to their ESG scores in the previous year ($t-1$ year). Firms with scores above the median are classified as "High ESG firms," while those below the median are considered "Low ESG firms." Figure III.2 presents annual trends and numbers of high and low ESG firms indicating similar growth patterns annually.

III.5.4. Stock Return, Turnover rate, ESG Scores, ESG-related Subsidy amount and Firm's Characterises Data

CARs, CATs, and Firm's Characteristics

We collect firm-level daily stock market returns, characteristics, the Fama-French three-factor (FF-3), five-factor (FF-5) models, and the Carhart four-factor model specific to the China market from the CSMAR database. Additionally, we include China's three-factor model (CH-3), sourced from the Mingshi Database[11]. We also gather firms' daily trading turnover rates and other relevant characteristics from the CSMAR database to calculate the CARs and CATs. We provide the definitions and descriptions of the variables used in Table III.1.

ESG Scores and ESG-related Subsidy Amounts

Additionally, we obtain ESG score data from the SSI Company and source our ESG-related subsidy policies using the approach described by chapter II, employing ESG keywords provided by the SSI

[11] See Mingshi database.

benchmark[12] to separate ESG-related subsidy from total government subsidies.

Data Summary Descriptions

The data in Table III.2 is divided into two groups based on ESG performance for presenting descriptive statistics. In Panel A, we observe that firms with high ESG scores, indicative of strong environmental, social, and governance practices, post a modest CAR of 0.068 after policy announcements, suggesting some positive market responses. These firms also report an average ESG-related subsidy (ESGSUB) of 2.629 million USD and an average ESG score of 77.075. This higher subsidy amount reflects not only the recognition of their superior ESG practices but also the tendency of policymakers to allocate more funds to firms that are better aligned with sustainability goals. Conversely, firms with lower ESG scores exhibit an average CAR of 0.037 and receive a smaller average ESGSUB of 1.599 million USD, with a mean ESG score of 68.277. This lower subsidy amount and weaker performance outcome suggest a dual disadvantage: not only do these firms have less robust ESG practices, but they also attract less financial support for ESG initiatives, potentially due to a perceived lower capability or commitment to effectively utilise such subsidies to enhance their ESG standings.

The operational growth rate (Growth), cash flow from operations (CFO), return on assets (ROA), capital expenditures (CAPEX), Tobin's Q (TobinQ),leverage (LEV), and Market Capitalisation (Size) are examined as control variables in Panel B. High ESG firms have a higher average ROA than low ones with means of 0.031 and 0.020 respectively. This group also reports larger CFOs averaging about $122,666$ compared to low counterpart's USD $57,043$ million which indicates better financial performance so far based on these numbers.

[12] See Appendix A.

III.6. Empirical Results and Discussions

III.6.1. Market Reaction to ESG-related Subsidy Policy Announcements

Baseline Results

We embrace standard event study methodology to capture CARs within certain event windows surrounding the ESG-related subsidy policy announcements and gain insight into the response of the Chinese capital market. These windows are described as CAR $[-2:+2]$ which run from two days before to two days after, a five-day period that is usually chosen to investigate potential information leakage as well as immediate market reaction. The window CAR $[-2:+3]$ extends one day further, covering six days, while the window CAR $[0:+1]$ concentrates on the announcement day and its next one as a shorter two-day period capturing the immediate effects of the announcement.

The returns reported by various windows for firms with high ESG scores (Column 1, Table III.3) indicate positive and statistically significant returns. As seen in subfigure a of figure III.3, the pre-announcement period return is not statistically significant which leads to the conclusion that these shares are not affected by any pre-announcement effect referred to as information leakage. Thus, for $[-2:+2]$ window, we have returns of $+0.028\%$ (T-value = 4.334), To contextualize the economic magnitude, the average 5-day return of the Shanghai Composite Index over our sample period is approximately 0.0074%, suggesting that the observed CARs in this window represent returns four to five times higher than typical market movements over a comparable horizon. Next, it reaching peak value at $+0.038\%$ (T-value = 5.332) for this stock at $t = +3$ in CAR $[-2:+3]$ window, while shorter CAR $[0:+1]$ window confirms the existence of significant positive returns equalling to $+0.016\%$ (T-value = 3.907). This indicates that reactions on the date of the announcement are both positive and relevant even afterwards following it up with other days because there is also significance beyond the announcement date.

On the other hand, for firms with low ESG scores (Column 2), the returns do not show statistical significance across any of the observed periods. This implies that only high-scoring ESG firms

benefit from ESG-related subsidy announcements. A lack of significant change implies that there is no positive market reaction to the announcement in the case of low ESG performance firms.

Regression results on the relationship between ESG scores, amounts of ESG-related subsidies, and CAR are presented in Column 3. Our findings reveal that CARs are positively related to firms' ESG scores and amounts of their respective ESG-related subsidies during all event windows except for the $[0 : +1]$ window as regards ESG score. This means that better-performing firms in terms of corporate social responsibility cause higher CARs due to higher ESG ratings.

To sum up, our study reveals different response patterns for high and low-performing firms during such policy announcements. There is no pre-announcement effect among high-ESG firms which can be attributed to efficient markets without revealing information ahead of time. After the news announcement, these firms enjoyed a positive and significant market response suggesting strong governance coupled with an ability to gain from improved environmental policies.

In contrast, it seems as if low-environmental-performance firms do not respond at all considering they cannot also be beneficiaries if new programs come out. It may take considerable effort to improve upon their environmental records; however, this would not lead immediately to expectation changes by investors.

Firms with high ESG ratings and strong ESG frameworks in place are best suited to take advantage of ESG-related subsidies. These firms can advance timely when it comes to changes in policies, and leverage government incentives to become more competitive and align themselves with emerging norms. The higher the amount of ESG-related subsidy that a firm gets, the more it can improve its overall ESG performance leading to a positive cycle that boosts its competitive position in the market (See Chapter II). Besides, they obtain more subsidies due to their ability to adopt new policies quickly.

This dynamic is why firms that commit themselves to being eco-friendly and still manage to get some money from the government as compensation for such commitment have higher CARs. In terms of finance, these grants make it easier for businesses to operate and provide financial support

for cleaner practices which improves valuation. Thus, the cooperation between superior ESG plus efficient utilisation of subsidies raises confidence among investors thus increasing stock values and translating into a significant increase in CARs.

In summary from these results, we observe that CARs respond favourably upon the announcement of ESG-related subsidies; however, this is only applicable for highly ranked ESG firms which showed substantial positive responses. On the other hand, there are no notable reactions by low-ESG-rated entities. Additionally, good ESG scores and a greater percentage of total gains are coupled with large CARs.

III.6.2. Heterogeneity Analysis

Next, we examine the influence of the Paris Agreement 2015 (Paris), ownership by SOEs, and various sectors on the effectiveness of ESG scores and ESG-related subsidies (ESGSUB) on CARs. We present these results in Table III.4, with the results for the Paris Agreement and SOEs detailed in Panel A, and the sector-specific impacts presented in Panel B.

Conditions on Paris Agreement and SOEs

Panel A presents the results for the influence of the Paris Agreement and SOEs on ESG-related subsidy amount a firm received. We show that for ESG-related subsidies, the results differ notably across different contexts. Specifically, ESG-related subsidies are positively associated with CARs in the period following the Paris Agreement, whereas the association is negative before this period. Furthermore, ESG-related subsidies have a positive impact on CARs in non-SOEs, but it indicates a negative impact on SOEs.

Specifically, in column 1, the coefficient for ESGSUB is -0.062, significant at the 1% level before the Paris agreement periods, and 0.085, significant at the 1% level following the agreement. In column 2, the coefficient for ESGSUB is 0.027, significant at the 1% level for non-SOEs, and -0.017, significant at the 5% level for SOEs.

This indicates that the Paris Agreement marks a critical shift in global climate policy, with

investors increasingly favouring firms that benefit from ESG-related subsidies, thereby boosting their CARs. This extends the findings of Bolton and Kacperczyk (2023a), Bolton and Kacperczyk (2023b), and Bolton and Kacperczyk (2024) and suggests closer alignment between global climate commitments and market valuation.

In China, however, the stock market reacts differently to ESG-related subsidies granted to SOEs, which are associated with negative CARs. This asymmetric response reflects several complementary mechanisms. First, investors tend to apply an inefficiency discount to SOEs because bureaucratic constraints, weaker managerial incentives, and politically influenced capital allocation are widely observed in China (Fan et al. 2020; Allen et al. 2024). Under this view, investors interpret subsidies not as value-enhancing transfers but as signals of persistent agency problems and lower operational efficiency, which reduces expectations of future cash flows.

Second, ESG-related subsidies to SOEs often convey limited new information to the market. Investors generally expect SOEs to receive preferential government support, so subsidy announcements produce little positive surprise, consistent with semi-strong form market efficiency (Fama 1970). At the same time, these announcements reinforce perceptions of state dependence.

Third, subsidy announcements tend to raise perceived policy uncertainty. Stronger government involvement increases concerns about regulatory unpredictability and political intervention. Investors therefore raise required rates of return, and through this discount-rate channel, even neutral cash-flow news can trigger negative stock price reactions (Pastor and Veronesi 2012). In contrast, non-SOEs face fewer political and administrative constraints, allowing them to deploy ESG-related subsidies more flexibly and efficiently, which generates more favourable market responses.

Conditions on Various Sectors

Panel B presents the results for various sectors including Industry, Business, Public Utility, Real Estate, Finance, and the Comprehensive sector, with the Comprehensive sector set as the baseline group.

Notably, Column 1 shows that the ESG coefficient on CAR is negative and significant for the comprehensive sector, with a value of -0.101 at the 5% level. Compared to this baseline, the ESG effect on CAR increases significantly in the industry sector by $+0.127$ and in the public utility sector by $+0.163$, both significant at the 1% level. The effect also rises in the business ($+0.034$), real estate ($+0.059$), and finance ($+0.006$) sectors, though these changes are statistically insignificant. In Column 2, the ESGSUB coefficient for the comprehensive sector is -0.047, significant at the 10% level. Relative to this, the ESGSUB effect on CAR significantly increases in the industry and business sectors (both by $+0.075$, significant at the 1% and 5% levels, respectively), in the public utility sector by $+0.056$ (10% level), and in the finance sector by $+0.047$ (10% level). The increase in the real estate sector ($+0.038$) remains statistically insignificant.

This means that sectors like industry and public utilities which are highly influenced by ESG performance will receive maximum benefits from ESG-related subsidies. This indicates that sectors highly exposed or susceptible to any changes experienced under the current standards governing ESG may have more positive effects on their CARs when they improve those standards and offer subsidies instead.

III.6.3. Robustness Check

We conducted Robustness checks for CARs in two parts, first, we used different alternative models to predict expected returns and forecast CARs while assigning the high and low ESG-related subsidy groups on an annual basis. This classification helps us explore how firms with various ESG scores are affected by subsidy levels. It also confirms our hypothesis that firms with higher levels of ESG–related subsidies have more positive CARs. We present our results in Table III.5.

Use of Various Models to Predict Expected Returns

To begin with, we make use of different models to ensure the robustness of our results such as Sharpe (1964), Carhart (1997), Fama and French (2015), and Liu et al. (2019), which are used in predicting ERs while calculating CARs. We give these outcomes in Panel A.

The coefficients for ESG in columns 1 to 4 indicate a positive connection with CARs specifically. For instance, ESG has a coefficient of 0.015 and is significant at the 10% level under the CAPM model in column 1. Similarly, in column two where we have the Four-Factors model by Carhart (1997), the calculated coefficient for ESG is 0.017 and significant at 5%. The positive influence of ESG carries on into column three under China's Three-Factors model with a coefficient of 0.015 which is significant at 5%, and column four has the Fama-French Five-Factors model also giving a coefficient of 0.015 which is significant at 10%. Regarding the ESG-related subsidy depicted in columns five through eight, this relationship still exists: they are all significant at respective models' levels, i.e., they are all equal to 1%.

Analysing ESG Subsidy Effects on CARs Based on ESG Scores

We first classify firms into high and low ESG-related subsidy groups based on the median subsidy received in the previous year ($t-1$) within each annual sample. Within the $[-2:+2]$ event window, Panel B presents the CARs for high and low ESG score firms segmented by high and low ESG-related subsidies. The findings reveal that all firms irrespective of their ESG scores respond positively when they receive high ESG-related subsidies. In particular, firms with higher subsidies that have higher ESG scores had a CAR of 0.081% (T-value = 7.195), whereas those with lower subsidies that have lower ESG scores had a higher CAR of 0.098% (T-value = 10.949).

On the contrary, responses to low ESG-related subsidies are less clear-cut. High-ESG-score firms react with a CAR of 0.04% (T-value = 3.100), while firms having poor ESG scores give rise to an insignificant CAR of 0.014% (T-value = 1.071). This trend illustrates how significant market reactions are determined by levels of environmentally related government aid. This is crucially important for corporations having lesser environmental social governance ratings if this is sufficient.

Excluding Mergers and Acquisitions (M&A) Event-Date Overlaps

To further ensure that our baseline results are not confounded by concurrent Mergers and Acquisitions (M&A) information releases, we exclude any firm–day observation where an ESG-related subsidy policy announcement coincides with the firm's own M&A disclosure. The results are reported in Panel C. The findings remain consistent with our baseline analysis, further confirming that only firms with high ESG scores benefit significantly from ESG-related subsidy policy announcements.

Overall, our findings consistently indicate that the positive relationship between ESG scores, ESG-related subsidy, and CARs remains strong across various alternative models and subsidy levels. Further, we show that high ESG-related subsidies are crucial for yielding significantly positive CARs, especially in firms with lower ESG scores. These substantial subsidies provide the necessary resources for these firms to enhance their ESG practices, aligning them more closely with broader sustainability goals and improving their market returns. These results suggest that our results are robust.

III.6.4. Additional Tests

Institutional Ownership and CARs

To further illustrate how the structure of the investor base may shape the market reaction to ESG related subsidy announcements, we divide the full sample into two groups based on ownership concentration (IO). Firms with IO above the annual median are classified as high IO firms, and those below the median as low IO firms. We then compute CARs in the $[-2, +2]$ window separately for the two groups. Figure III.4 presents the cumulative average CARs for high IO and low IO firms around the announcement date.

A clear difference emerges between the two groups. High IO firms display significantly positive CARs, while low IO firms exhibit significantly negative CARs. This pattern is closely aligned with our main findings that firms with stronger ESG profiles receive more favourable market reac-

tions. Prior work documents that institutional investors tend to overweight firms with better ESG practices, higher disclosure quality and more reliable governance structures (Cornell 2021; Pástor et al. 2023; Starks et al. 2017; Cao et al. 2023). Higher institutional ownership therefore signals stronger ex ante confidence in the firm's ability to use ESG related subsidies effectively. Consistent with this interpretation, the market reacts positively for firms widely held by institutional investors.

Low IO firms generate the opposite response. These firms typically combine weaker ESG performance with less transparent information environments. Investors are therefore more uncertain about whether subsidy funds will be transformed into meaningful ESG improvements. This interpretation is consistent with evidence that policy announcements can trigger downward revisions in valuations when markets perceive implementation risk or uncertainty (Pastor and Veronesi 2012; Bond and Goldstein 2015; Pan et al. 2016). The negative CARs for low IO firms suggest that investors interpret subsidy announcements for these firms as ambiguous and potentially costly signals rather than straightforward positive news.

Overall, this test shows that firms with higher institutional ownership benefit more from ESG related subsidy announcements. Firms with low institutional ownership, by contrast, experience negative pricing responses. The comparison between the two groups further reinforces our main conclusion that market participants reward firms with stronger ESG credibility and more stable investor bases when government sustainability policies are introduced.

Investment Sentiments

Next, to assess how investor sentiments respond to such announcements and test which channels may affect the CARs triggered by ESG-related subsidy policy announcements, we follow the methodologies of Connolly and Stivers (2003). We use Cumulative Abnormal Turnover (CAT) to measure the change in trading volume relative to the normal trading level during an ESG-related subsidy policy announcement. This metric reflects the market's immediate reaction to the announcements and illustrates how different investor segments reassess their positions based on the

perceived benefits or drawbacks of the policy changes. By employing CAT, we aim to explore how trading behaviour alters in response to policy shifts, highlighting the differential impact on firms with high and low levels of ESG performance. Similar to CARs, we distribute our CATs time window across $[-2:+2]$. We report the results of CATs in Figure III.5 and Table III.6, we find that high and low ESG performance firms exhibit opposing patterns. High ESG firms show a negative CATs response to ESG-related subsidy policy announcements, while low ESG firms exhibit positive CATs responses.

Specifically, for firms with high ESG scores (Column 1), the CATs during the periods leading up to and including the announcement demonstrate significant negative changes. In the event window from $[-2:+2]$, the CATs are -0.021% (T-value = -13.844), and in the $[-2:+3]$ window, the negative trend continues with a CAT of -0.022% (T-value = -13.247). By the $[0:+1]$ window, the negative trend slightly moderates to -0.004% (T-value = -4.098); Conversely, firms with low ESG scores (Column 2) exhibit consistently positive CATs across similar window intervals. Starting from $[-2:+2]$ with a CAT of 0.023% (T-value = 38.923) and peaking in the $[-2:+3]$ window at 0.027% (T-value = 41.156).

In summary, we find that there are notable differences in CATs after ESG-related subsidy announcements across high and low ESG firms. Although these initial patterns are consistent with the interpretation that investor sentiment varies across ESG levels, CAT may also capture other trading frictions or market microstructure effects. Short term liquidity shocks, inventory adjustments by market makers, or mechanical portfolio rebalancing can increase turnover without reflecting changes in sentiment. These mechanisms are consistent with empirical evidence that policy events in China sometimes trigger market wide trading adjustments that do not necessarily depend on investor beliefs (Allen et al. 2024). However, the asymmetric patterns we document, including negative CATs for high ESG firms and positive CATs for low ESG firms together with corresponding differences in CARs, are more consistent with sentiment driven reactions. High ESG firms exhibit higher CARs and lower CATs, which aligns with the behaviour of long horizon in-

vestors who adjust positions infrequently, whereas low ESG firms experience elevated CATs but insignificant CARs, which is characteristic of uncertainty driven trading rather than liquidity or market making effects. Therefore, although CAT may contain elements of market microstructure noise, the overall evidence indicates that investor sentiment remains the predominant explanatory channel.

For high ESG firms, sustainability is becoming an increasingly important element of institutional investment strategies (Cornell 2021; Giglio et al. 2021). Pástor et al. (2021) and Pástor et al. (2023) also highlight a growing preference for green assets among investors. Lins et al. (2017)'s research showed that when there are positive policy changes or financial crises, assets with high ESG performance tend to outperform others in their class. Additionally, ESG investors are typically long-term institutional investors who focus on long-term investments rather than exploiting short-term pricing errors for arbitrage purposes, leading to a generally lower turnover rate (Starks et al. 2017; Cao et al. 2023). This tendency reinforces the stability and sustainability-focused approach of firms with high ESG ratings, making them particularly attractive during periods of market volatility or regulatory changes.

However, low ESG score firms are usually less attractive to risk-averse investors who experience increased trading volumes following policy announcements. This increase can be linked to market expectations of falling stock prices after major policy shifts outlined by Pastor and Veronesi (2012) and Bond and Goldstein (2015). Shareholders likely think these firms will not be able to fulfil such requirements, hence they sell them off mostly in anticipation of declines that may follow subsequent policy changes, thereby doubting the ability of low-ESG compliant firms considering these decreases in share price due to non-compliance with environmental subsidies discussed earlier as noted by. In turn, these firms have significant deficiencies in achieving ESG thresholds resulting in higher trade volumes indicating investors' lack of faith in them. As they become aware of the shortcomings; some investors sell immediately believing these guidelines might hit their profits hard. The resultant herding effect, therefore, amplifies this trend, proving that market

reactions are deeply influenced by negative feelings and risk aversion.

Also, high abnormal turnover rates are often associated with lower stock returns in China, particularly when there have been policy declarations that encourage speculative trading according to Pan et al. (2016) and Allen et al. (2024). Generally, speculative pressures are because of investors preferring high ESG firms which tend to affect low ESG firms mostly. This speculation can cause a spike in CATs, which usually results in lower stock market returns.

This pattern shows that the market responses of high ESG firms are positively affected by CATs as compared to those for low ESG firms. Thus, we can deduce such a relationship since high CARs would mean fewer CATs among firms indicating strong belief in continued profitability regulatory compliance by these organisations while low CARs would equal more CATs reflecting weak faith about stable earnings and governance standards over the long-term horizon given the stable trading volumes seen on several occasions. The decrease in CATS on high ESG firms is matched by an increase in CARs. Thus. showing that it's not only the most robust traders who can make decent judgements but also they tend to trust their ability to make money. Before arriving at conclusions, we need assurance that nothing sends new risks into the system.

On the other hand, insignificant changes in CAR indicate large increases in abnormal turnover among low ESG firms meaning higher trade fluctuations rather than better alignment with sustainability or governance criteria as some observers have suggested over the past decade. In essence, though, it implies markets think low-ESG-compliant firms may suffer more severely from any negative impacts brought about by economic environmental policies. This implies the likelihood of fear-based selling. These firms have become more reactive investors as sceptical attitudes have been adopted leading to frequent changes in their portfolios based upon recent events that could affect investment prospects, such as new data coming out and shifts in market regulation.

In conclusion, when firms provide information that is related to ESG, the market becomes more confident and this brings about lower CATs and positive CARs over time for the high ESG firms. Investors place their trust in these firms' future performance increasing their market value as well.

Conversely, there is a different scenario for low-ESG firms; investors are not sure about new ESG requirements. This reduces investor confidence and causes a increased CATs with insignificant change in CARs overall. Thus, our findings again confirm only high ESG firms benefit from such policy announcements.

III.6.5. Institutional Features and Generalizability

Finally, we reflect on how China's institutional setting may have shaped our results, and consider whether similar effects are likely to occur in other contexts. In China, the state plays an active role in the financial system, SOEs dominate many key sectors, and capital markets frequently respond to explicit or implicit government policy signals. These institutional features are likely to amplify investor reactions to ESG-related subsidy announcements, particularly among non-SOEs, which face more direct market pressures yet remain sensitive to government support signals.

This situation differs markedly from more mature, market-oriented economies—such as the US or Western European countries—where investor responses are primarily shaped by corporate fundamentals, transparency, governance practices, and long-term strategic positioning, rather than explicit state support. Nonetheless, in many other emerging markets—such as India, Brazil, or Southeast Asian economies—similar institutional characteristics, including strong government influence, relatively limited regulatory enforcement, and policy-driven capital allocation, can produce comparable investor behaviours. However, it is important to recognise that our study may not fully capture other potentially influential institutional dimensions, such as regulatory quality, governance standards, market transparency, and cultural factors, all of which could modify the relationship between ESG-related subsidies and market reactions. Therefore, while our findings are most directly applicable to China, they carry significant implications for understanding market dynamics in similar emerging markets.

III.7. Conclusion

III.7.1. Summary

Our research findings show that investors respond favourably to subsidies that support ESG performance in high-ESG firms, which results in positive CARs. A notable finding was that firms with superior ESG ratings and higher ESG-linked grant receipts recorded higher CARs. It is post-2015 only, after the Paris Agreement, where this positive relationship between ESG grants and CARs became apparent having seen a negative correlation before then. This shows how China's government interventions on climate change risk have been effective and how it has impacted investor confidence concerning high ESG firms. Our results therefore support the notion that there is a global consensus on climate change as expressed in the Paris Agreement (Bolton and Kacperczyk 2023a; Bolton and Kacperczyk 2023b; Bolton and Kacperczyk 2024).

Moreover, for non-SOEs, it is a positive relationship while SOEs record negative returns. Since non-SOEs enjoy more autonomy, SOEs suffer from lower profits and bureaucratic red tape. The negative CARs observed for SOEs are consistent with long-standing institutional features of China's state-led financial system. Investors interpret subsidies to SOEs not as value-creating news but as signals that reinforce operational inflexibility and politically influenced capital allocation (Fan et al. 2020; Allen et al. 2024). Because SOEs already receive substantial government support, subsidy announcements provide limited new information, which is consistent with semi-strong form market efficiency (Fama 1970). At the same time, greater state involvement increases perceived policy and intervention risk, raising required returns and dampening announcement-window price reactions (Pastor and Veronesi 2012). These mechanisms jointly explain why SOEs experience muted or even negative CARs, while non-SOEs—facing fewer administrative constraints—can translate ESG-related subsidies into clearer value signals. We further prove that investor sentiment is behind the higher CARs of high ESG firms. Optimistic attitudes from investors result in constant positive CARs among high ESG firms because they have strong faith in their

policies of appropriate corporate governance. As a result, it leads to reduced CATs thus increasing their investment returns due to such sentiments. Conversely, low ESG firms face uncertainty and pessimism resulting in decreased investor trust which causes sell-offs and thus leads to insignificant gains from CARs. Taken together, these findings suggest that high ESG assets perform better than low ones when policy decisions on subsidies are based on environmental considerations for investments.

III.7.2. Policy Implication

This study offers practical implications for policymakers, corporations, and investors. For policymakers, the results highlight the importance of designing ESG-related subsidy programs that are targeted, performance-linked, and consistent with broader climate goals such as those set under the Paris Agreement. These programs are most effective when they are accompanied by clear signals and institutional support, particularly in emerging markets with state-led financial systems.

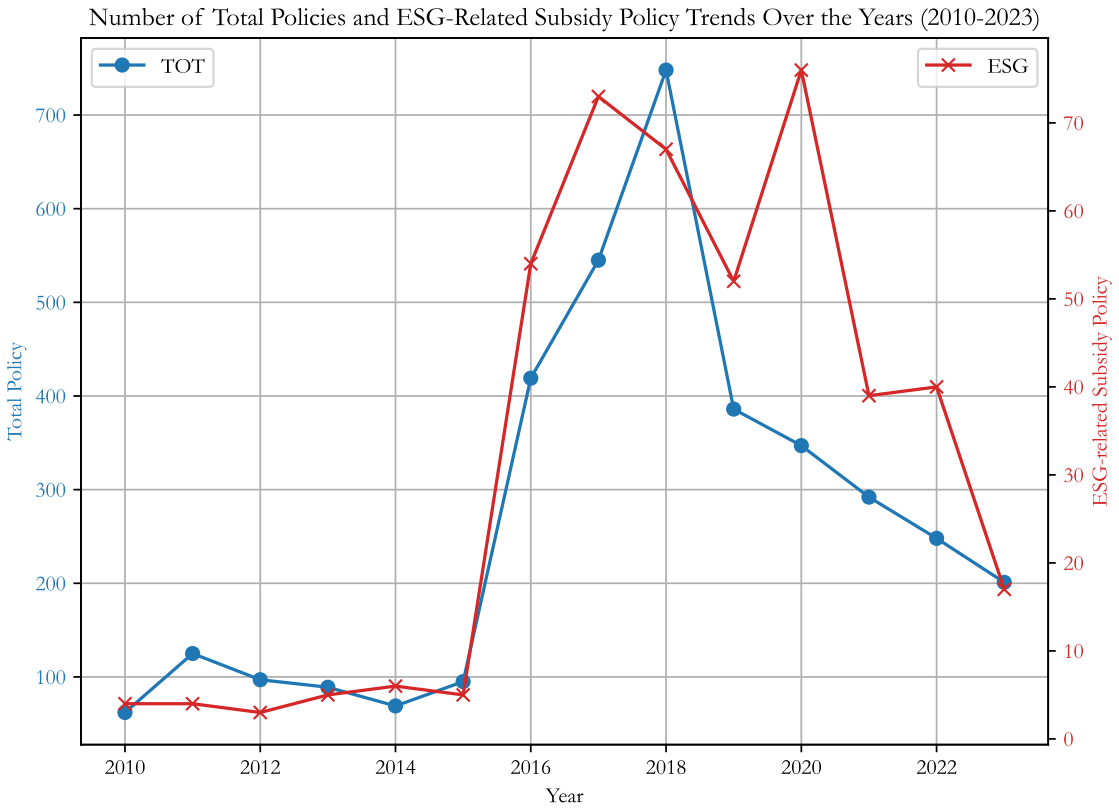
Policymakers should also consider differentiated approaches between SOEs and non-SOEs, addressing bureaucratic inefficiencies in the former while preserving flexibility and market orientation in the latter. For corporations, especially those seeking to benefit from ESG-related subsidies, the findings suggest that maintaining strong ESG practices and transparent communication is key to attracting investor support and realising performance gains. SOEs, in particular, may need to strengthen internal governance and responsiveness to make the most of policy incentives.

For investors, this research highlights the practical value of incorporating ESG considerations—particularly around government subsidy announcements—into portfolio strategies. Firms with high ESG ratings are more likely to deliver stable returns and benefit from policy support, while those with weak ESG profiles may face greater uncertainty and higher trading volatility. In addition, the results suggest that ownership structure matters for how policy signals are priced: firms with higher institutional ownership concentration tend to exhibit stronger and more stable market reactions to ESG-related subsidy announcements, indicating that informed and long-

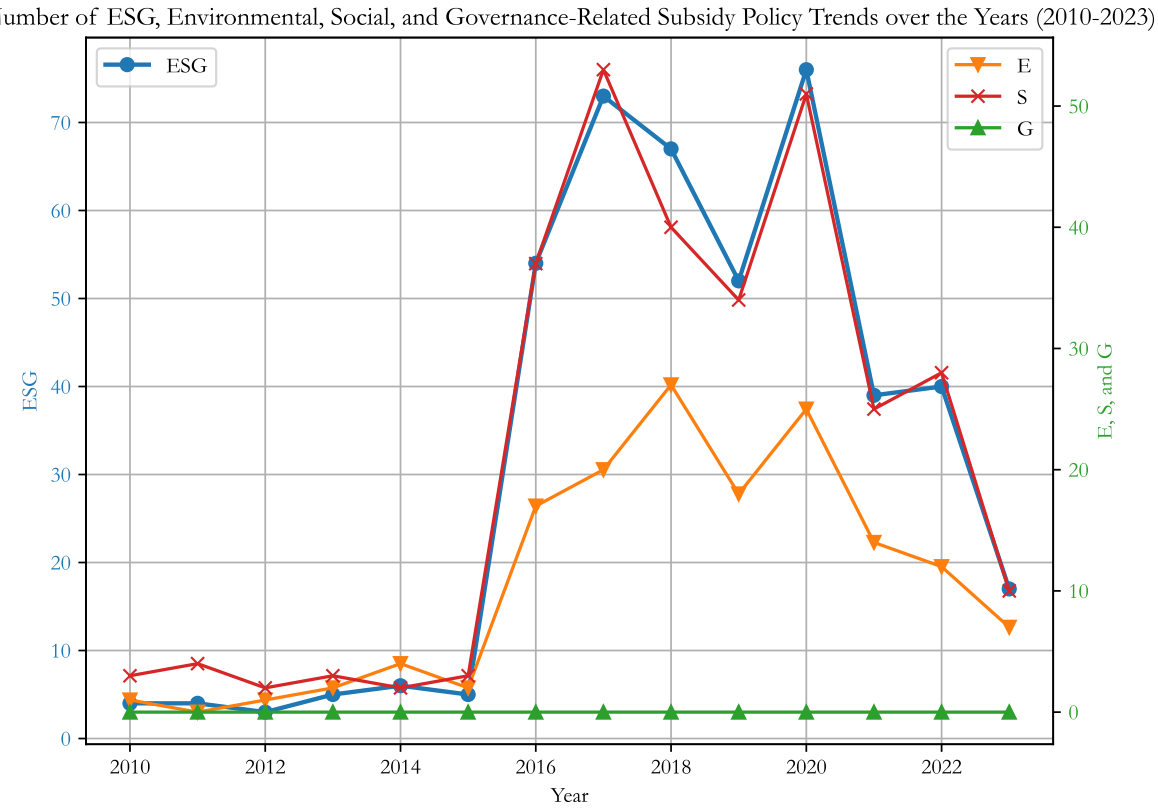
horizon investors amplify the effectiveness of such policy interventions. Moreover, the economic magnitude of the observed market reaction is non-trivial: for instance, the average CAR for high ESG firms over the $[-2:+2]$ window is approximately 0.028%, which is nearly four times greater than the average five-day return of the Shanghai Composite Index over the same period (0.0074%). This suggests that ESG-related subsidy announcements present tangible trading opportunities for investors. These insights are particularly relevant in emerging markets where state intervention and policy signals continue to shape capital market dynamics.

Figure III.1: **Trends in the Number of ESG-related Subsidy Policies and Overall Government Policies in China** (2010 – 2023)

a: Trends in the Number of ESG-Related Subsidy Policies and Total Policies (2010 – 2023)

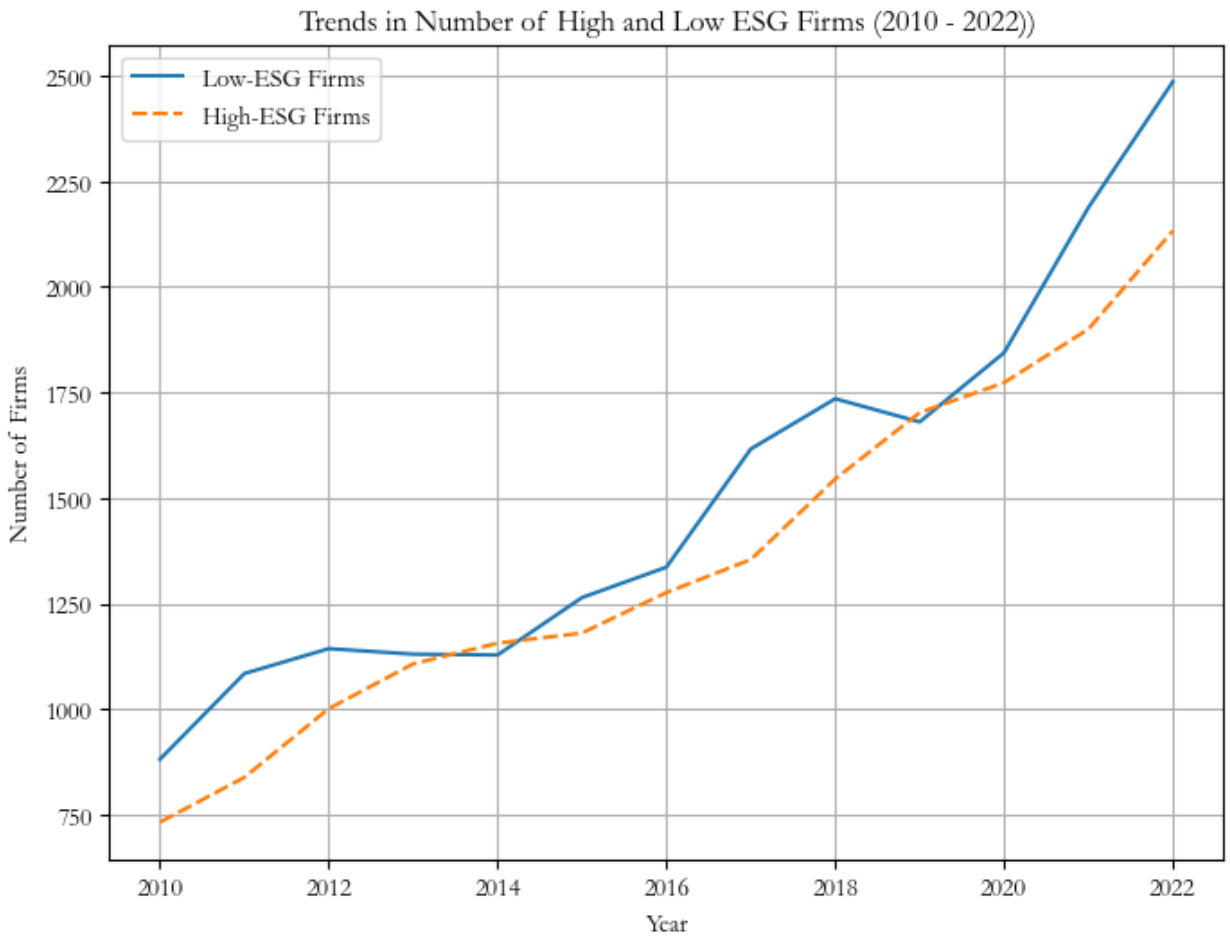


b: Trends in the Number of ESG-Related Subsidy Policies and Separated E/S/G Related Subsidy Policies (2010 – 2023)



Notes: This figure visually represents the trends in the number of ESG-related subsidy policies alongside the number of overall government policies in China from 2010 to 2023. Subfirgure a presents the overall growth of total policies in comparison to ESG-specific policies, while subfigure b distinguishes between the number of policies related to Environmental (E), Social (S), and Governance (G) aspects.

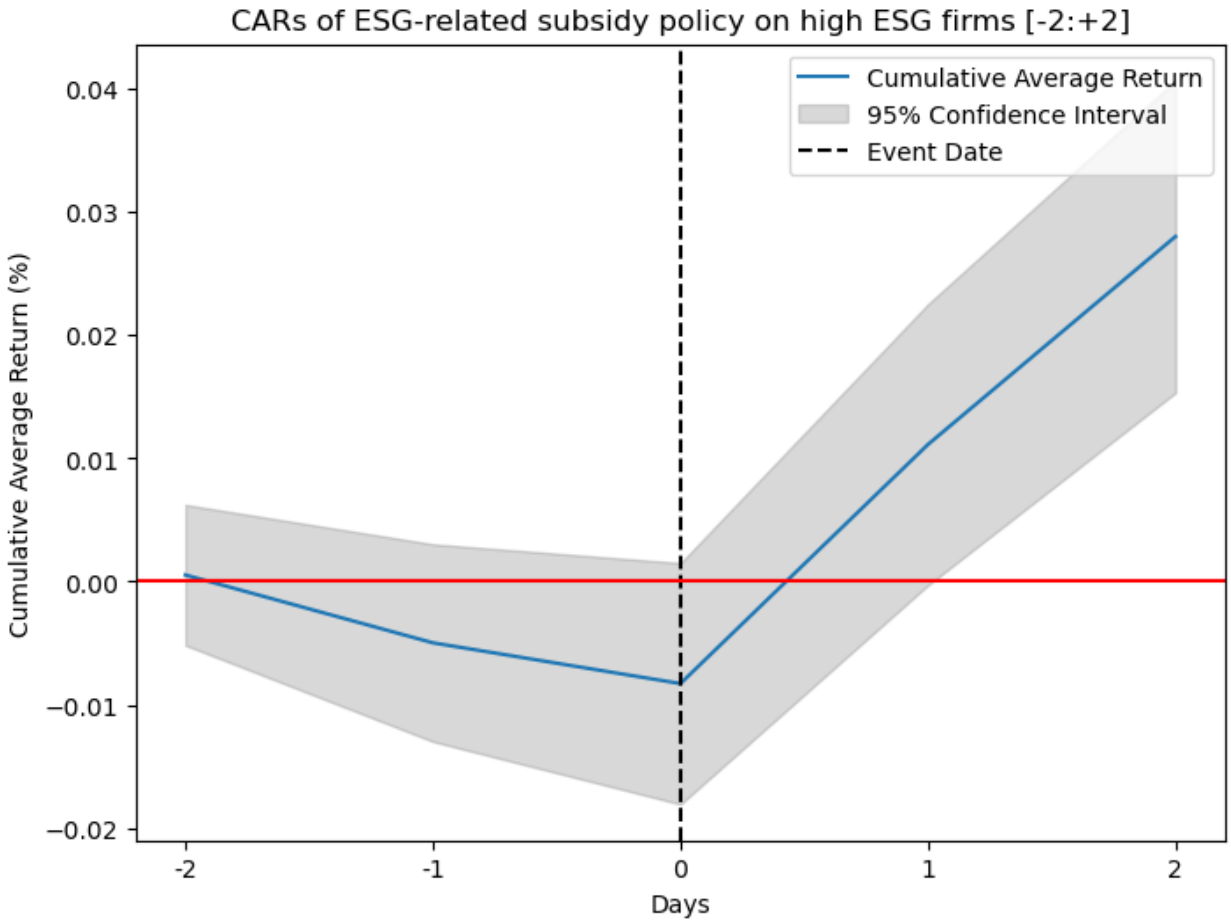
Figure III.2: **Trends in Number of High and Low ESG Firms** (2010 – 2022)



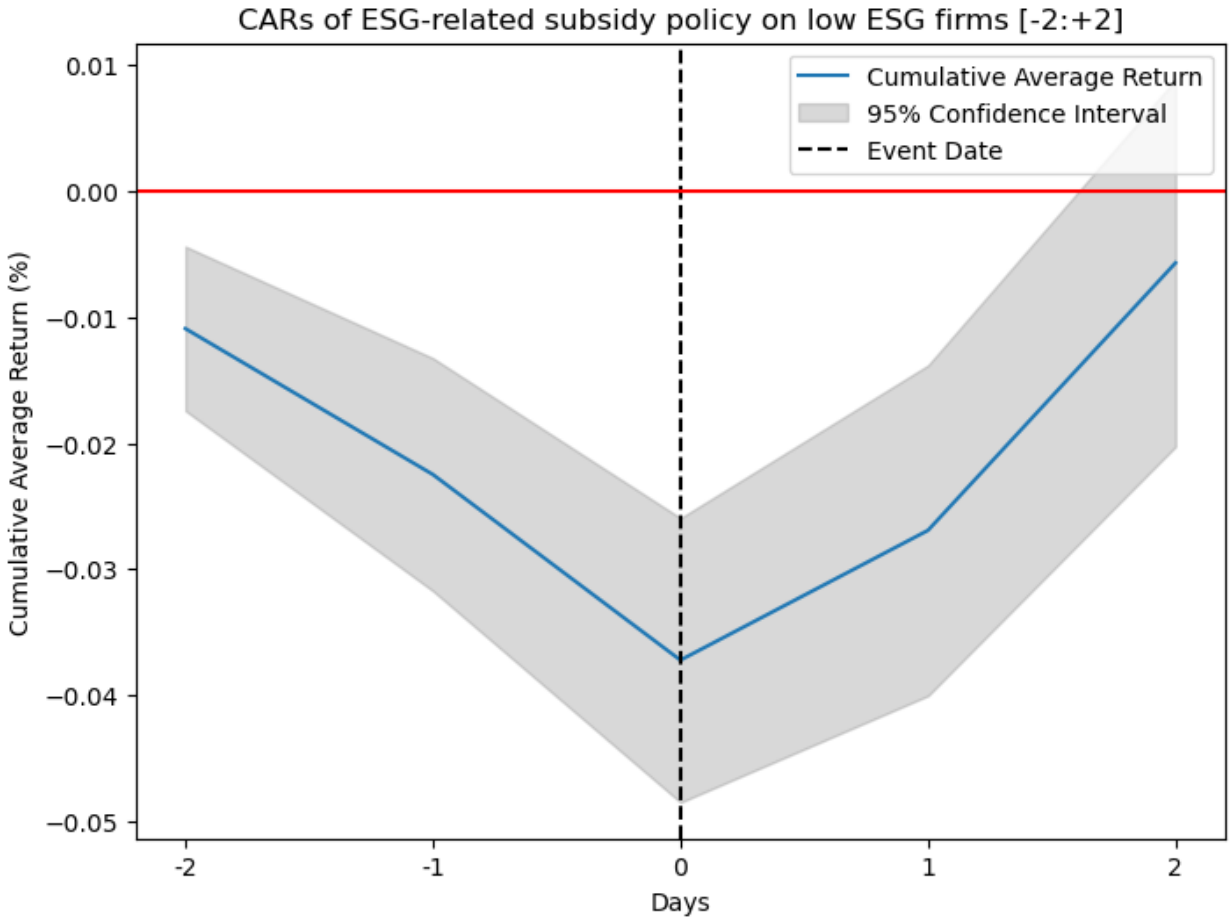
Notes: This figure presents the trends in the number of high and low ESG firms annually from 2010 to 2022.

Figure III.3: **Trends of Cumulative Abnormal Returns (CARs) Triggered by ESG-Related Subsidy Policy Announcements on Listed Firms Conditional on ESG Scores** $[-2:+2]$

a: High ESG Performance Firms



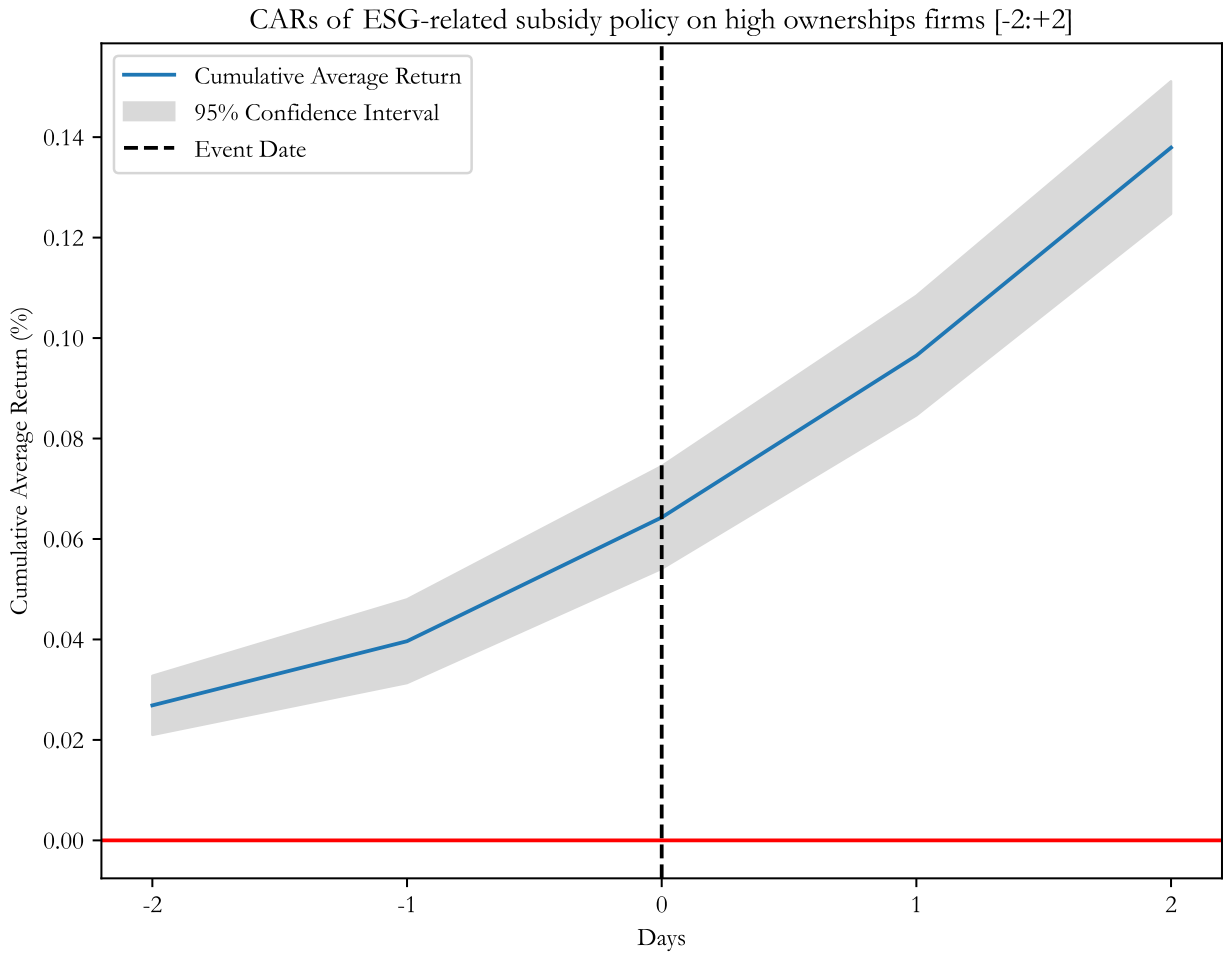
b: Low ESG Performance Firms



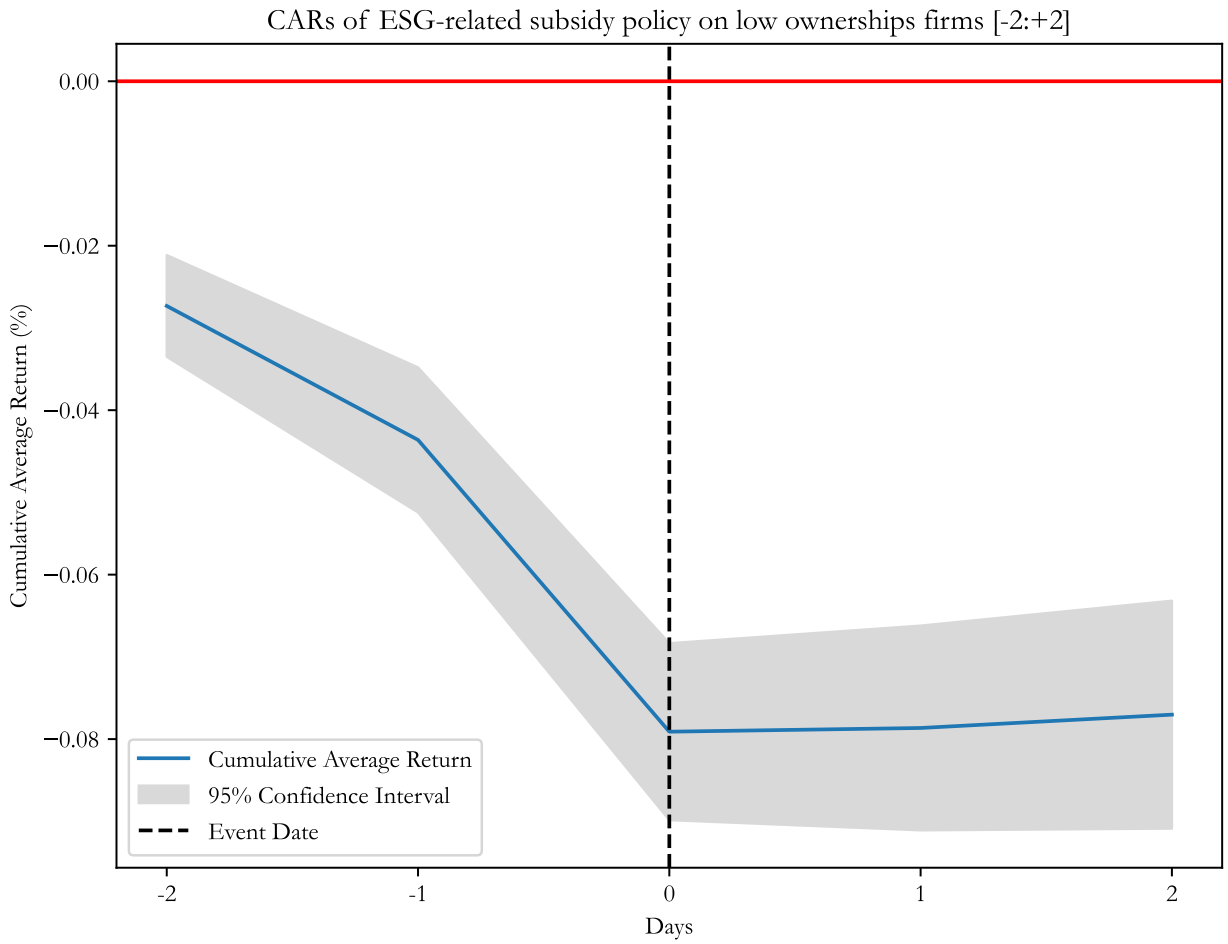
Notes: This figure presents the cumulative abnormal return (CAR) responses to ESG related subsidy announcements for the full sample of firms. Firms are classified into high and low ESG performance groups using the annual cross sectional median ESG score across all firms. Results are shown for the $[-2, +2]$ event window. Subfigure a reports the CARs for high ESG firms, and subfigure b reports the CARs for low ESG firms.

Figure III.4: **Trends of Cumulative Abnormal Returns (CARs) Triggered by ESG Related Subsidy Policy Announcements on Listed Firms Conditional on Ownership Concentrations** $[-2:+2]$

a: High ownership concentration firms

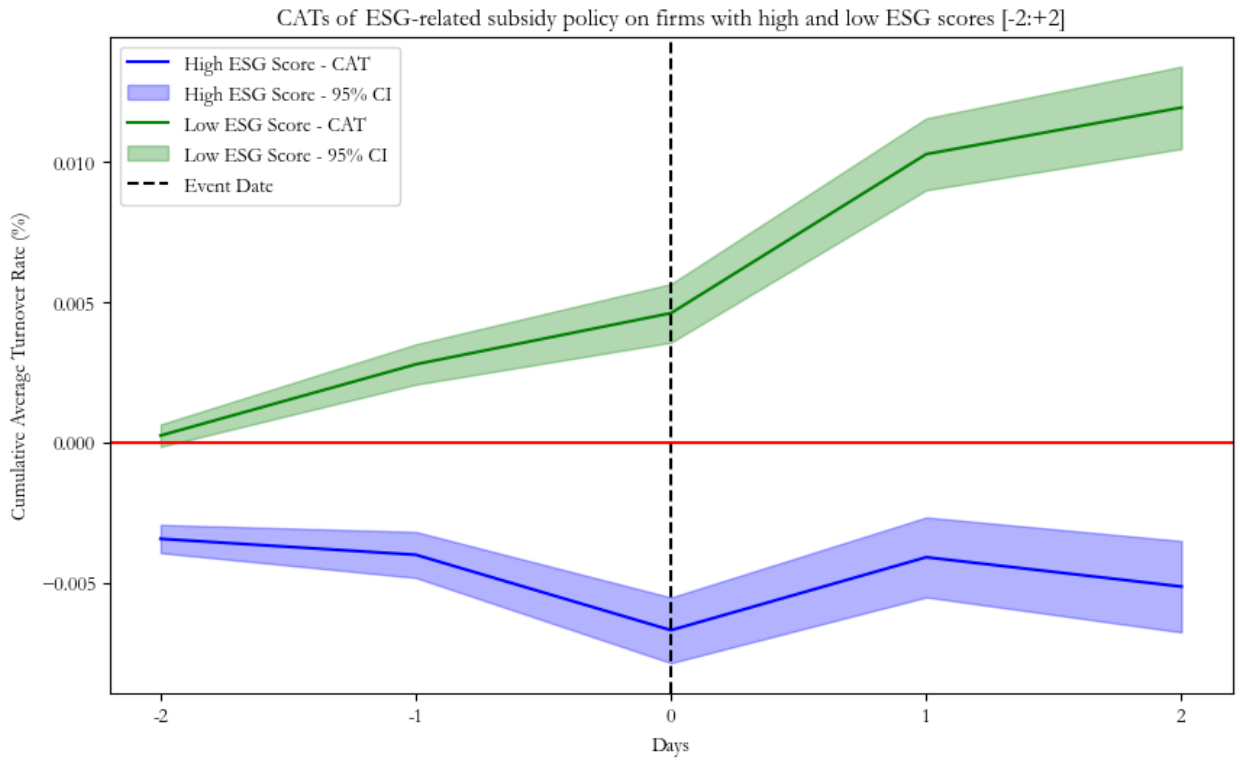


b: Low ownership concentration firms



Notes: This figure presents the cumulative abnormal return (CAR) responses to ESG related subsidy announcements for the full sample of firms. Firms are classified into high and low ownership concentration groups using the annual cross sectional median ownership concentration across all firms. Results are shown for the $[-2, +2]$ event window. Subfigure a reports the CARs for high ownership concentration firms, and subfigure b reports the CARs for low ownership concentration firms.

Figure III.5: **Trends of Cumulative Abnormal Turnovers (CATs) Triggered by ESG-Related Subsidy Policy Announcements on Listed Firms Conditional on ESG Scores** $[-2:+2]$



Notes: This figure presents the trend of Cumulative Abnormal Turnover Rates (CATs) for firms with high and low ESG scores in response to ESG-related subsidy policy announcements.

Table III.1: **Variable Definitions**

Variables	Full Name of Variable	Description
Dependent Variables		
CAR	Cumulative Abnormal Return	Cumulative Abnormal Return of ESG subsidy policy announcement.
CAT	Cumulative Abnormal Turnover	Cumulative Abnormal Turnover of ESG subsidy policy announcement.
Independent Variables		
ESG	Firm's ESG Performance	A measure of a firm's overall ESG Performance.
ESGSUB	ESG-related Subsidy	Natural log of the total ESG-related subsidy amount.
Control Variables		
SIZE	Market Capitalization	The natural log of total market capitalization.
TobinQ	Tobin's Q Ratio	The ratio of Tobin's Q of a firm.
CAPEX	Capital Expenditure	The natural logarithm of total CAPEX value.
ROA	Return on Asset	The total net income divided by total book value of assets.
CASH	Operating Cash Flow to Asset Value	The total operating cash flow divided by total assets.
Growth	Operating Revenue Growth	The rate of growth of operating revenue of a firm.
LEV	Leverage Ratio	The total value of debt divided by the total book value of assets.
Dummy Variables		
Paris	Paris Agreement 2015	Equals 1 if the year is 2015 and later, 0 otherwise.
SOE	State-Owned Enterprises	Equals 1 if the firm is state-owned, 0 otherwise.
Industry	Industrial Sector	Equals 1 if the firm operates within the industrial sectors, 0 otherwise.
Finance	Financial Sector	Equals 1 if the firm operates within the financial sectors, 0 otherwise.
Business	Business Sector	Equals 1 if the firm operates within the business sectors, 0 otherwise.
Public Utility	Public Utility Sector	Equals 1 if the firm operates within the public utility sectors, 0 otherwise.
Comprehensive	Comprehensive Sector	Equals 1 if the firm operates within the comprehensive sectors, 0 otherwise.

Table III.2: **Summary Statistics of Variables**

Panel A: Dependent and Independent Variables (Winsorized at 99%)

	High ESG Firms							
	N	Mean	SD	Min	p25	Median	p75	Max
CAR	289,403	0.07	4.84	-14.86	-2.47	-0.37	2.08	20.84
ESGSUB ($million)	289,403	2.63	5.33	0.00	0.23	0.76	2.26	30.61
ESG	289,403	77.08	3.01	71.83	74.67	76.51	78.93	89.81
	Low ESG Firms							
	N	Mean	SD	Min	p25	Median	p75	Max
CAR	278,532	0.04	5.21	-14.86	-2.72	-0.44	2.19	20.84
ESGSUB ($million)	278,532	1.60	3.49	0.00	0.16	0.50	1.46	30.61
ESG	278,532	68.28	4.32	39.98	66.56	69.44	71.38	73.80

Panel B: Control Variables (Winsorized at 99%)

	High ESG Firms							
	N	Mean	SD	Min	p25	Median	p75	Max
TobinQ	289,403	2.66	1.85	0.89	1.36	2.06	3.30	10.39
CAPEX ($million)	289,403	94.44	215.40	0.18	8.37	22.73	68.20	1,292.90
ROA	289,403	0.03	0.03	-0.08	0.01	0.03	0.05	0.13
CFO ($million)	289,403	122.67	293.15	-274.85	6.94	30.37	105.00	1,526.81
Growth (%)	289,403	0.17	0.38	-0.51	-0.01	0.11	0.26	2.77
LEV	289,403	0.42	0.20	0.05	0.26	0.41	0.57	0.93
SIZE ($million)	289,403	3,569.10	5,594.61	202.72	818.81	1,527.84	3,577.86	29,523.29

	Low ESG Firms							
	N	Mean	SD	Min	p25	Median	p75	Max
TobinQ	278,532	2.86	1.98	0.89	1.50	2.21	3.51	10.39
CAPEX ($million)	278,532	48.43	123.51	0.18	4.96	14.74	40.30	1,292.90
ROA	278,532	0.02	0.03	-0.08	0.00	0.02	0.04	0.13
CFO ($million)	278,532	57.04	170.48	-274.85	1.99	17.51	53.25	1,526.81
Growth (%)	278,532	0.18	0.49	-0.51	-0.05	0.09	0.26	2.77
LEV	278,532	0.43	0.21	0.05	0.27	0.42	0.58	0.93
SIZE ($million)	278,532	2,024.48	3,224.17	202.72	672.13	1,111.51	1,995.39	29,523.29

Notes: This table offers an overview of the summary statistics for the variables used in our analysis, with data spanning from 2009 to 2021. Panels A and B are segmented into high and low ESG performance groups based on firms' ESG performance, with all variables winsorized at the 99% level to limit the influence of outliers. Panel A provides a detailed breakdown of CARs, ESG scores (ESG) and ESG-related subsidy amount (ESGSUB). Panel B explores a range of control variables including growth, cash holdings (CFO), return on assets (ROA), and other financial metrics. Continuous variables are winsorized at the 1% and 99% levels.

Table III.3: **Measuring Cumulative Abnormal Returns (CARs) Triggered by ESG-Related Subsidy Policy Announcements on Listed Firms**

	CARs conditional on ESG score				Panel regression on CARs			
	High ESG score		Low ESG score		ESG scores		ESG-related subsidy	
Event window	CAR%	T-value	CAR%	T-value	Coefficient	T-value	Coefficient	T-value
CAR[-2:+2]	0.028	4.334***	-0.006	-0.765	0.023	2.840***	0.020	4.470***
CAR[-2:+3]	0.038	5.332***	0.004	0.530	0.026	2.980***	0.023	4.780***
CAR[0:+1]	0.016	3.907***	0.003	0.624	0.008	1.620	0.009	3.290***

Notes: This table presents the impact of ESG score distinctions on cumulative abnormal returns (CARs), conditional on firms' ESG classifications. Firms are divided into high and low ESG groups using the median ESG score from the previous year ($t-1$) as a threshold. CAR[τ_1:τ_2] indicates the cumulative abnormal return (in percentage) from day τ_1 to day τ_2 relative to the event day ($day0$). We report CARs separately for the high and low ESG groups. The table also includes panel data regressions where ESG scores and ESG-related subsidy amounts predict CARs over various event windows. Following Fiordelisi and Ricci (2016) and Chaudhry et al. (2022), all regressions include year and industry fixed effects. ESG scores, ESG-related subsidies, and control variables—including Tobin's Q (TobinQ), capital expenditures (CAPEX), return on assets (ROA), cash flow (CASH), growth, leverage (LEV), and firm size (SIZE)—are lagged by one year to mitigate reverse causality. Standard errors are clustered at the industry level. All continuous variables are winsorized at the 1% and 99% levels. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively. Regression intercepts and control variable coefficients are omitted for brevity.

Table III.4: **Heterogeneity Analysis of ESG Scores and ESG-related subsidy on CARs Window of [$-2 : +2$]**

Panel A: Paris Agreement 2015 and SOEs

	(1)	(2)
	CAR	CAR
ESGSUB	-0.062***	0.027***
	(0.020)	(0.006)
ESGSUB × Paris	0.085***	
	(0.021)	
SOE		0.239*
		(0.125)
ESGSUB × SOE		-0.017**
		(0.008)
Controls	Y	Y
R-sq	0.001	0.001
N	461099	461099
Industry FE	Y	Y
Year FE	Y	Y

Panel B: Various Sectors

	(1) CAR	(2) CAR
ESG	-0.101**	
	(0.046)	
ESGSUB		-0.047*
		(0.028)
ESG × Industry	0.127***	
	(0.047)	
ESG × Business	0.034	
	(0.061)	
ESG × Public utility	0.163***	
	(0.049)	
ESG × Real Estate	0.059	
	(0.061)	
ESG × Finance	0.006	
	(0.081)	
ESGSUB × Industry		0.075***
		(0.029)
ESGSUB × Business		0.075**
		(0.034)
ESGSUB × Public utility		0.056*
		(0.030)
ESGSUB × Real Estate		0.038
		(0.033)
ESGSUB × Finance		0.047
		(0.043)
Controls	Y	Y
R-sq	0.001	0.001
N	461099	461099
Industry FE	Y	Y
Year FE	Y	Y

Notes: This table shows heterogeneity in CARs by Paris Agreement (post-2015), SOE status, and firm sectors. Panel A reports interactions of ESG-related subsidies with Paris and SOEs. Panel B uses the 'comprehensive' sector as the baseline. Coefficients of ESG and ESGSUB show effects in the baseline group; interaction terms capture incremental effects in other sectors. All regressions include industry and year fixed effects. Continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the industry level. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively, with standard errors in parentheses.

Table III.5: **Robustness Checks**

Panel A: Use of Various Models to Predict Expected Returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep Var.	CAR [-2:+2]							
	CAPM	Carhart4	CH3	FF5	CAPM	Carhart4	CH3	FF5
ESG	0.015*	0.017**	0.015**	0.015*				
	(0.008)	(0.008)	(0.008)	(0.008)				
ESGSUIB					0.022***	0.018***	0.024***	0.015***
					(0.005)	(0.004)	(0.004)	(0.004)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
R-sq	0.007	0.001	0.001	0.002	0.007	0.001	0.001	0.002
N	461099	461099	461099	461099	461099	461099	461099	461099
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Panel B: High and Low ESG Subsidy Firms

	High ESG score		Low ESG score	
	CAR%	T-value	CAR%	T-value
High ESG-related Subsidy	0.081	7.195***	0.098	10.949***
Low ESG-related Subsidy	0.040	3.100***	0.014	1.071

Panel C: Excluding Event-Date Overlaps With M&A Announcements

	CARs conditional on ESG score			
	High ESG score		Low ESG score	
Event window	CAR%	T-value	CAR%	T-value
CAR[-2:+2]	0.019	2.863***	-0.018	-2.434**
CAR[-2:+3]	0.027	3.852***	-0.009	-1.151
CAR[0:+1]	0.012	2.803***	-0.002	-0.332

Notes: This table presents robustness check results related to the impact of ESG scores and ESG-related subsidies on cumulative abnormal returns (CARs). Panel A shows regression estimates using various expected return models to compute CARs, including the Sharpe (1964), Carhart (1997), Fama and French (2015), and Liu et al. (2019). All regressions include industry and year fixed effects. Continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the industry level. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parentheses. Panel B evaluates CARs in the $[-2{:}+2]$ event window, comparing firms with high versus low ESG-related subsidy values, based on the median of the prior year's $(t-1)$ subsidy amount. Panel C reports results from a subsample that excludes firm-day observations with M&A announcements coinciding with ESG-related subsidy disclosures.

Table III.6: **Additional Tests**

	CATs conditional on ESG score			
	High ESG score		Low ESG score	
Event window	CAT%	T-value	CAT%	T-value
CAT[-2:+2]	−0.021	-13.844***	0.023	38.923***
CAT[-2:+3]	−0.022	-13.247***	0.027	41.156***
CAT[0:+1]	−0.004	-4.098***	0.013	40.511***

Notes: This table presents our additional tests, with a focus on investor sentiments on such announcements. We examine the impact of ESG score distinctions on Cumulative Abnormal Turnovers (CATs) across firms to test investor sentiment on such announcements, conditional on their ESG score classification. CAT$[\tau_1 : \tau_2]$ indicates the cumulative abnormal turnover (expressed as a percentage) for the period starting at τ_1 and ending at τ_2, relative to the event day (day 0). Continuous variables are winsorized at the 1% and 99% levels. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively.

Chapter IV

Institutional Social Responsibility Concentration: A Novel ESG Alternative

IV.1. Introduction

Global warming poses a critical threat to sustainable development, necessitating immediate and collective efforts from all sectors, including financial markets. Environmental, Social, and Governance (ESG) initiatives play a pivotal role in mitigating climate risks (Choi et al. 2020). As global awareness of these risks increases, substantial capital flows into ESG-compliant investments, reshaping investor landscapes and preferences (Pedersen et al. 2021; Hong et al. 2020). This trend extends into Socially Responsible Investing (SRI), where investors seek not only returns but also positive social impacts, gaining non-pecuniary benefits (Pástor et al. 2021; Avramov et al. 2022; Cao et al. 2023). Typically, SRI investors, with their long investment horizons, do not react to short-term mispricing for arbitrage profits (Starks et al. 2017; Cao et al. 2023). They also enhance corporate transparency in climate risk disclosures, exerting a significant financial influence that drives firms towards robust climate risk management (Kim et al. 2014; Ilhan et al. 2023).

However, despite the increasing sustainability and enthusiasm in SRI investor strategies and preferences, current ESG reporting methods are focused on the firm level and are typically reported annually. This traditional approach limits the ability of investors, industry, and academia to capture shifts in both a firm's ESG practices and investor sentiment in the stock market, particularly the preferences of SRI investors from a more accurate perspective. A more granular quantification of investors' responses to ESG metrics is needed. Recognising this limitation, and motivated by Hwang et al. (2022) and Cao et al. (2023), where they introduce a method to classify institutions to social responsibility (SR) and NON-social responsibility (NSR) institutions, based on their Institutional Social Responsibility Scores (ISRS), calculated by aggregating size-adjusted ESG scores of portfolio stocks, weighted by their portfolio proportions on a quarterly basis.

We extend their study, develop a novel stock-level indicator - Institutional Social Responsibility Concentration (ISRC) metrics, which quantifies the concentration of social responsibility attributed to a stock by mutual fund investors quarterly. ISRC is calculated by aggregating institutional shareholding percentages, weighted by each institution's ISRS [13].

A higher ISRC for a stock integrates two fundamental aspects: ISRC not only signifies the magnitude of a firm's current adherence to ESG principles but also highlights the active engagement and support from investors who prioritize these ESG values, integrating key information about the firm's social responsibility commitment and the market's acknowledgment thereof. Based on this measure, if a stock is predominantly held by institutions with strong commitments to ethical and sustainable practices, it will receive a high ISRC score, and thus, stocks with a higher ISRC are favoured by investors who align their portfolios with ethical and sustainable practices. The rationale behind this measure is that, in response to growing global demands for corporate responsibility, investors in stocks with high social responsibility are likely to support these businesses consistently, even in challenging economic times; therefore, when a stock is mainly held by institutions with a high socially responsible score, it suggests that the stock is less susceptible to sudden disinvestment and contributes to greater stock market stability.

Moreover, ISRC offers two additional advantages over traditional ESG metrics: first, while traditional ESG disclosures are annual, ISRC provides a more granular, quarterly metric. Second, traditional ESG metrics are self-disclosed by firms and do not capture investors' preferences, whereas the ISRC can more directly quantify investors' preferences for a firm, it can also use changes in the ISRC to detect shifts in investor sentiment affecting the firm.

[13] **Illustrative Example:** Suppose stock j is owned by three funds, F_1, F_2, and F_3 at quarter t. Their ISRS scores are 2.0, 1.0, and -0.5, respectively, and their holding weights in stock j are 4%, 3%, and 2%. Then

$$ISRC_{j,t} = (2.0 \times 4\%) + (1.0 \times 3\%) + (-0.5 \times 2\%) = 0.08 + 0.03 - 0.01 = 0.10.$$

Since the positive (high-ISRS) funds hold larger positions, the resulting ISRC is positive, indicating that stock j is more heavily owned by socially responsible investors overall. In other words, each fund's ESG inclination has a varying degree of influence on the stock, and the fund's holding weight is precisely the key factor that "transmits" the fund-level ESG inclination to the stock level.

We expect higher ISRC to be positively associated with future stock returns, as markets increasingly reward firms demonstrating genuine ESG efforts. This positive relationship arises because ISRC embeds several behavioural and informational mechanisms that link responsible ownership to future performance. First, ISRC reflects credible signalling of firms' genuine ESG commitment, which enhances investor trust and lowers perceived risk. Second, socially responsible investors reduce information asymmetry through continuous monitoring and engagement, improving price efficiency and mitigating crash risk. Third, the stability of SR investors with long investment horizons dampens short-term volatility and turnover, supporting more resilient valuations. Together, these mechanisms explain why firms with higher ISRC not only attract sustained demand but also enjoy stronger, risk-adjusted long-term returns. Mutual funds focusing on ISRC face less uncertainty around ESG ratings, reducing the impact of rating inconsistencies and climate risk underestimation. As firms' true sustainability value is recognised, returns improve through mean reversion. Next, we propose that ISRC influences returns through two key channels. First, the ESG Demand Channel: firms with higher ISRC enhance ESG practices to attract SR investors, boosting reputation and capital inflows, which raises valuations. Second, the Market Stability Channel: higher ISRC is linked to lower turnover, longer holding periods, and reduced crash risk due to improved transparency and lower information asymmetry, leading to stronger, risk-adjusted long-term returns. Finally, the Paris Agreement amplifies these effects by shifting global investor sentiment towards stricter ESG compliance, especially in Asia, thereby strengthening the link between ISRC and market performance (Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2021; Bolton and Kacperczyk 2023b).

We derive our dataset from two principal sources. Data at the mutual fund and stock levels, including rates of return, turnover, trading amounts, and other variables for controls, are obtained from the China Stock Market and Accounting Research Database (CSMAR). We source our ESG scores from the Sino Securities Index Company (SSI). Our focus is on stocks traded on China's A-share markets, encompassing the Shanghai and Shenzhen stock exchanges. We exclude any firms

that are delisted, as indicated by the 'ST (Special Treatment)' marker. By integrating the ESG scores with mutual fund and stock level data, our research spans a sample period from the 2010Q1 to the fourth quarter of 2023Q4, covering 56 quarters and including 4,032 firms listed on China's stock exchanges. Additionally, following the classification method of mutual funds by Cao et al. (2023), as of the end of 2023Q4, there are 3,086 SR funds compared to 5,438 NSR funds.

Our chapter presents the following key findings. First, we show that SR funds hold larger average assets under management (AUM), maintain longer investment horizons, and are less prone to stock price crashes compared to non-socially responsible funds (NSR). SR funds also exhibit stronger ESG performance, reflecting a greater commitment to sustainability. However, SR funds earn lower investment returns, indicating a preference for non-pecuniary social benefits over short-term financial gains.

Second, following Cao et al. (2023), we examine the trading behaviours of SR and NSR funds in response to short-term mispricing signals using quintile sorting on Short-term Unexpected Earnings (SUE). Both fund types react to mispricing, but SR funds do so with less intensity, prioritizing ESG stability over arbitrage. This pattern, while similar to the US, is less pronounced in China's speculative and less mature market. Furthermore, portfolios double-sorted on ISRC and SUE reveal that undervalued stocks with high ISRC generate significantly higher abnormal returns. This suggests SR investors respond less aggressively to mispricing, enabling investment strategies that exploit undervaluation in high-ISRC stocks, consistent with Cao et al. (2023).

Third, we find a significant positive relationship between ISRC and future stock performance. A one-unit increase in ISRC leads to a 0.031 unit rise in future stock returns and a 0.023 unit improvement in ESG performance (both at the 1% level), supporting the ESG Demand Channel. ISRC also enhances firm reputation ($+0.117$) and increases mutual fund inflows ($+0.093$), confirming its role in attracting SR capital. Regarding the Market Stability Channel, higher ISRC extends investment horizons ($+0.012$) and reduces future turnover (-0.019) and trading amount (-0.011), all significant at the 1% level. It also lowers crash risk (-0.025, significant at 5%),

mutual fund selling pressure (-0.092), and net outflows (-0.052), indicating improved market stability.

Finally, these effects—on returns, turnover, crash probability, and holding periods—only emerge after the 2015 Paris Agreement, highlighting its role in amplifying investor focus on ESG and reinforcing ISRC's influence on market outcomes.

Our robustness checks include two main tests. First, to address endogeneity, we use the Climate Physical Risk Index (CPRI) as an instrument for ISRC in a GMM 2SLS model. CPRI influences investor demand for ESG but does not directly affect firm-level financial performance, satisfying both relevance and exclusion criteria (Choi et al. 2020; Stroebel and Wurgler 2021; Hong et al. 2020). The GMM results align with our baseline, confirming that ISRC has a causal effect on stock performance. Second, we address sample selection bias by dividing stocks into high and low ISRC groups based on the median (ISRC50). Using propensity scores from control variables, we match each high ISRC firm with five low ISRC peers via 5-nearest-neighbour matching. The results remain consistent with our main findings, further supporting robustness.

Our additional tests show that ISRC predicts long-term outcomes, including future ESG scores, investment horizons, crash risk, fund outflows, and mutual fund inflows. These effects persist over time. However, ISRC's impact on returns, turnover, and trading volume appears short-lived. Finally, ISRC performs best in ESG-sensitive sectors like Industrial, Utilities, and Business, where it predicts better ESG outcomes, higher returns, and lower risk. In contrast, it shows weaker effects in Real Estate and Finance, suggesting that industry context matters when applying ISRC in ESG investing.

We contribute to the literature by introducing a novel stock-level metric, the ISRC, which captures the degree to which SR investors allocate capital to individual firms. Prior studies have attempted to measure such preferences using ESG fund flows (Riedl and Smeets 2017), the ESG tilt of institutional investors (Dyck et al. 2019), or the implications of ESG engagement and shareholder activism (Dimson et al. 2015). More recently, Pástor et al. (2021) show that sustainable

mutual funds impact asset prices, particularly when they reallocate capital toward ESG-compliant firms. ISRC adds to this literature by offering a stock-level signal that reflects the revealed preferences of SR investors, capturing both ESG demand (through fund inflows and ESG alignment) and market stability (via lower crash risk and selling pressure). Unlike traditional ESG scores that are backward-looking and based on annual corporate disclosures, ISRC provides a more granular and forward-looking measure of ESG alignment, directly linking investor behaviour to firm-level ESG concentration. This advancement enables investors to make more informed investment decisions by identifying how SR investors influence stock performance and stability, supporting enhanced portfolio management and risk assessment (Anderson and Robinson 2019; Krueger et al. 2020; Pedersen et al. 2021).

For academia, ISRC serves as a robust measure for studying the impact of ESG investing on market outcomes and asset pricing (Hong et al. 2020; Stroebel and Wurgler 2021). Our analysis also extends the findings of Hwang et al. (2022) and Cao et al. (2023) by demonstrating that, in China, both SR and NSR investors respond to mispricing signals, with SR investors reacting less intensely—contrasting with US evidence where SR investors tend to disregard such signals. Finally, we show that the positive effects of ISRC on stock returns and market stability are significantly amplified after the 2015 Paris Agreement, supporting the view that global climate commitments enhance market recognition of ESG practices (Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2021; Bolton and Kacperczyk 2023b). Thus, ISRC provides a valuable addition to ESG research by reflecting investor-driven social responsibility at the stock level, enhancing understanding of ESG's role in market performance and risk.

The rest of this chapter is organised as follows: Section IV.2 provides our literature review; Section IV.3 outlines our research hypotheses and presents our research methodology; Section IV.5 details our data description; Section IV.6 presents our empirical results; Section IV.7 shows the channels and theoretical mechanisms that drive the relationship between ISRC and stock market returns; Section IV.8 provides our additional checks; and Section IV.9 concludes.

IV.2. Literature Review

Global warming is a significant long-term challenge that demands collective action from humanity, bolstered by robust efforts from governments globally (Choi et al. 2020). Countries actively promote the development of ESG initiatives to mitigate and adapt to climate risks. These efforts greatly influence investors' beliefs, reshaping the investment landscape. Extensive research underscores the pivotal role of these initiatives in mitigating climate risks, highlighting how strategic investments in sustainable practices are vital for long-term environmental and economic stability.

IV.2.1. Investor Beliefs on Mitigating Climate Risks

Investor belief plays a key role in funding climate risk mitigation and pricing climate-sensitive assets (Hong et al. 2020). Stroebel and Wurgler (2021) conducts a comprehensive survey among financial scholars and investors worldwide on climate finance. The results highlight that physical risks are perceived as the predominant climate-related threat over the next 30 years, whereas transition risks are seen as the most significant over the next five years. Furthermore, the survey indicates that asset prices currently underestimate these climate risks. Similarly, Krueger et al. (2020) finds that institutional investors consider transition risks as having significant financial implications for their portfolios because current stock valuations fail to price in these risks fully. This underscores the necessity for institutional investors to manage these risks collaboratively. Additionally, these findings imply that assets currently undervalued due to unrecognised climate risks may experience value correction as market understanding improves, potentially yielding higher long-term returns for investors who proactively manage and price these risks accurately. Together, these surveys and findings collectively underscore the significant impact of investor beliefs on the perception and integration of climate risks into financial decision-making, compelling investors to reconsider their asset allocation strategies.

Additionally, Choi et al. (2020) utilises a comprehensive dataset of U.S. stock performance, weather anomaly records, and Google search frequencies to investigate the influence of climate

conditions on financial markets. Their study examines the valuation of carbon-intensive firms listed on major U.S. exchanges, highlighting that retail investors are increasingly attentive to the environmental impacts of such firms in the context of extreme climate events. This heightened focus reflects a growing awareness and responsiveness to climate risks among retail investors. Furthermore, a study by Anderson and Robinson (2019) on personal pension data in Sweden reveals that after the extremely hot summer of 2014, investors who feared future climate disasters were more inclined to allocate a larger portion of their retirement portfolios to green funds and were willing to pay higher management fees for these investments, such shift leads too a significant movement towards environmentally sustainable investments as awareness and concern over climate impacts continue to rise.

IV.2.2. Investor Preferences for ESG Performance

As awareness of climate risks grows, it directly influences investor strategies and preferences, increasingly reflected in firms' ESG performance, which garners significant attention. ESG not only provides valuable information about firm fundamentals but also significantly influences investor preferences (Pedersen et al. 2021). This dual role cements ESG's centrality in both corporate and public spheres, often surpassing legal requirements in market and economic contexts (Kitzmueller and Shimshack 2012). Many companies voluntarily engage in CSR/ESG initiatives, aiming to protect and enhance the well-being and financial returns of their stakeholders (Liang and Renneboog 2017). Furthermore, favourable ESG ratings act as a safeguard against risks associated with climate change and economic transitions, driving substantial capital inflows into ESG-focused investments (Cornell 2021; Pedersen et al. 2021), while also offering non-pecuniary benefits that enhance investor satisfaction and societal approval Pástor et al. (2021) and Avramov et al. (2022). Next, we explore the relationship between ESG performance and firm stock market performance, as well as the role of investor preferences.

ESG Performance and Stock Market Returns

The relationship between a firm's ESG performance and stock market returns shows mixed outcomes, early studies frequently report a negative relationship. However, as research continues, more papers find that strong ESG performance positively affects stock market returns, reflecting a shift towards acknowledging the benefits of sustainable practices.

i. Negative Relationships

Hong and Kacperczyk (2009) examine U.S. stock data to classify firms involved in alcohol, tobacco, and gaming as sin stocks, noting these firms consistently demonstrate low ESG performance yet achieve high stock returns. They attribute this phenomenon to reduced ownership by norm-constrained investors, such as pension funds, who ethically avoid these sectors, resulting in underpricing and consequently higher returns. Similarly, Bolton and Kacperczyk (2020), Bolton and Kacperczyk (2021), and Bolton and Kacperczyk (2023b) find that firms with lower ESG scores generally achieve higher stock returns. In their analysis of U.S. market data focusing on carbon emissions, they identify a carbon risk premium, suggesting that investors require compensation for the heightened carbon risks associated with these firms due to potential regulatory and technological risks. Their findings indicate that, after adjusting for factors like size, book-to-market ratio, and momentum, companies with higher total CO2 emissions consistently outperform. This inverse relationship between ESG performance and stock returns is linked to the anticipated higher operational costs, which are expected by the market to potentially decrease in the future due to reduced regulatory challenges or technological advancements.

Additionally, Avramov et al. (2022) analyse the impact of ESG rating uncertainty on stock performance, revealing that uncertainty about a firm's ESG profile increases market risk premiums and diminishes stock demand, further contributing to the observed negative correlation between ESG scores and stock returns. This relationship is underpinned by investors' height-

ened risk perception in the face of ESG uncertainty, possibly leading to an underestimation similar to that observed with climate risks.

The negative correlation between ESG performance and stock market returns can be attributed to three primary factors. First, stocks with lower ESG scores are often overlooked and undervalued by the market, similar to how climate risks are frequently underestimated, allowing them to yield higher returns once their true value is recognized potentially. Second, these firms generally incur higher operational costs, leading to elevated capital costs that may decrease in the future as regulatory and technological advancements take place, offering a prospect for capital appreciation. Third, the presence of ESG rating uncertainty introduces additional market risks, contributing further to these stocks' undervaluation. This scenario suggests that market corrections may occur over time as these mispricings are recognized and the regulatory, technological, and informational contexts evolve.

ii. Positive Relationships

As discussed, an increasing body of research and consensus reveals that investing in ESG is a profitable endeavour (Financial Times 2017). For instance, Kempf and Osthoff (2007) implement a long-high and short-low trading strategy based on socially responsible (SR) ratings in the U.S. stock market, finding that portfolios long on stocks with high SR ratings and short on those with low ratings substantially outperform, achieving abnormal returns of up to 8.7% annually. Moreover, Lins et al. (2017) examine the impact of investor trust on stock returns during the 2008 financial crisis, using data from US stocks. Their research demonstrates that firms with higher ESG scores achieve significantly higher returns amid the crisis. This outcome links to the heightened trust these firms inspire in investors and stakeholders, which becomes crucial during periods of market instability. The findings illustrate that elevated ESG ratings not only enhance investor confidence but also act as a buffer against negative market shocks, suggesting that investments in ESG can provide substantial protective benefits for

firms during economic downturns.

Likewise, Pástor et al. (2021) develop an equilibrium model to analyse how investors' consideration of ESG standards impacts asset prices and corporate behaviours. They find that while green assets generally have lower expected returns due to widespread investor preference, their performance relative to brown assets improves as consumer and investor awareness of ESG issues intensifies. This suggests that under certain conditions, firms with good ESG performance can excel in the stock market, especially when market awareness of these risks increases. These two studies by Lins et al. (2017) and Pástor et al. (2021) align with findings from Avramov et al. (2022), which initially indicate a negative impact of ESG rating uncertainty. However, as this uncertainty diminishes, the positive influence of ESG performance on firm returns becomes apparent.

Finally, Kim et al. (2014) studies the U.S. stock market from 1995 to 2009 to explore the relationship between ESG and stock price crash risk, finding that strong ESG performance significantly reduces the likelihood of price crashes. This reduction results from enhanced transparency and lower information asymmetry in firms with robust ESG practices, suggesting that high ESG levels contribute to stabilising stock prices and reducing market volatility.

In summary, ESG performance significantly enhances a firm's resilience, and stock returns, and reduces the likelihood of stock price crashes, especially under economic stress or when market sensitivity to sustainability issues increases. As understanding and valuation of ESG factors improve, the positive impact of high ESG scores on firm valuations and market stability becomes increasingly apparent.

Investor Preferences

Since ESG investing offers both profitable actual returns and non-pecuniary benefits, there is an increasing trend in investor preference for ESG. Pástor et al. (2023) explore how U.S. financial institutions now tilt their portfolios towards greener stocks. Using data from 13F filings, they find

that many smaller, actively managed funds start to prioritise stocks with strong ESG credentials, favouring those with lower volatility. Similarly, Starks et al. (2017) show that long-term institutional investors favour firms with robust ESG performance and adjust their portfolios in response to new ESG information. They use U.S. stock data and employ portfolio turnover ratios to investigate investment behaviours, showing a clear preference for ESG-strong firms among long-term investors. Additionally, Choi et al. (2020) observe that retail investors often sell stocks of high-emission companies during unusually warm weather, further evidencing a reactive investment pattern aligned with ESG principles. These papers touch on elements of SRI, next, we review this topic.

IV.2.3. Sustainable Responsible Investments

Since the launch of the United Nations Principles for Responsible Investment (PRI) in 2006, Socially Responsible Investing (SRI) grows exponentially. According to a 2016 report from the U.S. SIF[14] Foundation, 20% of the professionally managed assets in the USA follow SRI principles (Cao et al. 2023).

The role of SRI

Ilhan et al. (2023) examine the impact of SRI principles on corporate climate risk disclosures. By analyzing data from institutional investors in France, Switzerland, and the USA, they show that SRI significantly promotes greater transparency about climate risks. Likewise, Stroebel and Wurgler (2021) highlights the role of SRI in exerting pressure to mitigate corporate climate risks. Their survey of finance professionals reveals that such pressure from SRI is considered the most influential financial mechanism driving firms towards more robust climate risk management practices. Furthermore, Hwang et al. (2022) investigates the impact of SRI and NSRI on CSR activities and stock returns. Their research reveals that increased holdings by SRI investors generally associated with improvements in future CSR scores of firms. These findings underscore the pivotal role that

[14] United States Forum for Sustainable and Responsible Investment.

SRI plays not only in promoting transparency but also in shaping corporate behaviours towards environmental sustainability.

SRI and Stock market performance

Cao et al. (2023) analyse how SRI institutional investors respond to quantitative mispricing signals such as SUEs of a stock. They discover that institutions adhering to SRI principles are less responsive to these mispricing signals compared to non-SRI institutions in the U.S. market, since SRI investors often prioritize long-term ESG investments over short-term market mispricing arbitrage opportunities (Starks et al. 2017). As SRI investors prioritize non-pecuniary benefits associated with ESG investing, this behaviour suggests a shift in traditional stock return patterns due to the rise of ESG investing and indicates that SRI behaviour affects pricing efficiency in the stock market. Furthermore, they find that stocks more heavily held by SR institutions exhibit larger abnormal returns associated with these mispricing signals.

In their methodology, Cao et al. (2023) classify institutions into two groups based on their Institutional Social Responsibility Score by calculating value-weighted ESG scores from the MSCI KLD database, using tertiles. Institutions in the top third are designated as SRIs, while the rest are classified as NSRI. In contrast, Hwang et al. (2022) classify institutions into three groups (SRI, MID-SRI, NSRI) using a similar method.

IV.3. Hypothesis Development

Governmental efforts actively promote ESG initiatives, profoundly influencing investor beliefs and strategies regarding climate change risks (Choi et al. 2020). Favourable ESG ratings act as safeguards against risks associated with climate change and economic transitions, driving substantial capital flows into ESG-focused investments (Cornell 2021; Pedersen et al. 2021). These investments not only enhance investor satisfaction and societal approval but also provide non-monetary benefits (Pástor et al. 2021; Avramov et al. 2022; Pástor et al. 2023). While studies Starks et al. (2017) and Cao et al. (2023) show that SRIs in the U.S. prefer long-term holdings in

high ESG stocks and typically do not react to mispricing signals (SUE) for short-term arbitrage profits—leading to abnormal returns for high ESG stocks—the situation in the Chinese market is notably different. Because China, in comparison to the United States, is an emerging market (Allen et al. 2005; Allen et al. 2024) characterized by a speculative investment environment (Pan et al. 2016) and relatively immature investors, it has a lower priority for ESG investments.

Thus, we propose our first hypothesis (H1):

> *H1: In the Chinese stock market, both SR and NSR investors react to mispricing signals; however, SR investors show a lower magnitude of response than NSR investors, leading to abnormal returns for high ESG stocks.*

Although high ESG ratings can sometimes be undervalued (Hong and Kacperczyk 2009; Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2021; Bolton and Kacperczyk 2023b), stocks strongly supported by socially responsible investors tend to achieve better long-term performance once their true value is recognized (Krueger et al. 2020; Pástor et al. 2021). Avramov et al. (2022) further show that rating uncertainty can diminish returns, suggesting that reducing uncertainty via stable, ESG-focused ownership boosts performance. Unlike annual ESG scores, ISRC offers a more granular and timely metric of a stock's socially responsible investor base, thus mitigating uncertainty about the firm's ESG commitment (Cao et al. 2023). Consequently, we expect:

> *H2: Firms with higher ISRC exhibit higher future stock market returns.*

Next, the 2015 Paris Agreement marks a significant shift in global investor sentiment, with heightened regulatory focus and public pressure driving greater attention to climate change mitigation and ESG practices (Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2021; Bolton and Kacperczyk 2023b). This global policy commitment strengthens the integration of sustainability factors into investment decisions, leading to a market environment that increasingly rewards

firms demonstrating credible ESG efforts. Thus, following the Paris Agreement, firms with higher ISRC—representing stronger credible ESG commitment—should command greater valuation premiums and attract more stable investment flows, amplifying their stock return advantages. Therefore, we expect:

> *H3: Following the 2015 Paris Agreement, the positive effect of ISRC on stock market returns strengthens due to heightened investor emphasis on credible ESG practices.*

Firms attracting socially responsible investors typically face greater scrutiny of their environmental, social, and governance practices, motivating them to improve ESG performance and reputation (Stroebel and Wurgler 2021; Ilhan et al. 2023). This dynamic not only reinforces ethical and sustainable governance but also draws additional capital from investors who seek strong ESG profiles (Anderson and Robinson 2019; Pedersen et al. 2021). We label this mechanism the **ESG Demand Channel**, as higher ISRC reflects concentrated SR investment that fuels demand for ESG-oriented stocks. Consequently, the capital inflows spurred by this demand often boost firm valuation and future returns.

> *H4a: Firms with higher ISRC achieve higher future ESG performance.*
>
> *H4b: Firms with higher ISRC experience an enhanced future reputation.*
>
> *H4c: Firms with higher ISRC attract greater capital inflows from investors, leading to higher future returns.*

Meanwhile, SRIs often hold stocks for longer durations, focusing on sustainable returns over short-term mispricing (Starks et al. 2017; Cao et al. 2023). Hence, high ISRC is associated with longer investment horizons and reduced trading activity. Furthermore, robust ESG performance is shown to lower crash risk by reducing informational asymmetry and enhancing transparency (Kim et al. 2014). We term these combined effects the **Market Stability Channel**: stable long-term ownership structures, reduced volatility, and lower tail risk jointly facilitate stronger risk-adjusted returns over time.

H5a: Firms with higher ISRC exhibit longer investment horizons and lower turnover rates/trading amounts.

H5b: Firms with higher ISRC face lower crash risk and selling pressure, strengthening their long-term returns.

IV.4. Research Methodology

IV.4.1. Key Measurement — Institutional Social Responsibility Concentration

In this section, we introduce our key measurement, the *Institutional Social Responsibility Concentration* (ISRC), which extends the notion of a fund-level ESG preference (i.e., ISRS) to the stock level. This two-stage aggregation provides a more granular view of how institutional investors' social responsibility orientations translate into ownership patterns for individual stocks.

Mutual Fund Level: ISRS

Following Hwang et al. (2022) and Cao et al. (2023), we first construct a fund-level measure of ESG orientation, referred to as the *Institutional Social Responsibility Score* (ISRS). This score reflects how socially responsible (or ESG-focused) a fund is, based on the ESG characteristics of the stocks it holds.

Step 1: Size-Adjusted ESG Scores

Firms often have higher raw ESG scores simply because they are larger. To mitigate this bias, we adjust each firm's ESG score for size deciles. Specifically, we define

$$ESG_{j,t}^{\text{adj}} = ESG_{j,t} - ESG_{\text{ave(decile)},t}, \tag{IV.1}$$

where $ESG_{j,t}$ is the raw ESG score of firm j at time t, and $ESG_{\text{ave(decile)},t}$ is the average ESG score of all firms in the same size decile as firm j.[15]

[15] We divide the market into 10 deciles each year based on firms' market capitalizations. A negative $ESG_{j,t}^{\text{adj}}$ indicates that firm j's ESG performance is below the average within its size decile.

Step 2: Fund-Level ISRS

Next, we aggregate these size-adjusted ESG scores across each fund's holdings. Let $w_{i,j,t}$ denote the portfolio weight of firm j in fund i's portfolio at quarter t.[16] Since ESG scores are typically disclosed with a time lag, we use the most recent available annual ESG data from the previous year (denoted as $t-1$ year) to construct:

$$ISRS_{i,t} = \sum_{j} \left(w_{i,j,t} \times ESG^{\text{adj}}_{j,t-1\text{year}} \right), \tag{IV.2}$$

a larger $ISRS_{i,t}$ signifies that fund i allocates a higher proportion of its portfolio to stocks with better (size-adjusted) ESG performance, indicating a stronger ESG (or socially responsible) orientation.

Following Cao et al. (2023), we sort all funds each quarter by their ISRS scores. Any fund with an $ISRS_{i,t}$ above the first-tertile threshold is classified as a *Socially Responsible (SR) fund*, while those at or below the first-tertile cut-off are classified as *Non-Socially Responsible (NSR) funds*. Formally,

$$Investor\text{-}category_{i,t} = \begin{cases} \text{SR Fund}, & \text{if } ISRS_{i,t} > \text{Tertile}_1\left(ISRS_{i,t}\right), \\ \text{NSR Fund}, & \text{otherwise.} \end{cases} \tag{IV.3}$$

Stock Level: ISRC

while $ISRS_{i,t}$ captures a fund-level ESG tilt, our main interest is how these ESG-oriented funds collectively shape a particular stock's ownership. Hence, we construct a stock-level indicator *ISRC* by "mapping" ISRS scores to each stock via the fund's ownership proportions. Specifically, we define

$$ISRC_{j,t} = \sum_{i} \left(\text{ISRS}_{i,t} \times w_{i,j,t} \right), \tag{IV.4}$$

where $w_{i,j,t}$ denotes fund i's ownership weight in stock j at time t. If a stock j is primarily held by funds with high $ISRS_{i,t}$ (i.e., SR funds), then $ISRC_{j,t}$ will be high, indicating that socially

[16] Portfolio weights are computed as the fraction of the fund's total equity holdings invested in firm j.

responsible investors collectively own a large fraction of that stock. Conversely, if a stock is mainly held by NSR funds (i.e., funds with low or negative ISRS values), its ISRC will be low (or potentially negative).

A higher ISRC indicates that a significant proportion of a stock's institutional investors prioritize social responsibility. Such stocks are therefore more likely to attract additional investment from funds committed to ethical and sustainable practices. Unlike a mere fund-level measure, ISRC offers two advantages. First, it provides *granularity*, directly capturing which stocks are favoured by ESG-oriented funds, rather than focusing solely on the average ESG tilt of the funds themselves. Second, it reflects *market dynamics*, highlighting the collective, real-money votes of ESG-oriented investors on a per-stock basis, rather than relying only on firm-disclosed ESG data or on aggregated fund preferences. By transforming the concentration of ESG commitment from the fund level to the stock level, ISRC offers a more granular insight into the actual ESG orientation of the investor base and helps to reveal how institutional commitment to ESG principles may influence a stock's market performance and future ESG outcomes.

IV.4.2. Other Variable Measurements

This subsection outlines additional key variables used in our analysis. Detailed calculation methodologies and equations for these variables are provided in Appendix B.

Standardized Unexpected Earnings (SUE) SUE serves as a proxy for mispricing signals in the stock market. It measures the deviation of a firm's earnings from market expectations. A higher SUE value suggests potential undervaluation, while a lower SUE indicates possible overvaluation.

Investment Horizon Investment horizon reflects the duration stocks are held by investors, derived as the reciprocal of the Churn Ratio. It serves as an indicator of long-term investment strategies, where higher values indicate longer holding periods.

Stock Price Crash Risks This variable captures the probability of extreme negative stock returns within a year. It is defined based on a threshold approach using weekly adjusted returns to identify

significant downside deviations.

Selling Pressure Selling pressure measures market sentiment by quantifying net selling activities on a stock by mutual funds during periods of significant inflows or outflows. It includes two components: (1) selling pressure based on fund flows, and (2) net outflow scope.

Firm Reputation We calculate firm reputation by employing factor analysis on twelve selected reputation evaluation indicators, encompassing four distinct perspectives: consumer and societal, creditor, shareholder, and corporate. This method allows us to generate a composite reputation score for each firm. Based on these scores, firms are categorized into ten distinct groups. Each group is assigned a reputation value ranging from 1 (lowest) to 10 (highest).

IV.4.3. ISRC Predictive Power Testing Designs

Variable Definitions

We examine the predictive power of ISRC on corporate performance and market indicators using regression analysis. These indicators include firms' annual ESG performance, quarterly stock returns, turnover rates, trading volume, crash risks, investment horizons, and selling pressure. ISRC reflects institutional commitment to social responsibility, influencing investor confidence, volatility, and corporate ESG performance.

To control for potential endogeneity, we include current ESG performance ($year+0$) and aggregated institutional ownership (Inv holding)[17]. Additional controls are firm leverage (LEV), price-to-earnings ratio (PE), earnings before interest and taxes (EBIT), firm age (Age), revenue growth rate (Growth), and market capitalization (SIZE). These variables help isolate ISRC's effect by addressing factors affecting returns, liquidity, and stability (see Table IV.1).

Regression Design

We employ the following regression model, presented in $Eq.$ (*IV*.5), to examine the predictive power of the ISRC on various firm-level performance indicators.

[17] Includes shares held by institutional investors such as pension and social security funds.

$$Y_{j,t+1} = \alpha + \beta ISRC_{j,t} + \gamma^{\top} \mathbf{X}'_{j,t} + \varepsilon_{j,t}, \tag{IV.5}$$

where $Y_{j,t+1}$ denotes the dependent variables measured in the subsequent period, including annual ESG performance, firm reputation, and stock price crash risk; as well as quarterly stock market returns, turnover rates, investment horizon, semi-annual selling pressure, and fund inflow. The variable $ISRC_{j,t}$ represents the standardized ISRC score for stock j at time t. The term $\gamma^{\top} \mathbf{X}'_{j,t}$ denotes the vector of coefficients associated with the control variables $\mathbf{X}'_{j,t}$, which are measured at time t. We include both industry and year fixed effects to control for unobserved heterogeneity across sectors and time. Standard errors are clustered at the firm level to account for potential within-firm correlation of residuals. To reduce the influence of outliers, all continuous control variables are winsorized at the 1% and 99% levels.

To further explore whether the predictive relationship of ISRC metrics changed after the Paris Climate Agreement in 2015, we estimate the following extended model, shown in *Eq.* (*IV*.6):

$$Y_{j,t+1} = \alpha + \beta ISRC_{j,t} + \theta ISRC_{j,t} \times Paris_t + \gamma^{\top} \mathbf{X}'_{j,t} + \varepsilon_{j,t}, \tag{IV.6}$$

where $Paris_t$ is a time dummy variable equal to 1 for years 2015 and later, and 0 otherwise.

IV.5. Data Descriptions

In this section, we provide detailed information about our data sources and describe the variables used in our analyses.

IV.5.1. Data Sources and Sample Selection

Our data are sourced from two primary databases. Fund-relevant data, as well as stock-level data such as stock return rates, stock turnover rates, stock trading amounts, and other firm characteristics for control variables are obtained from the China Stock Market and Accounting Research Database (CSMAR). Our ESG data are sourced from the Sino Securities Index Company (SSI).

Our target stocks are listed on China's A-shares markets (Shanghai and Shenzhen stock exchanges). We exclude firms that have been delisted during the sample period, as indicated by the 'ST' marker. After merging the ESG scores with fund and stock-level data, our final sample spans the period from 2010Q1 to 2023Q4, covering a total of 56 quarters, and includes 4,032 firms listed on China's stock markets. As of the end of the 2023Q4, there are $3,086$ classified as SR funds and $5,438$ as NSR funds.

IV.5.2. Data Summary Statistics

Stock Level

Panel A of Table IV.2 provides the summary statistics for our stock level data. The ISRC has a mean value of 0.118, indicating a generally low concentration of institutional social responsibility across the firms in our sample. This suggests a more diversified investment strategy among investors, with ISRC values ranging widely from -0.865 to 2.017.

The average raw ESG score is relatively high at 73.584, with a standard deviation of 4.280, suggesting modest variability around this high mean. This reflects generally good ESG practices among the observed firms, with scores ranging from 44.200 to 92.380. Stock Return Rates average at a mere 0.021%, reflecting the subdued market returns during the observed period, and vary widely from -0.266% to 0.467%, indicating periods of market loss and gain. The Stock Turnover Rate, with an average of 45.589%, underscores a moderate trading frequency in the market, peaking at an exceptionally high 205.141%, which points to specific instances of high trading activity. The mean Trading Amount is \$2.090 billion, highlighting the substantial capital movement within the market, with some instances reaching as high as \$19.218 billion.

The Investment Horizon averages at approximately 2.577 quarters, suggesting a medium-term investment strategy among market participants. Selling Pressure and Net Outflow Scope, with average values of -3.300% and -10.481 respectively, generally indicate a market tendency towards buying rather than selling, reflecting positive investor sentiment overall. This is further supported

by the low average Stock Crash Status of 0.086, showing minimal occurrences of significant price drops within the market. Finally, the average Reputation value stands at 6.022, indicating that most firms in the sample maintain a moderate reputational standing.

Fund Level

Panel B of Table IV.2 focuses on the fund-level indicators, presenting key metrics for both SR and NSR mutual funds. This panel clearly delineates differences in asset management and investment strategies between the two types of funds.

SR Mutual Funds demonstrate a more substantial capital base with an Average Assets Under Management (AUM) of $0.232 billion, compared to $0.191 billion for NSR Mutual Funds. This not only suggests a larger scale of operations but also potentially greater market influence among SR funds, consistent with the findings of Riedl and Smeets (2017), where they show that SR investors maintain larger portfolios than NSR investors. Additionally, SR funds exhibit a longer Investment Horizon of 2.839 quarters versus 2.513 quarters for NSR funds, indicative of a strategic preference for longer-term investments, which aligns with Starks et al. (2017).

The commitment of SR to social responsibility is further underscored by their higher Value-Weighted (VW) ESG score of 5.440, in contrast to 3.870 for NSR. This higher score reflects the proactive engagement of SR in promoting environmentally and socially responsible practices. Moreover, the lower VW SUE of 0.910 for SR, compared to 1.130 for NSR, suggests more stable or predictable earnings, reinforcing the notion that SR may prioritize sustainability and long-term stability over unexpected short-term arbitrage gains, also aligns with Cao et al. (2023).

Market activity metrics reveal that SR are less actively trading with lower VW Return Rates at 0.010%, VW Turnover Rates at 10.56%, and VW Trading Amounts of $15.130 billion, compared to NSR which report more active trading with return rates of 0.030%, turnover rates of 14.16%, and trading amounts of $18.130 billion. The significantly lower number of Stock Price Crashes for SR, at $79,058$ compared to $162,097$ for NSR, underscores the potentially lower risk profile

and better risk management practices inherent in the investment strategies of SR. Interestingly, SR's conservative trading approach results in a less negative Selling Pressure, with values such as -0.949 compared to -2.266 for NSR. This indicates that despite engaging in less frequent trading, the investments of SR are met with stronger market acceptance and a lower inclination to sell. This reflects a positive market sentiment towards their sustainable investment approach, suggesting that their conservative strategy effectively enhances market confidence and stability in their investments. This indicates that adopting socially responsible investment principles not only contributes to market stability but also garners positive investor response, highlighting the effectiveness of sustainable investing practices in maintaining investor confidence and market stability.

Overall, we show that, compared to NSR, SR maintain larger AUMs, demonstrate longer investment horizons, have significantly fewer stock price crash likelihoods, and show a higher commitment to sustainability through their superior ESG scores. However, they experience lower investment returns, trade less actively, reflecting a more conservative yet stable investment approach.

Summary

Overall, at the stock level, the data reveal a generally low concentration of institutional social responsibility, suggesting a diversified investment strategy, coupled with moderate market returns and trading frequencies. The consistently high ESG scores indicate robust corporate responsibility practices among firms. At the fund level, the differences between SR and NSR Mutual Funds are pronounced. SR funds display higher Average AUM, longer investment horizons, and superior ESG scores, signalling a strong commitment to sustainable investing.

Additionally, the selling pressure analysis shows that SR funds experience less negative selling pressure compared to NSR funds, suggesting that the market reacts more favourably towards stocks held by SR funds, reflecting a positive sentiment and reduced propensity to sell. This might be attributed to the market's trust in the stability and ethical standards of SR investments. Furthermore, SR funds demonstrate lower market activity and fewer stock price crashes, reflecting a

more conservative investment approach and potentially more effective risk management strategies. These findings emphasise the significant impact of social responsibility on investment behaviours and market outcomes, highlighting the potential advantages of adopting sustainable investment practices, where a more cautious trading approach combined with a positive market reception can lead to enhanced stability and investor confidence.

IV.6. Empirical Results and Discussions

IV.6.1. Revised Cao et al. (2023) Findings: Validating the Effectiveness of ISRC

SR and NSR Funds' Reactions to Mispricing Signals

Following Cao et al. (2023), first, we investigate how SR and NSR funds react to quantitative mispricing signals. Specifically, at the beginning of each quarter, we categorise all stocks into quintiles based on the SUE calculated from the earnings reported in the corresponding quarter of the previous year. We then analyse the relationship between changes in institutional holdings at the end of each quarter and the SUE. We perform this analysis separately for SR and NSR funds.We measure changes in holdings as the variation in the percentage of shares held by each fund type. This approach allows us to discern whether SR and NSR funds behave differently in response to potential market mispricings indicated by SUE scores.

Panel A of Table IV.3 indicates that both SR and NSR funds in China's market respond to mispricing signals, albeit SR funds exhibit a lesser response compared to NSR funds. This partial alignment with the findings of Cao et al. (2023), which indicate that SR funds in the U.S. market do not react to mispricing, underscores that ESG-focused investment behaviours are more prioritised or emphasised in the U.S. compared to China.

We observe that NSR funds react more aggressively across all quintiles, particularly in the underpriced (P5) and overpriced (P1) segments. Specifically, NSR funds show significant adjustments in their holdings with changes of -0.18 in P1 and 0.72 in P5, reflecting their opportunistic, profit-driven strategies. This is in contrast to SR funds, which show more modest changes of -0.06

in P1 and 0.24 in P5. It also indicates that both SR and NSR funds adjust their holdings by selling overpriced (P1) stocks and buying underpriced (P5) stocks, albeit with different intensities. The differences in reactions (Diff SR-NSR), which are 0.12 in P1 and -0.48 in P5, highlight that NSR funds significantly adjust their holdings more than SR funds when facing extreme mispricing, suggesting that NSR funds in China may exploit short-term mispricing more aggressively than their SR counterparts.

Furthermore, the consistently smaller magnitude of changes among SR funds across all SUE categories supports the notion that these funds likely adhere more closely to their long-term investment strategies and ESG commitments, potentially at the expense of capitalising on short-term arbitrage opportunities. This behaviour reflects a fundamental difference in investment philosophy, where SR funds prioritize sustainability and stability over short-term gains. Notably, in the most extreme categories, the high-low spread (P5-P1) shows a differential adjustment in holdings of 0.30 for SR and 0.90 for NSR, significantly larger for NSR funds. These findings align with the literature, such as Starks et al. (2017) and Cao et al. (2023), underscoring a strategic divergence between SR and NSR funds' responses to market mispricing. SR funds' focus on long-term investment horizons and their valuation of non-pecuniary benefits further distinguish their trading behaviours, demonstrating a commitment to sustainable investment practices that extend beyond immediate financial returns.

Stock Return Patterns, ISRC, and Mispricing Signals

As discussed by Cao et al. (2023), the predictive power of mispricing signals may be enhanced when stocks are predominantly held by SR mutual funds. These funds typically exhibit a less reactive behaviour to mispricing compared to NSR mutual funds, as observed in Panel A. The underlying logic is that SR mutual funds, which often hold stocks with high ISRC, may not adjust their holdings rapidly enough to reflect the true value of their stocks. This slower response can create arbitrage opportunities, especially for investors capable of identifying these under-adjusted

prices.

To investigate this, we perform an independent double-sort (2×5) of our stock pool each month, categorising stocks into two groups based on their ISRC scores from the previous quarter and five groups based on the latest SUE scores from the prior quarter. We then calculate the value-weighted monthly abnormal returns for all portfolios. Specifically, we compute the Capital Asset Pricing Model (CAPM) alpha (Sharpe 1964), the Fama-French three-factor (FF3) alpha (Fama and French 1993), and the Carhart four-factor (Carhart-4) alpha (Carhart 1997) for each portfolio.

Panel B reports that, under the CAPM, high ISRC portfolios record alphas of -0.18 for P1 and -0.15 for P5, with a long-short spread (P5-P1) of 0.02. The FF3 model shows similar trends, with alphas of -0.20 for P1 and -0.19 for P5, and a narrower long-short spread of 0.01. The Carhart-4 model indicates alphas of -0.20 for both P1 and P5, demonstrating virtually no spread.

In contrast, low ISRC portfolios under the CAPM exhibit alphas of -0.15 for P1 and -0.14 for P5, with a long-short spread of 0.01. This pattern persists across the FF3 and Carhart-4 models, where alphas for P1 and P5 are consistently near -0.15 and -0.14, respectively, with minimal spreads.

These findings illustrate that portfolios containing stocks categorised as high ISRC consistently exhibit more negative alphas, especially notable in the stocks within the P5 (undervalued) and P1 (overvalued) quintiles. This suggests that stocks held by high ISRC portfolios are slow to adjust to market information, influenced by the stabilising investment strategies of SR funds, as they are less concerned about mispricing. Furthermore, it indicates that high ISRC stocks, associated with these mispricing signals, yield larger abnormal returns, demonstrating that ISRC impacts stock pricing efficiency and pricing patterns, which is consistent with Cao et al. (2023).

IV.6.2. Predicative Power of ISRC on Stock Market Returns

Considering the significant abnormal returns of high ISRC stocks, we examine the predictive power of ISRC as an indicator for future stock market returns, which is crucial for informing long-term

investment strategies.

Baseline Results

Panel A of Table IV.4 reports our baseline results that the predicative power of ISRC on firm's stock market returns. Overall, we show that ISRC is positively predicated future firm's stock market return.

Specifically, it indicates that one unit increase in ISRC leads to an average increase of 0.031 units in stock market return at the next quarter, significant at the 1% level. Interestingly, despite the control variable ESG showing a negative correlation with stock market returns (-0.003), significant at the 1% level, the positive association of ISRC notably illustrates its crucial role. This divergence emphasizes that ISRC, unlike traditional ESG score, specifically reflects the investor confidence and commitment to firms with strong social responsibility practices.This suggests that firms with higher levels of social responsibility concentration by institutional investors tend to achieve higher stock market returns. The positive relationship indicates that as uncertainties/disagreements associated with climate risks stabilize, firms with higher ISRC are compensated for potential regulatory and technological risks, leading to better returns for SR investing. This finding aligns with studies such as Krueger et al. (2020) and Stroebel and Wurgler (2021), which argue that the market currently underestimates climate risks.

ISRC's Predictive Power on Stock Returns under the 2015 Paris Agreement Conditions

The 2015 Paris Agreement marked a turning point in global investor beliefs about climate change (Bolton and Kacperczyk 2020; Bolton and Kacperczyk 2021; Bolton and Kacperczyk 2023b), further catalysing commitments to sustainable practices among SR investors. This subsection examines whether this external shock alters the efficacy of ISRC in forecasting stock market returns during the post-agreement period.

Panel B of Table IV.4 shows that the positive relationship between ISRC and stock market returns is predominantly observed in the periods following the 2015 Paris Agreement, whereas it

was negative prior to that period.

Specifically, Panel B indicates the coefficient of ISRC is negative at -0.027 (significant at the 1% level), indicating an adverse effect on returns pre-agreement, while the interaction term ISRC $\times$ Paris shows a significant positive coefficient of 0.072 (significant at the 1% level).

Overall, we demonstrate that the 2015 Paris Agreement serves as a critical juncture in the efficacy of ISRC metrics for forecasting stock market returns. Prior to the Agreement, higher ISRC scores correlated with lower returns, possibly reflecting a market undervaluation of socially responsible investments. After 2015, however, the positive shift in coefficients indicates that investors and markets began to recognize and reward firms with strong social responsibility commitments, likely influenced by the global emphasis on sustainability embedded in the Agreement.

This transformation underscores the Paris Agreement not merely as a political milestone but also as a catalyst for how institutional investors integrate social responsibility into their portfolios, extending the works by Bolton and Kacperczyk (2020), Bolton and Kacperczyk (2021), and Bolton and Kacperczyk (2023b). The reason these relationships manifest only in the post-Agreement period may be that before 2015, there was no unified global ESG practice or robust investment commitment, and financial markets' responses to ESG factors were neither pronounced nor coordinated. This evolution strengthens the strategic importance of refining ISRC metrics to align with global sustainability goals, offering investors a more robust framework for assessing the true value of ESG over the long term.

Robustness Check of the Predictive Power of ISRC on Stock Market Returns

i. Endogeneity Testing

Given the potential endogeneity concerns arising from unobserved factors that may simultaneously affect both ISRC and stock market returns, we implement GMM 2SLS and IV approaches to address these issues. Although lagging the explanatory variable helps alleviate concerns about reverse causality, the use of GMM 2SLS and IV techniques further mitigates

any remaining simultaneity bias. These methodologies enable us to control for industry-specific and year-specific fixed effects while clustering standard errors at the firm level.

We select the Climate Physical Risk Index (CPRI) faced by a city as our instrumental variable. CPRI satisfies relevance because local city's climate risk exposure is expected to influence investors' preferences for socially responsible holdings, thereby shaping the ISRC at the stock level; for instance, evidence shows that heightened climate risks prompt investors to allocate more capital to sustainable or low-emission assets (Choi et al. 2020; Stroebel and Wurgler 2021; Hong et al. 2020). At the same time, CPRI meets the exclusion restriction because city-level climate risk itself does not directly determine an individual firm's future returns. Rather, climate physical risk affects stock performance only indirectly by inducing shifts in investor demand toward ESG-oriented shares (Anderson and Robinson 2019; Pástor et al. 2021); absent such demand shifts, a firm located in a high-risk city would not necessarily earn higher (or lower) returns simply by virtue of local weather conditions. Consequently, CPRI's only pathway of influence on future returns is through its effect on ISRC, making it a valid IV.

Panel C of Table IV.4 presents the results from our first-stage and second-stage GMM IV model using CPRI as the instrument. The findings indicate that the results remain consistent with our baseline estimates, and the weak IV test's F-statistic (214.399) far exceeds the Stock et al. (2002) recommended threshold of 10. This consistency demonstrates that employing CPRI as an IV effectively addresses endogeneity concerns and enhances the credibility of our results.

ii. Propensity Score Matching (PSM) Technique

Panel D of Table IV.4 shows our PSM results. We split stocks into high and low ISRC groups at the ISRC's median (denoted as ISRC50), then estimate each stock's propensity score using all the control variables. Next, for each high-ISRC stock, we match it with the five low-ISRC

stocks that have the closest estimated propensity scores (i.e., using five nearest-neighbour matching). This approach ensures that the matched groups are comparable on observable characteristics, thereby mitigating sample selection bias.

Stock market returns in the matched sample are consistent with our baseline estimates, reinforcing the robustness of our findings.

Overall, our empirical findings consistently indicate that higher ISRC is strongly predictive of firms' future stock market returns (one quarter ahead), especially in the period after the 2015 Paris Agreement. The heightened global focus on sustainability during this post-Agreement era amplifies the market's recognition and valuation of socially responsible investments, giving rise to a pronounced return premium for stocks with greater ISRC. Further, our robustness checks—including GMM 2SLS and propensity score matching—demonstrate that this predictive relationship remains statistically and economically significant even after addressing endogeneity concerns and controlling for sample selection biases. These results collectively underscore the strategic relevance of ISRC for investors and policymakers seeking to incorporate ESG considerations into asset allocation and risk management decisions.

In the subsequent section, we delve into the mechanisms through which ISRC influences stock market returns, examining the underlying channels that may drive this observed positive relationship.

IV.7. The Channels and Theoretical Mechanisms Linking ISRC to Stock Market Returns

This section examines how ISRC affects stock market returns through two empirical channels and their underlying theoretical explanations. The first part analyses the ESG Demand Channel and the Market Stability Channel, which describe the observable mechanisms through which socially responsible investment behaviour influences firm valuation and market performance. Because investors increasingly consider sustainability in their portfolio decisions, these channels represent the

primary pathways by which ISRC shapes both corporate behaviour and financial outcomes. The ESG Demand Channel illustrates how socially responsible investors elevate the valuations of firms with credible ESG commitments, while the Market Stability Channel shows how ESG-oriented ownership improves transparency, reduces information asymmetry, and promotes long-term market stability. Building on the evidence from these two channels, the following section develops several theoretical perspectives that clarify why higher ISRC predicts higher future returns.

IV.7.1. ESG Demand Channel

First, we use annual ESG performance, annual reputation, and semi-annual funds' net inflow scope to proxy the ESG demand channel.

Panel A of Table IV.5 reports the relationships between ISRC on ESG demand channel's metrics. Overall, we show that ISRC is positively predicated on future firm's ESG score, firm's reputation, and funds' net inflow scope.

Specifically, column (1) indicates that a one-unit increase in ISRC leads to an average increase of 0.023 units in ESG performance in the following year, significant at the 1% level. This suggests that firms with higher levels of investor focus on social responsibility tend to enhance their ESG practices over time. Our finding extends the work of Anderson and Robinson (2019), Choi et al. (2020), Pedersen et al. (2021), and Pástor et al. (2021), underscoring that investor preferences and beliefs can profoundly influence firm behaviour, driving improvements in ESG performance. Firms are motivated to improve their ESG standards to meet SR investor expectations, creating a cycle where SRI further strengthens compliance with sustainability and ethical governance, continuously enhancing their operational and strategic measures.

Moreover, such commitments also bolster a firm's reputation. As shown in column (2), a one-unit increase in ISRC is associated with an average increase of 0.117 units in the firm's reputation in the following year, significant at the 1% level. This finding highlights that alongside improving ESG practices, firms actively enhance their reputation to align with the expectations

of SR investors. This creates a mutually reinforcing dynamic, as firms gain reputational benefits by meeting SRI priorities, while investors reward firms that demonstrate genuine social responsibility and governance, fostering long-term alignment between firms and their socially responsible investor base.

Likewise, column (3) shows that a one-unit increase in ISRC is associated with an average rise of 0.052 units in the number of investing funds experiencing inflows in the following quarter, significant at the 1% level. This pattern suggests that investors are increasingly willing to allocate capital to stocks with a strong social responsibility orientation, reflecting a growing demand for ESG-aligned investments. As more funds flow into high-ISRC firms and fewer outflows occur, these stocks benefit from a more stable and predictable market environment, ultimately fostering a healthier financial ecosystem for all stakeholders.

Overall, these findings highlight how the ESG Demand Channel operates: higher ISRC drives tangible improvements in ESG performance and corporate reputation, which in turn attract more capital from socially responsible investors. This creates a reinforcing cycle where strong ESG signals meet rising investor demand, ultimately contributing to a more stable and sustainable financial ecosystem.

IV.7.2. Market Stability Channel

Next, we use annual stock turnover rate, annual stock trading amount, and the likelihood of a future annual stock price crash, quarterly investment horizon, and selling pressure caused by funds to proxy the market stability channel.

Since SR investors prioritize long-term returns and sustainable development over short-term mispricing, they often hold their investments for longer periods. This enduring approach tends to stabilize the market. Their tendency to be less reactive to short-term market fluctuations results in reduced volatility and trading volumes. Therefore, a higher concentration of ESG investors typically leads to increased future stability of a stock, as their investment behaviour supports a

steadier and more predictable market environment.

Panel B reports the relationships between ISRC on market stability's metrics. Overall, we show that ISRC is negatively predicated on stock's turnover rates, trading amounts, the likelihood of stock price crashes, and selling pressure exerted by funds, while it is positively predicated on investment horizons.

Column (1) indicates that a one-unit increase in ISRC corresponds to an average increase of 0.012 units in the investment horizon in the following quarter, significant at the 1% level. This indicates that firms with higher ISRC scores, which are favoured by funds with high social responsibility scores, tend to have longer investment holding periods. This behaviour aligns with the strategies of SR investors who focus on long-term ESG performance and non-pecuniary benefits rather than short-term market mispricing arbitrage opportunities.

This finding aligns with the research by Starks et al. (2017), which shows that long-term institutional investors prefer firms with solid ESG performance. The extended investment horizons associated with high ISRC scores suggest that these firms are viewed as more stable and sustainable investments. Furthermore, the commitment of SR investors to these firms likely initiates a virtuous cycle, promoting continuous improvements in ESG standards that, in turn, attract further SR investments. This cycle not only bolsters the firms' stability and sustainability but also shields them from the market's short-term volatility, particularly the speculative trading that impacts firms with weaker ESG commitments.

Column (2) indicates that a one-unit increase in ISRC corresponds to an average decrease of 0.019 units in the turnover rate in the following quarter, significant at the 1% level. Similarly, column (3) shows that a one-unit increase in ISRC corresponds to an average decrease of 0.011 units in the trading amount, also at the 1% level. These findings are consistent with Starks et al. (2017), who suggest that lower turnover rates can serve as a proxy for identifying long-term institutional investors' preference for companies with strong ESG performance. Such observations also align with Chae (2005), who find that trading amount is negatively correlated with information

asymmetry. In our story, the decline in trading amount induced by higher ISRC suggests reduced disagreement or uncertainty regarding ESG attributes, enhancing consensus among investors and contributing to a more stable market environment. Moreover, since SR investors are generally less sensitive to mispricing signals and prefer long-term investments, they contribute further to reduced turnover rates and trading amounts.

One might question whether the observed reduction in trading volume associated with high ISRC scores is beneficial: does it decrease liquidity or does it actually reduce risk? To address this concern, we next utilize two specific indicators: stock price crash probability and selling pressure exerted by funds to test whether the presence of high ISRC indeed lowers market risk. We show that that ISRC is negatively correlated with future stock price crash probability and selling pressure exerted by funds.

Column (4) indicates that a one-unit increase in ISRC corresponds to an average decrease of 0.025 units in the stock price crash probability in the following quarter, significant at the 5% level. This suggests that firms with higher levels of social responsibility concentration among their institutional investors experience a lower risk of stock price crashes. This finding extends the work of Kim et al. (2014), who show that strong ESG performance reduces crash risk by enhancing transparency and reducing informational asymmetry. We show that the presence of ESG-focused investors in a firm's shareholder base contributes to more stable stock prices and suggests that ISRC is a significant predictor of reduced stock price crash risk. Column (5) indicates that a one-unit increase in ISRC corresponds to an average decrease of 0.092 units in the selling pressure exerted by funds in the following quarter, significant at the 1% level.

This suggests that firms with a higher ISRC experience significantly less selling pressure and fewer investor withdrawals, underscoring the confidence that socially responsible investors place in these firms. This commitment helps maintain investments during periods of potential market volatility, stabilizes the stock, and enhances its attractiveness to long-term investors who prioritize stability and responsible governance. Furthermore, the observed increase in the number of funds

experiencing inflow for high-ISRC stocks likely contributes to a more stable and predictable market environment for these firms, thereby supporting a healthier financial ecosystem for all stakeholders involved. The relationship between high ISRC and reduced selling pressure and outflows highlights the protective effect socially responsible investments have against market downturns, demonstrating that ethical investment strategies are beneficial not only for societal and environmental outcomes but also for financial resilience.

Moreover, such market stability can translate into higher long-run returns for two primary reasons. First, when a stock exhibits less crash risk and sustained shareholding by long-term investors, its perceived overall risk profile diminishes. Investors thus demand a lower risk premium, allowing for higher valuations and stronger realized returns over time (Pástor et al. 2021). Second, with fewer short-term trading pressures, the firm can focus on long-horizon projects and sustainable business strategies, rather than constantly catering to transient market sentiments. As a result, the firm's consistent growth prospects and improved stakeholder relationships eventually reflect in share price appreciation, further reinforcing the positive link between ISRC and future stock returns.

Overall, these findings indicate that firms with higher ISRC, strongly supported by socially responsible investors, exhibit significantly longer investment horizons, lower turnover rates, and reduced trading amounts, alongside decreased stock price crash risk, selling pressure and increase fund inflow. This stability stems from the long-term ESG commitment and resilience that SR investors bring, effectively insulating these firms from speculative trading and market downturns. In essence, a higher ISRC serves as a robust predictor of enhanced market stability and financial resilience.

IV.7.3. Mechanisms Summary

To sum up, we present two key mechanisms by which ISRC shapes stock market returns. Through the ESG Demand Channel, we show that higher ISRC drives improvements in ESG performance

and corporate reputation, which in turn attract greater capital inflows and foster a more supportive market environment. This virtuous cycle reflects growing investor enthusiasm for sustainability and their willingness to reward firms that exhibit genuine social responsibility.

Meanwhile, the Market Stability Channel reveals that higher ISRC is associated with extended investment horizons, diminished turnover rates, and lower trading volumes. Moreover, firms with higher ISRC face reduced selling pressure, and display a lower risk of stock price crashes. By reinforcing transparency and enhancing the long-term commitment of socially responsible investors, ISRC promotes market stability, reduces vulnerability to speculative trading, and ultimately contributes to stronger long-term stock returns.

IV.7.4. Why SR Concentration Should Predict Stock Market Returns?

Building on the previous analysis, this section explains why higher ISRC predicts higher future returns. The effect of ISRC on stock performance operates through two main channels, the ESG Demand Channel and the Market Stability Channel. These channels can be understood through several theoretical perspectives, including signalling, information asymmetry reduction, investor clientele stability, agency improvement, risk hedging, and social norm effects. Together, these perspectives describe the behavioural and informational mechanisms through which SR concentration enhances firm value and future returns.

Signalling: A high ISRC sends a credible signal of a firm's authentic ESG commitment because it reflects the revealed preferences of informed and socially responsible institutional investors rather than firm self disclosure. This credible signal attracts additional investor demand and strengthens the firm's reputation, directly corresponding to the ESG Demand Channel. Concentrated SR ownership mitigates concerns about greenwashing and reassures other investors about the authenticity of ESG engagement, which increases investor confidence, lowers perceived risk, and reduces the cost of capital (Lins et al. 2017; Pedersen et al. 2021). As a result, firms with higher ISRC enjoy a valuation premium and superior expected returns due to enhanced investor trust and lower financ-

ing costs.

Information Asymmetry: Socially responsible investors promote higher transparency and stronger governance practices (Kim et al. 2014; Ilhan et al. 2023). Their continuous engagement and monitoring reduce informational opacity, stock price crash risk, and volatility. This interpretation aligns with the Market Stability Channel because improved information quality and lower uncertainty stabilise stock prices and enhance market efficiency. Consequently, firms with higher ISRC experience smoother price discovery, lower risk premia, and ultimately higher risk adjusted returns.

Clientele: ISRC also reflects the composition of a firm's investor clientele. Following Starks et al. (2017) and Cao et al. (2023), socially responsible investors have longer investment horizons and derive non pecuniary satisfaction from holding ESG aligned firms. This stable investor base reduces turnover and selling pressure, providing an additional micro foundation for the Market Stability Channel. By maintaining steady demand during market fluctuations, these investors reduce volatility and help sustain higher long term returns (Pástor et al. 2021; Avramov et al. 2022). Therefore, higher ISRC contributes to superior returns by ensuring a more patient and less procyclical investor base that supports price resilience.

Agency and Governance: SR-oriented institutional investors also act as active monitors who improve governance quality and discipline managerial behaviour. By reducing agency conflicts and promoting long-term decision-making, concentrated SR ownership enhances firm efficiency and risk management, reinforcing the Market Stability Channel through better oversight and governance outcomes (Ferreira and Matos 2008; Dyck et al. 2019; Ilhan et al. 2023). Improved governance reduces wasteful investment, enhances profitability, and thereby leads to higher long-term shareholder returns.

Risk Hedging: High ISRC may also capture a collective preference for hedging non-financial risks. SR investors tend to avoid firms with high exposure to environmental or reputational tail risks and allocate capital to firms that provide downside protection during crises (Lins et al. 2017;

Pástor et al. 2021). This behaviour links to both the ESG Demand and Market Stability Channels by lowering systematic risk exposure and improving the risk-return trade-off. Consequently, high ISRC portfolios exhibit superior performance through reduced downside risk and more stable long-term payoffs.

Social Norms and Value Alignment: SR concentration reflects social and ethical preferences in investment behaviour. Investors derive utility from aligning their portfolios with socially desirable or environmentally responsible firms (Bénabou and Tirole 2010; Riedl and Smeets 2017). Such value-driven demand contributes to the ESG Demand Channel by sustaining valuation premia for responsible firms and strengthening long-term investor commitment. This persistent demand elevates valuations and supports higher long-run returns for firms that align with prevailing social and ethical norms.

Overall, higher ISRC predicts superior stock performance because these two channels jointly operate through multiple behavioural, informational, and normative mechanisms. ISRC reflects investors' revealed ESG preferences and embodies the signalling credibility, information transparency, investor stability, governance quality, risk management, and social value alignment through which responsible ownership translates into sustained financial value.

IV.8. Additional Tests

IV.8.1. Long Term Effect of ISRC on Various Metrics

First, to assess the predictive power of ISRC on various metrics and their sustainability over time, we extend our analysis by lagging all dependent variables by an additional three periods to test for long-term effects.

Figure IV.1 presents that ISRC effectively predicts long-term outcomes for ESG scores, investment horizons, stock price crash probability, stock selling pressures exerted by mutual funds, and the number of funds experiencing inflows. These effects are significant and persist without reversal across the future four periods. Conversely, the impacts of ISRC on stock market returns, stock

market turnover rates, and trading amounts appear to be short-term, lacking consistent effects over the extended periods.

These findings demonstrate that while ISRC effectively forecasts long-term sustainability and market stability, its impact on short-term stock market metrics like stock returns and stock trading amounts is less pronounced. This suggests that ISRC-aligned investments are geared more towards long-term value creation than immediate speculative returns. Such a focus is in line with literature that underscores the long-term benefits of robust ESG practices, such as Kim et al. (2014), Starks et al. (2017), Avramov et al. (2022), among others. The significant role of ISRC in enhancing corporate resilience—by reducing stock price volatility and increasing mutual fund inflows—supports its utility in creating a more stable market, especially valuable during financial uncertainties.

These insights are valuable for portfolio managers and institutional investors integrating ESG factors into risk management strategies, aiding in informed asset allocation and stock selection. Overall, ISRC's limited influence on short-term market fluctuations contrasts with its crucial role in promoting long-term financial stability and sustainability. Investors and policymakers should consider these aspects when leveraging ESG factors for strategic decision-making.

Overall, evidence suggests that a higher ISRC not only predicts enhanced ESG and financial performance but also bolsters market stability. Firms with high ISRC scores, strongly supported by SR investors, exhibit improved ESG practices, higher stock market returns, and reduced trading turnovers and amounts. Moreover, these firms benefit from reduced market risks such as lower stock price crash probabilities, decreased selling pressures and increased fund inflows, illustrating the stabilizing role of SRI.

Importantly, our long-term effect analysis demonstrates that ISRC's predictive power extends well beyond immediate financial metrics, effectively forecasting sustainability and market stability over extended periods. This enduring influence is particularly significant in fostering a market environment that is less prone to sudden fluctuations and speculative pressures. The behaviour of SR investors, who prioritize long-term investments over short-term gains, further supports a market

atmosphere conducive to sustainable growth.

These findings robustly argue for the benefits of adopting SRI strategies that not only foster corporate sustainability but also safeguard investments against market downturns and instabilities. By promoting less speculative trading and enhancing overall market predictability, high ISRC scores contribute to creating a more resilient financial ecosystem, benefiting both investors and the broader financial community in a long path.

IV.8.2. ISRC's Predictive Power Across Different Sectors

Table IV.6 reports the regression results examining the predictive power of ISRC on future metrics across various sectors. Overall, the findings reveal distinct cross-sector differences in ISRC's predictive capacity.

In the **Utilities** sector (Column 1), ISRC exhibits significantly positive coefficients for future ESG performance, stock returns, and investment horizon, with values of 0.036, 0.023, and 0.018 (all significant at the 1% level), respectively. ISRC also shows a negative relationship with crash risk (coefficient of -0.006, significant at the 5% level) and selling pressure (-0.108, significant at the 1% level). Moreover, the coefficients for reputation and inflow are 0.242 (10% level) and 0.061 (1% level), respectively, indicating that higher ISRC corresponds to improved corporate reputation and greater capital inflows in the Utilities sector.

In the **Business** sector (Column 2), ISRC is positively related to future stock returns (0.026, 1% level), investment horizon (0.014, 1% level), and inflow (0.049, 1% level), while it exhibits a negative association with crash risk (-0.006, 10% level) and selling pressure (-0.065, 1% level). Reputation also increases in response to ISRC (coefficient of 0.298, 10% level). These results suggest that in the Business sector, high ISRC fosters stronger financial performance, higher reputation, and reduced market risks.

In the **Industrial** sector (Column 3), the results are particularly comprehensive. ISRC significantly and positively predicts future ESG performance (0.019, 1% level), stock returns (0.037, 1%

level), and investment horizon (0.011, 1% level), and it is significantly negatively correlated with turnover and trading amount (both at 1% level) as well as crash risk (-0.003, 5% level). Selling pressure also decreases significantly (-0.094, 1% level). Additionally, the coefficients for reputation and inflow are positive and significant, implying that higher ISRC in the Industrial sector not only enhances both ESG and financial performance but also bolsters market stability.

In contrast, the **Real Estate** sector (Column 4) only shows statistical significance for future ESG performance (0.039, 10% level), selling pressure (-0.024, 1% level), reputation (0.536, 1% level), and inflow (0.065, 1% level). This outcome suggests that ISRC's predictive power in Real Estate remains relatively constrained. In the **Financial** sector (Column 5), ISRC has a significantly negative effect only on selling pressure (-0.116, 10% level), while all other metrics remain statistically insignificant. The **Comprehensive** sector (Column 6) similarly shows a negative coefficient for selling pressure (-0.050, 10% level), but does not exhibit significance in other outcomes.

Taken together, these results indicate that ISRC exerts stronger predictive power in the Industrial, Utilities, and Business sectors, contributing to higher ESG and financial performance, reduced crash risk, lower trading activity, improved capital inflows, and better corporate reputation. In Real Estate, Financial, and Comprehensive sectors, ISRC appears to play a more limited role in influencing future firm outcomes.

The results indicate that ISRC's predictive power on future firm performance metrics is most pronounced in sectors where environmental sustainability is crucial to operations—namely, the Industrial, Utilities, and Business sectors. In these sectors, a higher ISRC correlates with improved future ESG performance, enhanced stock returns, longer investment horizons, decreased trading activity, reduced market risk indicators, and increased corporate reputations.

Further, these findings suggest that in sectors like Industrial, Utilities, and Business, where direct environmental impacts and regulatory compliance are critical to operational efficiency, ISRC provides significant insights for investors. The strong correlations observed here could be attributed to the intense regulatory scrutiny and the substantial environmental considerations inherent in their

operations, coupled with heightened investor sensitivity to ESG issues.

In contrast, sectors such as Real Estate, Financial, and Comprehensive might not directly influence environmental outcomes as intensely or visibly as the sectors previously mentioned. Consequently, investor sensitivity to ESG issues tends to be lower in these areas. This diminished sensitivity arises because the environmental impacts of these sectors are often less immediate or tangible, making ESG factors less integral to their operational or strategic relevance from an investor's perspective. For example, the financial sector's impact on sustainability is more abstract, predominantly linked to the indirect financing of environmental footprints of other industries rather than direct emissions or resource usage. Similarly, the real estate sector, while impactful over the long term, presents less immediate ESG concerns that might be overshadowed by short-term economic returns.

Overall, we show that the importance for ESG-focused investors to consider sector-specific characteristics when evaluating the utility of ISRC as a tool for guiding investment decisions. Investors looking to optimize their ESG portfolios should focus on ISRC in these high-ESG-sensitivity sectors, leveraging it to make informed decisions that align with long-term sustainability goals and risk management. By doing so, investors not only contribute to promoting sustainable practices but also enhance their potential for achieving robust long-term returns and securing market stability.

IV.8.3. External Validity of ISRC in Developed Markets

The ISRC measure is developed within the institutional context of the Chinese equity market. This setting is characterised by a relatively high share of retail trading, heterogeneous ESG disclosure quality, and evolving regulatory frameworks. These features create a favourable environment for identifying the behavioural patterns of socially responsible investors, including their longer investment horizons, lower sensitivity to short-term mispricing, and stronger alignment with sustainability-oriented firms. The ability of ISRC to predict future ESG performance, market sta-

bility, and return dynamics in such a complex market indicates that the metric captures fundamental investor-driven sustainability mechanisms rather than China-specific structural features.

The theoretical mechanisms underpinning ISRC are not exclusive to emerging markets. Developed markets such as the United States and Europe exhibit more standardised ESG disclosure regimes, higher transparency in institutional holdings, and deeper penetration of the SRI industry. These institutional characteristics improve the precision of ownership-based sustainability measures and strengthen the channels that allow socially responsible investors to influence corporate behaviour. Prior evidence from developed markets shows that SRI-oriented investors demonstrate longer investment horizons, enhanced monitoring capacity, and greater commitment to sustainability objectives (Starks et al. 2017; Pástor et al. 2021). These documented patterns are consistent with the mechanisms captured by ISRC.

Given this alignment, the ISRC measure offers a methodological contribution that extends beyond the Chinese setting. ISRC provides a scalable and forward-looking ownership-based sustainability indicator that can be applied in markets with richer data environments and more mature ESG infrastructures. Its application in developed markets has the potential to produce cleaner identification of sustainability-driven investor behaviour and stronger predictive performance. Cross-country implementation of ISRC would enable comparative analyses of how institutional environments, regulatory standards, and investor compositions shape the extent to which socially responsible ownership affects firm outcomes.

Therefore, future research can apply ISRC in advanced economies, compare its performance across institutional environments, and examine whether the magnitude of its predictive power differs between emerging and developed market settings. This analysis would enhance the generalisability and international relevance of the ISRC metric.

IV.9. Conclusion

IV.9.1. Summary

In summary, we demonstrate that in China's stock market, both SR and NSR investors react to mispricing signals, albeit with differing magnitudes. SR investors, who typically hold stocks with high ISRC scores, exhibit a tempered response, not adjusting their holdings rapidly enough to mirror the true value of their stocks. This slower response rate creates arbitrage opportunities, particularly for investors adept at identifying these under-adjusted prices. By capitalizing on the delays in price adjustments, savvy investors can exploit these discrepancies for profit, suggesting that high ISRC stocks often represent undervalued opportunities in the market. However, both SR and NSR investors in China exhibit a lack of persistence in their investment strategies, reflecting that ESG investing remains a lower priority in China compared to more mature markets.

Furthermore, our ISRC metric, which quantifies the overall concentration of social responsibility attributed to a stock by mutual fund investors, has a lasting impact on various firm and stock market metrics. Stocks with higher ISRC levels experience higher stock market returns, indicating that ISRC serves as a robust predictor of investment performance. This positive relationship is primarily driven by two key mechanisms: the ESG Demand Channel and the Market Stability Channel.

Through the ESG Demand Channel, higher ISRC scores lead to increased ESG performance and improved corporate reputation, which in turn attract greater capital inflows from socially responsible investors. This growing demand not only elevates stock valuations but also fosters a cycle of sustainable investment, reinforcing firms' commitment to ESG practices. Consequently, firms with strong social responsibility concentrations are better positioned to meet investor expectations, enhancing their long-term sustainability and market standing.

Simultaneously, the Market Stability Channel demonstrates that higher ISRC is associated with reduced trading turnover rates and trading amounts, as well as lower stock price crash probabili-

ties. By mitigating information asymmetry and promoting long-term investment horizons, ISRC enhances market stability and reduces susceptibility to speculative trading. This leads to a more resilient financial ecosystem, where firms with high ISRC benefit from a stable and predictable market environment, thereby reducing risks and supporting sustained financial performance.

These empirical mechanisms can be further interpreted through several theoretical perspectives, including signalling, information asymmetry reduction, investor clientele stability, agency improvement, risk hedging, and social norm effects. Together, these perspectives clarify the behavioural, informational, and normative foundations through which socially responsible concentration translates into superior stock performance.

Notably, these effects are particularly pronounced in the periods following the Paris Agreement, suggesting a significant shift in market dynamics and investor behaviours post-agreement. This indicates that the long-term market response to high ISRC stocks aligns with the goals of international sustainability frameworks, emphasizing the enduring benefits of sustainable investment practices. The Paris Agreement effectively catalysed a global reorientation toward climate-conscious investment, strengthening the market's recognition and reward for SRI behaviour. As a result, the positive relationship between ISRC and stock returns becomes more evident, highlighting the strategic importance of integrating ESG factors into investment decisions. Although the ISRC measure is developed and tested in the Chinese market, the underlying mechanism is not unique to China. Future research can apply ISRC in developed markets with more mature SRI industries to assess its external validity and examine whether its predictive power strengthens under different institutional frameworks.

IV.9.2. Policy Implications

For policymakers, the results highlight the effectiveness of international agreements like the Paris Agreement in shaping financial markets and influencing investor behaviours towards more sustainable and responsible practices. Policymakers should consider strengthening ESG disclosure

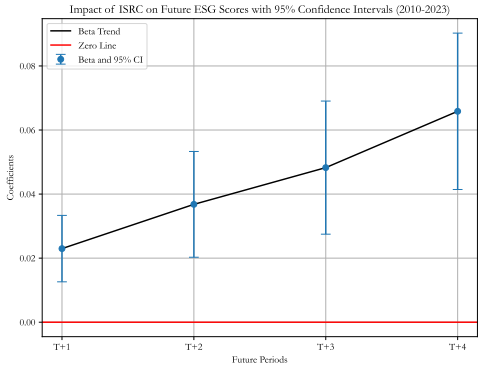
requirements to enhance transparency and enable more accurate ISRC assessments. Additionally, promoting ESG integration into mainstream investment processes through incentives or guidelines could further align financial markets with sustainability objectives. Recognizing the role of policies in facilitating or hindering ESG-oriented investments, policymakers should continue to create and enforce frameworks that support sustainable investment practices, thus fostering a financial environment conducive to long-term societal and environmental well-being.

For investors, these results are consistent with the theoretical interpretation that responsible ownership improves information efficiency, reduces risk, and builds stable investor relations, which together support superior long-term returns.

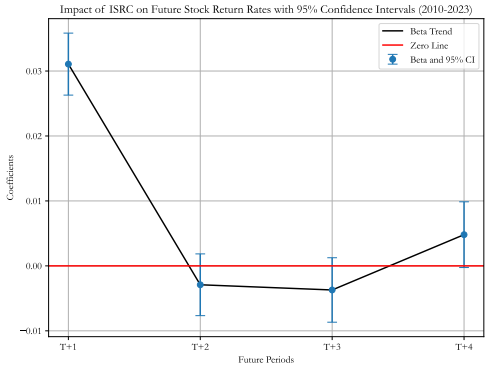
For investors, the findings underscore the importance of considering ESG factors and ISRC metrics when assessing potential investments. High ISRC stocks not only exhibit reduced volatility and lower crash probabilities but also offer higher stock market returns, suggesting that incorporating ESG considerations provides a more stable and potentially profitable investment strategy. Over time, the market tends to correct the underestimation of climate risks associated with these stocks, leading to higher returns. Additionally, a viable investment strategy involves profiting from identifying and investing in undervalued high ISRC stocks, especially those overlooked due to the less reactive behaviours of SR investors.

Investors should also monitor developments in global sustainability policies and market responses, as shifts in regulatory landscapes, such as those following the Paris Agreement, significantly alter market investors' behaviours and investment outcomes. Staying informed on these changes helps investors capitalize on the evolving financial environment, aligning their investment strategies with sustainable practices increasingly recognized and rewarded in the market.

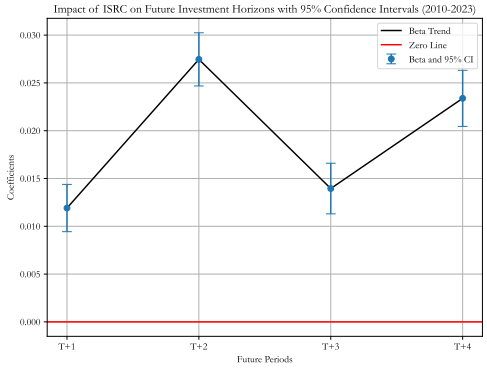
Figure IV.1: **Long Term Effect of ISRC on Various Metrics with 95% Confidence Intervals**



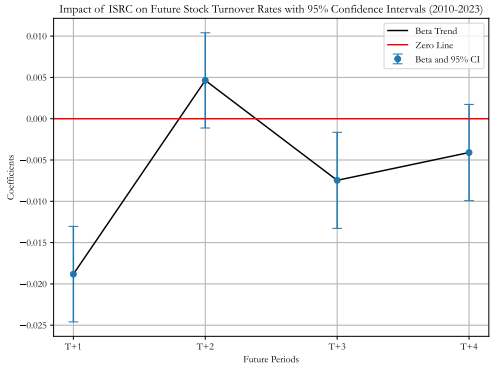
(a) Future ESG Scores



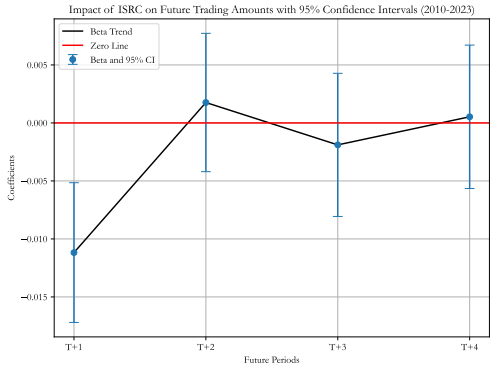
(b) Future Stock Market Return Rates



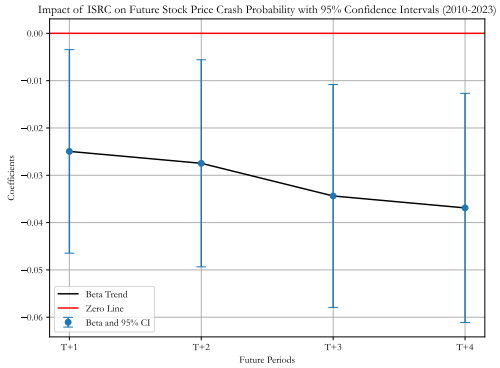
(c) Future Investment Horizons



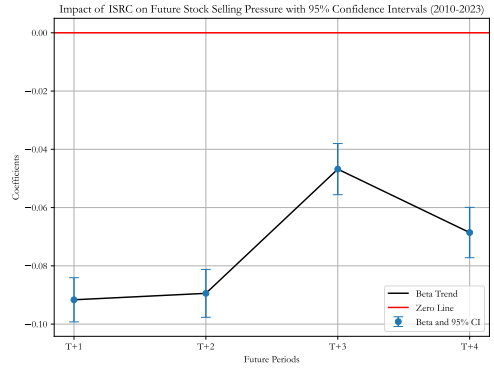
(d) Future Stock Market Turnover Rates



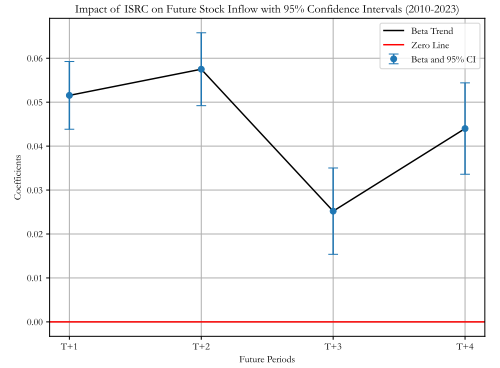
(e) Future Stock Market Trading Amounts



(f) Future Stock Price Crash Probability



(g) Future Stock Selling Pressures exerted by Mutual Funds



(h) Future Stock Inflow exerted by Mutual Funds

Notes: This figure presents the long-term effect of ISRC on various metrics with 95% confidence intervals, lagging four periods. The x-axis represents future periods from $T+1$ to $T+4$, and the y-axis represents coefficients. A red line indicates the zero line at $y=0$. Subfigure IV.1a and subfigure IV.1b represent the effects of ISRC scores on future ESG performance and stock market returns. Subfigure IV.1c and subfigure IV.1d show the effects of ISRC scores on future market stability metrics. Subfigure IV.1e and subfigure IV.1f illustrate the effects of ISRC on trading volumes and crash risk. Subfigure IV.1g and subfigure IV.1h present the effects of ISRC scores on mutual fund selling pressure and inflows, respectively.

Table IV.1: **Variable Definitions**

Variables	Full Name of Variable	Description
Dependent Variables		
ESG	Firm's ESG Performance	A measure of a firm's overall ESG Performance.
Return	Stock Market Return Rate	Cumulative quarterly stock market return rate.
Turnover	Stock Market Turnover Rate	Average quarterly stock market turnover rate.
Crash	Stock Price Crash Status	Annual stock price crash indicator: 1 if crashed, 0 otherwise.
Horizon	Investment Horizon	Average quarterly investment duration in a firm.
SP	Selling Pressure	Quarterly measure of selling pressure on a firm's stock.
Inflow	Net Inflow Scope	Share of investing funds experiencing inflows.
Reputation	Firm Reputation	Annual measure of a firm's reputation.
Independent Variable		
ISRC	Institutional Social Responsibility Concentration	Magnitude of ESG-oriented fund influence on a stock.
Control Variables		
Size	Market Capitalization	The natural log of total market capitalization.
ESG $(t+0)$	Current ESG Performance	The Firm's ESG score at the beginning of the period.
EBIT	Earnings Before Interest and Taxes	The Firm's earning before interest and taxes.
PE	Price-to-Earnings Ratio	The share price relative to earnings per share.
Inv holding	Aggregated Institutional Investors Ownership Share	The Share of stock held by total institutions.
Growth	Operating Revenue Growth	The rate of growth of operating revenue of a firm.
LEV	Leverage Ratio	The debt divided by the book value of assets.
Age	Firm Age	The Age of a firm since its incorporation.
Instrumental Variable		
CPRI	Climate Physical Risk Index	The index of physical climate risk index for a city.

Table IV.2: **Summary Statistics of Variables**

Panel A: Stock Level's Data (Winsorized at 99%)

	N	Mean	SD	Min	p25	Median	p75	Max
ISRC	60572	0.118	0.343	-0.865	0.003	0.031	0.124	2.017
ESG (Raw)	60572	73.584	4.280	44.200	70.990	73.540	76.260	92.380
Stock Return Rate (%)	60572	0.021	0.130	-0.266	-0.061	0.010	0.087	0.467
Stock Turnover Rate (%)	60566	45.589	39.559	3.633	18.080	33.002	59.835	205.141
Stock Trading Amount ($billion)	60572	2.090	3.050	0.087	0.476	1.033	2.309	19.218
Stock Investment Horizon (Quarter)	60412	2.577	1.525	0.744	1.691	2.232	2.965	10.802
Selling Pressure (%)	43148	-3.300	5.600	-29.600	-4.200	-0.900	0.000	0.100
Net Inflow Scope	43148	10.481	27.63	-54	0	2	11	158
Stock Crash Status (0 or 1)	60572	0.086	0.280	0	0	0	0	1
Reputation (1 -10)	29342	6.022	2.779	1	4	6	8	10
CPRI (City Level)	60562	43.293	7.508	26.083	37.923	43.769	48.656	63.873
EBIT ($billion)	60572	0.105	0.220	-0.030	0.009	0.028	0.086	1.164
Leverage Rate	60572	0.434	0.195	0.056	0.280	0.430	0.581	0.858
PE Ratio	60572	84.924	153.504	6.097	21.430	38.570	77.117	1121.585
Firm Age (Year)	60572	11.856	7.258	1.000	5.000	11.000	18.000	28.000
Growth Rate (%)	60572	0.087	0.138	-0.153	0.008	0.055	0.125	0.756
Aggregate Institutional Ownership (%)	60565	47.121	24.376	0.130	28.292	49.533	66.365	100.000
Market Capitalisation ($billion)	60572	4.097	7.226	0.111	0.767	1.533	3.736	38.070

Panel B: Mutual Fund Level's Data (Winsorized at 99%)

2010Q1 -2023Q4	Average AUM ($billion)	Number of Stock Holdings	Investment Horizon (Quarter)
SR Mutual Funds	0.232	4328	2.839
NSR Mutual Funds	0.191	4440	2.513
	VW Return Rates (%)	VW Turnover Rates (%)	VW Trading Amount ($billion)
SR Mutual Funds	0.010	10.66	15.130
NSR Mutual Funds	0.030	14.16	18.130
	VW ESG (Size-Adjusted)	VW SUE	
SR Mutual Funds	5.440	0.910	
NSR Mutual Funds	3.870	1.130	
	VW Selling Pressure (%)	Number of Stock Price Crashes	
SR Mutual Funds	-0.949	79058	
NSR Mutual Funds	-2.266	162097	

Notes: This table summarizes the statistics for variables used in our analysis, covering the period from 2010$Q1$ to 2023$Q4$. Statistical measures include: N (total observations), Mean, SD (Standard Deviation), Min, p25 (25th percentile), Median, p75 (75th percentile), and Max. Panel A presents the stock-level data, including our main independent variable, ISRC (Institutional Social Responsibility Concentration), and the dependent variables: Raw ESG Scores, Stock Return Rate, Stock Turnover Rate, Stock Investment Horizon, Selling Pressure, Net Inflow Scope, Stock Trading Amount, Stock Crash Status, and Reputation. Furthermore, we include EBIT, Leverage Rate, PE Ratio, Firm Age, Growth Rate, Aggregate Institutional Ownership, and Market Capitalisation as control variables. Lastly, CPRI (Climate Physical Risk Index) is introduced as our instrumental variable. Panel B reports indicators at the mutual funds level, where we categorise total mutual funds into two groups — Social Responsibility (SR) Mutual Funds and NON-Social Responsibility (NSR) Mutual Funds by using the method described in Section IV.4.1. Indicators include Average Assets under management(AUM), Number of Stock Holdings, Investment Horizons, Value-Weighted (VW) Size-Adjusted ESG, VW SUE, VW Return, VW Turnover, VW Trading Amount, VW Selling Pressure, and Number of Price Crashes. Continuous variables are winsorized at the 1% and 99% levels.

Table IV.3: **The Effect of Mispricing Signals on the Trading Behaviours and Stock Return Pattern of SR Funds and Non-SR Funds**

Panel A: SR and NSR Mutual Funds' Trading Behaviours on Mispricing Signals

SUE	P1 (Overpriced)	P2	P3	P4	P5 (Underpriced)	P5-P1 (H-L Spread)
SR	-0.06***	-0.03***	0.02*	0.11***	0.24***	0.30***
	(-6.10)	(-2.68)	(1.91)	(7.37)	(12.01)	(18.11)
NSR	-0.18***	-0.07***	0.02	0.34***	0.72***	0.90***
	(-8.45)	(-3.11)	(0.58)	(10.36)	(14.87)	(23.32)
Diff (SR – Non-SR)	0.12***	0.04**	0.01	-0.23***	-0.48***	-0.50***
	(6.10)	(2.11)	(0.22)	(-8.04)	(-11.13)	(-17.23)

Notes: This table reports the summary of quarterly trading behaviour and stock market return pattern of Socially Responsible (SR) mutual funds and Non-Socially Responsible (NSR) mutual funds towards stocks with different Standardized Unexpected Earnings (SUE) scores. The sample period covers from 2009Q1 to 2023Q4. To adjust for serial correlation, robust Newey and West (1986) t-statistics are reported in parentheses. Continuous variables are winsorized at the 1% and 99% levels. Statistical significance levels are denoted as follows: ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. Panel A reports the trading behaviours of SR and NSR mutual funds in response to mispricing signals. At the beginning of each quarter, all stocks are categorised into quintiles based on the SUE calculated from the earnings reported in the same quarter of the previous year. The quintiles range from P1 (most overpriced) to P5 (most underpriced), with P1 representing stocks with the highest SUE values and considered overpriced, and P5 representing those with the lowest SUE values and considered underpriced. We monitor the quarterly changes in mutual fund ownership for both SR and NSR funds across these quintiles. The P5 - P1 spread and the differences between SR and NSR funds (Diff SR-NSR) illustrate their relative reactions to these mispricing signals. Panel B reports the value-weighted average monthly abnormal returns (in percentage) of portfolios double-sorted on Institutional Social Responsibility Concentration (ISRC) and SUE. At the end of each month, we sort all available stocks into quintiles based on the most recent SUE scores from the preceding quarter. Stocks in the P5 quintile are identified as the most undervalued, having the highest SUE scores, while those in the P1 quintile are classified as the most overvalued, having the lowest SUE scores. Further, stocks are categorised into low and high ISRC groups based on their ISRC scores from the previous quarter. Stocks in the top 20% of ISRC scores are classified as high ISRC, and those in the bottom 50% as low ISRC, we deliberately omitting the middle segment to minimise noise and enhance the contrast between companies preferred by investors with high versus low ESG preferences. We present monthly value-weighted CAPM alpha (Sharpe 1964), Fama-French three-factor alpha (Fama and French 1993), and Carhart four-factor alpha (Carhart 1997) for all portfolios. Moreover, we report high-low (P5-P1) spreads based on the mispricing signal SUE for all stocks, as well as for the low ISRC and high ISRC groups separately.

Panel B: Stock Return Patterns, ISRC, and Mispricing Signals

SUE		P1 (Overpriced)	P2 P3 P4 (Fairly Priced)	P5 (Underpriced)	P5-P1 (H-L Spread)
CAPM	All Stock	-0.16***	-0.15***	-0.14***	0.02***
		(-107.95)	(-187.13)	(-105.79)	(8.55)
	Low ISRC	-0.15***	-0.15***	-0.14***	0.01*
		(-58.49)	(-100.50)	(-60.52)	(1.81)
	High ISRC	-0.18***	-0.17***	-0.15***	0.02***
		(-61.19)	(-96.18)	(-48.78)	(4.95)
FF3	All Stock	-0.16***	-0.15***	-0.14***	0.02***
		(-121.05)	(-206.73)	(-113.23)	(11.14)
	Low ISRC	-0.15***	-0.15***	-0.14***	0.01**
		(-55.47)	(-99.01)	(-59.45)	(2.38)
	High ISRC	-0.20***	-0.20***	-0.19***	0.01
		(-38.64)	(-67.94)	(-37.98)	(1.07)
Carhart-4	All Stock	-0.16***	-0.15***	-0.14***	0.02***
		(-115.06)	(-198.95)	(-110.31)	(8.84)
	Low ISRC	-0.15***	-0.16***	-0.14***	0.01***
		(-55.19)	(-99.50)	(-59.26)	(2.75)
	High ISRC	-0.20***	-0.20***	-0.20***	0.000
		(-37.61)	(-68.47)	(-39.23)	(-0.19)

Table IV.4: **The Predictive Power of ISRC on Stock Market Returns**

Panel A: Predicative Power of ISRC on Future Stock Market Returns

	(1)
	Return (T+1)
ISRC	0.031***
	(0.002)
ESG	-0.003***
	(0.001)
LEV	-0.001
	(0.025)
PE	0.000**
	(0.000)
EBIT	-0.004
	(0.006)
Firm Age	-0.001
	(0.001)
Growth	0.039
	(0.034)
Inv holding	0.001***
	(0.000)
Size	0.022***
	(0.008)
Constant	-0.141
	(0.109)
R-sq	0.134
N	46878
Industry FE	Y
Year FE	Y

Panel B: Predictive Power of ISRC on Returns Conditional on Paris Agreement

	(1)
	Return (T+1)
ISRC	-0.027***
	(0.005)
ISRC × Paris	0.072***
	(0.006)
Controls	Y
R-sq	0.137
N	46878
Industry FE	Y
Year FE	Y

Panel C: Endogeneity Tests (GMM 2SLS)

Step 1: Regression of CPRI on ISRC		Step 2: Regression of $\widehat{\text{ISRC}}$ on Stock Return	
Instrumented Variable: CPRI	(1)		(2)
	ISRC (T+1)		Return (T+1)
CPRI	0.180***	$\widehat{\text{ISRC}}$	0.647***
	(0.001)		(0.075)
Controls	Y		Y
R-sq	-		-0.612
N	46868		46868
Industry FE	Y		Y
Year FE	Y		Y
Weak Identification test (F Statistic)		214.399	

Panel D: Propensity Score Matching (PSM) Test

	(1)
	Return (T+1)
ISRC	0.032***
	(0.003)
Controls	Y
R-sq	0.138
N	42023
Industry FE	Y
Year FE	Y

Notes: This table presents our baseline results. Panel A reports the predictive power of Institutional Social Responsibility Concentration (ISRC) on future quarterly stock returns. The ISRC variable is log-transformed to reduce skewness. To isolate the effect of ISRC from confounding factors, we control for contemporaneous ESG scores (ESG in year t) and aggregated institutional ownership (Inv holding). Additional control variables include leverage (LEV), earnings before interest and taxes (EBIT), price-to-earnings ratio (PE), firm age, growth rate (Growth), and market capitalization (Size). Panel B presents the results of an interaction analysis with the 2015 Paris Agreement. The variable Paris is a dummy that equals 1 for years 2015 and onward, and 0 otherwise. Panel C presents robustness checks addressing endogeneity using a two-stage least squares (2SLS) generalized method of moments (GMM) approach, where the instrumented variable is the Climate Physical Risk Index (CPRI). Panel D displays results from a Propensity Score Matching (PSM) analysis based on a five-nearest-neighbours (5-NN) algorithm. All regressions include industry and year fixed effects. Continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively, with standard errors in parentheses.

Table IV.5: **The Mechanisms Driving the Relationship Between ISRC and Stock Market Returns**

Panel A: ESG Demand Channel

	(1)	(2)	(3)
	ESG (T+1)	Reputation (T+1)	Inflow (T+1)
ISRC	0.023***	0.117***	0.093***
	(0.005)	(0.022)	(0.008)
Controls	Y	Y	Y
R-sq	0.759	0.317	0.374
N	43845	20217	22668
Industry FE	Y	Y	Y
Year FE	Y	Y	Y

Panel B: Market Stability Channel

	(1)	(2)	(3)	(4)	(5)
	Investment Horizon (T+1)	Turnover (T+1)	Trading Amount (T+1)	Crash (T+1)	SP (T+1)
ISRC	0.012***	-0.019***	-0.011***	-0.025**	-0.092***
	(0.001)	(0.003)	(0.003)	(0.011)	(0.004)
Controls	Y	Y	Y	Y	Y
R-sq	0.118	0.252	0.369	0.118	0.163
N	43826	46876	46878	43826	22668
Industry FE	Y	Y	Y	N	Y
Year FE	Y	Y	Y	N	Y

Notes: This table reports the mechanisms driving the relationship between ISRC and stock market returns, examining two theoretical channels: the ESG Demand Channel and the Market Stability Channel. Panel A presents results for the ESG Demand Channel, including future annual ESG performance (ESG), annual corporate reputation scores (Reputation), and semi-annual fund net inflows (Inflow), capturing investor-driven demand for ESG-aligned firms. Panel B reports results for the Market Stability Channel, using proxies such as quarterly stock turnover rates (Turnover), quarterly total trading amounts (Trading Amount), the likelihood of an annual stock price crash (Crash), investment horizon measured quarterly (Invest Horizon), and semi-annual mutual fund selling pressure (SP). All regressions include industry and year fixed effects. Continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively, with standard errors in parentheses.

Table IV.6: **Predictive Power of ISRC on Various Firm Metrics Across Different Sectors**

Dependent Var.: ISRC	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Independent Var.	**Utilities**	**Business**	**Industrial**	**Real Estate**	**Financial**	**Comprehensive**
ESG (T+1)	0.036***	0.017	0.019***	0.039*	-0.008	0.018
	(0.013)	(0.022)	(0.006)	(0.021)	(0.094)	(0.038)
Return (T+1)	0.023***	0.026***	0.037***	-0.000	-0.042	0.009
	(0.006)	(0.009)	(0.003)	(0.009)	(0.045)	(0.018)
Investment Horizon (T+1)	0.018***	0.014***	0.011***	0.001	0.012	0.014
	(0.003)	(0.005)	(0.002)	(0.006)	(0.020)	(0.012)
Turnover (T+1)	-0.012	-0.012	-0.025***	-0.012	0.052	0.002
	(0.008)	(0.009)	(0.004)	(0.010)	(0.045)	(0.021)
Trading Amount (T+1)	0.004	0.005	-0.017***	-0.009	0.048	0.007
	(0.006)	(0.005)	(0.004)	(0.010)	(0.035)	(0.015)
Crash (T+1)	-0.006**	-0.006*	-0.003**	0.005	0.007	0.006
	(0.002)	(0.003)	(0.001)	(0.004)	(0.011)	(0.006)
SP (T+1)	-0.108***	-0.065***	-0.094***	-0.024***	-0.116*	-0.050*
	(0.010)	(0.010)	(0.005)	(0.008)	(0.057)	(0.026)
Reputation (T+1)	0.242*	0.298*	0.137**	0.536***	0.233	-0.322
	(0.142)	(0.156)	(0.059)	(0.180)	(0.759)	(0.367)
Inflow (T+1)	0.061***	0.049***	0.049***	0.065***	0.073	0.020
	(0.009)	(0.008)	(0.005)	(0.017)	(0.050)	(0.023)

Notes: This table presents regression results evaluating the predictive power of Institutional Social Responsibility Concentration (ISRC) on future firm performance metrics across various sectors. The dependent variable in all columns is ISRC (log-transformed), while independent variables include future ESG scores, stock returns, investment horizon, turnover rates, trading amounts, stock crash risk, selling pressure (SP), mutual fund net inflows, and corporate reputation scores, all measured at year $T+1$. Columns (1) to (6) correspond to regressions run separately for firms classified into Utilities, Business, Industrial, Real Estate, Financial, and Comprehensive sectors, respectively. All regressions include industry and year fixed effects. Continuous variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the firm level. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively, with standard errors in parentheses. Intercepts and control variable coefficients are omitted for brevity.

Chapter V

Conclusion

V.1. Overall Summary

This thesis comprehensively investigates the interconnected relationships between government ESG-related subsidies, corporate ESG performance, and market responses across three empirical studies, emphasizing the profound impact of policy interventions and investor behaviour in promoting sustainable corporate practices and enhancing market efficiency.

Chapter II employs panel regressions to examine how ESG-related subsidies influence firms' ESG performance. We find that ESG-related subsidies significantly elevate firms' ESG outcomes, particularly in the environmental and governance dimensions, with effects notably amplified after the Paris Agreement. These results underscore the effectiveness of global climate agreements in driving corporate sustainability efforts and highlight the necessity for continued international policy cooperation and reinforcement.

In Chapter III, we adopt an event study methodology to analyse the stock market's reaction to ESG-related subsidy announcements. The findings demonstrate that stock markets react positively to such announcements, especially for firms with strong ESG credentials, reflecting investors' appreciation for sustainability initiatives. However, positive market reactions are more pronounced among non-SOEs than SOEs, signalling a critical need for policy refinements to mitigate bureaucratic constraints that limit subsidy effectiveness in state-owned enterprises.

Chapter IV introduces and constructs a novel stock-level metric, the ISRC which aggregates the ESG orientation of institutional investors, measured by their ISRS, weighted by their portfolio holdings in individual stocks. Using this new indicator, we reveal a significant positive association between ISRC and higher stock market returns and enhanced market stability. Two mechanisms underlie this relationship. First, through the ESG demand channel, higher ISRC is associated with

superior future ESG performance, enhanced corporate reputation, and greater fund inflows from socially responsible investors. Second, through the market stability channel, firms with higher ISRC benefit from longer investment horizons, lower stock return volatility, lower likelihood of stock price crashes, and reduced selling pressure exerted by mutual funds. These two mechanisms operate through several theoretical pathways, including signalling credibility, information efficiency, investor clientele stability, governance improvement, risk hedging, and social norm alignment, which together explain why higher SR concentration translates into higher stock market return. Together, these findings reflect the financial market's increasing valuation of socially responsible investment practices.

Collectively, these findings underscore the critical role of ESG-focused policies and socially responsible investing in shaping sustainable market practices and enhancing firm value. By employing a diverse set of empirical strategies, including panel regressions, event study analysis, and novel metric construction, this thesis provides robust evidence and valuable insights for policymakers, investors, and corporate managers aiming to foster sustainable development in emerging markets like China.

V.2. Overall Implications

These research findings offer significant insights for policymakers, corporate management, and investors, not only within China but also for other emerging and developed markets seeking to advance sustainability objectives.

For policymakers, several implications follow from the empirical patterns documented in this thesis. First, subsidy design should emphasise targeting, conditionality, and verification. Targeting larger and longer-term support toward sectors with high marginal abatement potential, such as industrials and utilities, ensures efficient allocation of public resources, while capacity-building grants can assist lagging sectors. Conditionality should link disbursement to measurable milestones including emissions intensity reductions, governance improvements, or adoption of third-party as-

surance, and should incorporate staged payments and clawbacks to mitigate non-compliance. Verification through independent audits and publicly accessible, machine-readable disclosure of award criteria and achieved outcomes can reduce information asymmetry and discourage greenwashing.

Second, because subsidies display limited influence on the social (S) pillar, eligibility criteria may incorporate explicit social performance indicators such as employee welfare, occupational safety, community engagement, or workforce diversity. Allocating a portion of subsidy funds to certified social programmes or offering performance-based top-up incentives for verified improvements can strengthen the connection between fiscal support and social outcomes.

Third, effective subsidy policy must align with national climate strategy. Eligibility and performance metrics should reflect nationally determined contributions and sector-specific transition pathways, while subsidy timetables should coordinate with carbon pricing mechanisms to avoid policy arbitrage. Transparent alignment with the Paris Agreement can improve policy credibility, attract long-term capital, and lower financing costs for compliant firms.

Fourth, improvements in ESG disclosure standards are essential for efficient market responses. A quarterly core ESG reporting package covering energy use, emissions, environmental capital expenditure, governance indicators, and major incidents, combined with event-driven updates and alignment with a national taxonomy, would enhance comparability and allow investors to incorporate ESG information more effectively. Such standardisation also improves supervisory tools including the ISRC.

Finally, strengthening sustainable investment market infrastructure can enhance policy transmission. Clearer stewardship reporting guidelines, holdings-based fund classification, and disclosure of portfolio-level ownership concentration measures such as ISRC percentiles can increase transparency and support long-term investment strategies. Given the contrasting market responses observed in Chapter III, where SOEs display weaker or negative CARs while non-SOEs show positive reactions, policymakers may adopt differentiated approaches. Streamlined approval procedures and clearer managerial incentives could help SOEs respond more effectively to subsidies,

while maintaining flexibility for non-SOEs can reinforce their already positive market reactions.

On the corporate side, particularly for large enterprises, management should integrate environmental and social responsibility into strategic planning as a source of long-term competitiveness rather than treating it merely as compliance. Firms should actively leverage government subsidies and the growing demand for sustainable products to reduce operational and reputational risks, enhance firm value, and strengthen relationships with investors. Clear communication of ESG strategies and their financial implications remains critical. Establishing robust governance structures, such as dedicated ESG committees and transparent reporting frameworks, ensures that subsidy funds are used effectively and responsibly. Aligning executive incentives and performance evaluations with ESG outcomes sustains engagement over time. ESG strategies should also be tailored to sector-specific regulations and risks, particularly in industries where environmental performance directly affects operational resilience.

Since social outcomes are less responsive to financial incentives, firms should adopt complementary internal initiatives that directly target social performance, such as improved employee welfare programs, community partnerships, and diversity-enhancing recruitment. These actions strengthen corporate reputation, foster trust among stakeholders, and build long-term organisational resilience.

For investors, the findings highlight the importance of integrating both traditional annual ESG reports and higher-frequency indicators such as ISRC. ISRC provides timely insights into market perceptions of corporate responsibility, helping investors identify undervalued firms with strong ESG potential. Stocks with high ISRC values tend to exhibit longer investment horizons and lower crash risk, making them suitable for sustainable portfolios. The predictive power of ISRC is especially strong in environmentally sensitive sectors such as industrials and utilities, where it correlates with higher future ESG scores, stronger returns, and improved stability. By contrast, ISRC is less informative in sectors with indirect environmental impact, such as finance or real estate. ESG-oriented investors should therefore consider sectoral characteristics when interpreting ISRC

signals and prioritise exposure to high-ISRC firms in sustainability-critical industries. When markets display mispricing, investors may also exploit "high-ISRC plus undervalued" opportunities while remaining alert to potential greenwashing or policy adjustments that could affect valuations.

Overall, by connecting government policy, corporate strategy, and investor behaviour, this thesis demonstrates that well-designed public incentives, strategic corporate action, and informed investment practices can jointly advance sustainable development. China's experience, particularly the linkage between international agreements such as the Paris Accord and domestic financial policy, offers valuable lessons for other economies seeking to meet global climate goals through effective and market-sensitive ESG interventions.

V.3. Future Research Directions

This thesis has several limitations that suggest clear avenues for future work. First, despite GMM and instrumental-variable strategies, residual endogeneity may remain in policy effects and return predictability. Second, external validity beyond China is uncertain given the state-dominated financial architecture and disclosure regime. Third, sectoral heterogeneity is suggestive rather than fully structural; mechanisms behind stronger effects in industrials and utilities are not fully separated from regulation intensity, energy exposure, and supply-chain complexity. Fourth, measurement constraints persist: firm ESG scores are annual and provider-specific, while ISRC relies on fund-holdings coverage and quarterly granularity; both may embed classification error and timing mismatch. Fifth, SOE governance frictions are proxied indirectly; richer micro-data on incentives and approval processes would permit sharper tests.

Future research should strengthen identification using natural experiments. Regression discontinuity around subsidy eligibility thresholds and staggered adoption difference-in-differences, combined with event-time diagnostics and local projections, can trace dynamic causal paths from policy to performance to pricing. Where feasible, administrative micro-data on subsidy contracts, milestone audits, and management incentives would enable within-firm designs that reduce con-

founding.

To assess international generalisability, ISRC should be constructed and validated in developed markets such as the United States, where mutual-fund holdings and ESG disclosures are more granular and standardised. Comparing the predictive power of ISRC across the United States, China, and other major economies would provide valuable insights into whether the post-Paris amplification mechanism and ownership–stability relationships hold in different institutional and regulatory contexts. Such cross-country analyses would also help to identify which aspects of disclosure quality, investor composition, and policy design drive stronger market pricing of ESG performance.

Harmonised, machine-readable ESG templates (quarterly core indicators with limited assurance) would reduce timing noise and improve cross-market comparability. Sector-focused studies can interact ISRC with regulation intensity, energy-price exposure, and supply-chain complexity to isolate channels. Decomposing effects into demand (fund flows and ownership shifts), stability (turnover and horizons), and information (crash risk and disclosure quality) will help identify which component dominates by industry. For SOEs, linking variation in managerial incentives, interim disclosure timetables, and approval lags to treatment intensity would test whether governance alignment strengthens the policy–performance–pricing chain.

Methodologically, text and data innovations can improve measurement. Large Language Models can be used, after core causal designs are set, to extract standardised indicators from subsidy documents, board reports, and risk narratives, improving timeliness and reducing provider disagreement. LLM-based sentiment indices around environmental controversies and governance changes can be combined with ISRC to test whether qualitative shocks help explain short-term mispricing or reinforce long-horizon stability. Careful bias audits, human-in-the-loop validation, and pre-registered protocols are essential to avoid model-driven artefacts.

Finally, policy pilots could trial higher-frequency ESG disclosure (quarterly core metrics tagged to a national taxonomy), milestone-linked subsidy disbursement with clawbacks, and stew-

ardship reporting that includes portfolio-level ISRC distributions. Evaluating these pilots with pre-registered designs would provide credible evidence on which instruments most efficiently translate public support and investor demand into measurable sustainability and pricing outcomes.

APPENDIX A

ESG RATING INDICATOR SYSTEM – FROM SINO SECURITIES INDEX (SSI) COMPANY

3 Pillars	16 Themes	44 Key Indicators
E	Climatic change	Greenhouse gas emissions, carbon reduction routes, climate change, sponge cities
	Resource utilization	Land use and biodiversity, water consumption, material consumption
	Environmental pollution	Industrial emissions, hazardous waste, electronic waste
	Environmentally friendly	Renewable energy, green buildings, green factories
	Environmental management	Sustainability certification, supply chain management-E, environmental penalties
S	Human capital	Employee Health and Safety, Employee Motivation and Development, Employee Relations
	Product Liability	Quality certification, recalls, complaints
	Supply chain	Supplier risk and management, supply chain relationships
	Social contribution	Inclusion, community investment, employment, scientific and technological innovation
	Data security and privacy	Data security and privacy
G	Shareholders' equity	Protection of shareholders' rights
	Governance structure	ESG governance, risk control, board structure, management stability
	Information disclosure quality	ESG external assurance, credibility of information disclosure
	Governance risk	Majority shareholder action, solvency, legal proceedings, tax transparency
	External Sanctions	External Sanctions
	Business ethics	Business ethics, anti-corruption and bribery

Notes: This table the ESG rating system that the Sino Securities Index (SSI) Company offers. SSI provides the most comprehensive ratings, and it boasts the widest time span and coverage of firms among all Chinese listed companies. SSI compiles the ESG scores based on 16 themes and 44 key indicators. We use the provided keywords as our benchmark to identify whether a subsidy pertains to ESG. For example, if a subsidy project's name includes terms such as 'green', 'environmental', or 'clean energy', we classify it as an E-related subsidy. Similarly, if a subsidy project's name contains terms like 'employee', 'quality certification', 'patent', or 'tech', we classify it as an S-related subsidy.

APPENDIX B

DETAILED METHODOLOGY AND MEASUREMENT EQUATIONS FOR CHAPTER IV

B.1. Standardized Unexpected Earnings (SUE)

To quantify mispricing signals in China's stock market, we follow the approach of Cao et al. (2023), using SUE as a proxy. SUE is calculated as the difference between the earnings for the current quarter and the same quarter one year prior, normalized by the standard deviation of unexpected earnings derived from data over the past six months. This measure identifies significant deviations in earnings that the market may not have anticipated, providing a gauge for potential mispricing:

$$\text{SUE}_{j,t} = \frac{\text{Earnings}_{j,t} - \text{Earnings}_{j,t-4}}{\sigma(\text{Unexpected Earnings}_{j,t-6:t})}, \tag{B.1}$$

where $\text{Earnings}_{j,t}$ represents the earnings of firm j at time t, $\text{Earnings}_{j,t-4}$ represents the earnings of firm j from the same quarter one year prior ($t-4$), and $\sigma(\text{Unexpected Earnings}_{j,t-6:t})$ is the standard deviation of unexpected earnings for firm j calculated using data over the past six months ($t-6$ to t).

SUE serves as an indicator of how much a firm's earnings surpass or fall short of market expectations. A higher $\text{SUE}_{j,t}$ value suggests that firm j significantly outperforms expectations at time t, typically indicating potential undervaluation by the market. Conversely, a lower $\text{SUE}_{j,t}$ value implies that firm j's earnings underperform relative to expectations, which could suggest overvaluation by the market.

B.2. Investment Horizons

We adopt the approach outlined by Gaspar et al. (2005), Starks et al. (2017), and Cao et al. (2023) to measure the investment horizons of mutual fund investors. A common method to assess these horizons is by using the Churn Ratio, which is defined as the total value of shares traded (both bought and sold) by a fund within a given period, divided by the average value of the holdings of that fund during the same period. The underlying logic of this ratio is that more frequent trading or shorter holding periods imply shorter investment horizons; hence, a higher Churn Ratio indicates that institutional investors have shorter investment durations.

The Churn Ratio for each stock j held by fund i at the end of quarter t is computed in $Eq.(B.2)$:

$$Churn\ Ratio_{i,j,t} = \frac{\left|N_{i,j,t}P_{i,t} - N_{i,j,t-1}P_{j,t}\right|}{\frac{N_{i,j,t}P_{j,t}+N_{i,j,t-1}P_{j,t}}{2}}, \tag{B.2}$$

where $N_{j,i,t}$ is the number of shares of stock j held by fund i at the end of quarter t, and $P_{j,t}$ is the price of stock j at the end of quarter t. This formula calculates the absolute value of the change in the value of shares of stock j held between two consecutive quarters, using the current price to reflect changes driven by trading activities rather than price fluctuations.

To formally define the investment horizon for each stock j and at the fund i level in quarter t, we utilise the reciprocal of the Churn Ratio. For individual stocks, the investment horizon is calculated in $Eq.(B.3)$ and $Eq.(B.4)$:

$$Firm\text{-}level\ Investment\ Horizon_{j,t} = \frac{1}{Churn\ Ratio_{i,j,t}}, \tag{B.3}$$

similarly, at the fund level for fund i, we aggregate the Churn Ratios for all stocks within the fund to calculate an overall investment horizon:

$$Fund\text{-}level\ Investment\ Horizon_{i,t} = \frac{1}{\sum_{j\in I} Churn\ Ratio_{i,j,t}}, \tag{B.4}$$

these calculations transform the Churn Ratio into a more intuitive measure of duration. By using the reciprocal, we establish that a lower Churn Ratio, indicative of less frequent trading, directly corresponds to a longer implied investment horizon, both for individual stocks and for the fund overall. This approach highlights the inverse relationship between trading frequency and the duration of investments held by the institution at both the stock and fund levels.

B.3. Stock Price Crash Risks

Following Jiang and Xu (2015), we measure the stock price crash risk as an annualized indicator that captures the extreme negative outcomes in stock returns over a given year. The methodology involves estimating weekly stock returns adjusted for market movements, followed by identifying extreme negative deviations.

First, we calculate the adjusted weekly returns for stock i in week t using:

$$r_{i,t} = \alpha + \sum_{k=-2}^{2} \beta_{k,i} r_{m,t+k} + \varepsilon_{i,t}, \tag{B.5}$$

where $r_{i,t}$ is the return of stock i in week t, and $r_{m,t}$ represents the market-wide average return for all China's A-share stocks in week t, weighted by market capitalization. The summation term $\sum_{k=-2}^{2} \beta_{k,i} r_{m,t+k}$ accounts for market returns over a five-week window, including two weeks prior, the current week, and two weeks ahead.

Next, we compute the adjusted return as in $Eq.(B.6)$:

$$W_{i,t} = \ln(1 + \varepsilon_{i,t}), \tag{B.6}$$

where $W_{i,t}$ is the log-transformed residual from the regression model, representing the market-adjusted weekly return of stock i.

The crash risk indicator is defined as an annual dummy variable for each stock in $Eq.(B.7)$:

$$\text{Crash}_i = \begin{cases} 1 & \text{if } W_{i,t} < \overline{W}_i - 3.2 \times \sigma(W_{i,t}) \text{ for any week } t \text{ within the year} \\ 0 & \text{otherwise,} \end{cases} \tag{B.7}$$

where $\overline{W}_i$ is the annual mean and $\sigma(W_{i,t})$ is the standard deviation of $W_{i,t}$ calculated over the year. A value of 1 indicates that stock i experienced at least one weekly return during the year that

was significantly lower than its average adjusted return, specifically falling more than 3.2 standard deviations [18] below the mean, suggesting a status of stock price crash.

[18]The threshold of 3.2 standard deviations is commonly used in the common finance literature to identify extreme events or outliers (Black Swan Event). It corresponds to approximately the 0.1% tail in a standard normal distribution, highlighting severe deviations from the mean. This stringent criterion ensures that the crash indicator focuses on rare, significant negative returns.

B.4. Selling Pressure

We follow Coval and Stafford (2007) and Jiang et al. (2022) to construct two stock-level mutual fund selling pressure indicators, reflecting the impact of mutual fund trading activities on stock prices. Due to our data availability, both $Sell\ Amount_{i,j,t}$ and $Buy\ Amount_{i,j,t}$ are calculated semi-annually, thus the frequency of these indicators is also semi-annual.

B.4.1. Selling Pressure Based on Fund Flows

The first indicator measures the net selling pressure exerted on a specific stock j by mutual funds i during periods of extreme capital flows, for the semi-annual period t. The selling pressure is quantified using $Eq.(B.8)$:

$$Selling\ Pressure_{j,t} = \frac{\sum_{i=1}^{I} \left[\left(Sell\ Amount_{i,j,t} \;\middle|\; Flow_{i,t} < 25\% \right) - \left(Buy\ Amount_{i,j,t} \;\middle|\; Flow_{i,t} > 75\% \right) \right]}{\text{Market Capitalisation}_{j,t}}, \tag{B.8}$$

where $Flow_{i,t} < 25\%$ and $Flow_{i,t} > 75\%$ are thresholds used to identify significant fund outflows and inflows, respectively. Specifically, a $Flow_{i,t} < 25\%$ indicates that the fund is among the lowest quartile in terms of net asset flows, suggesting significant withdrawals or redemptions which typically imply selling pressure on the stocks held by the fund. Conversely, a $Flow_{i,t} > 75\%$ places the fund in the top quartile, indicating substantial new investments or fewer redemptions, generally associated with buying pressure. These thresholds are critical for pinpointing periods of heightened trading activity that are most likely to impact the stock's market price, particularly due to the volume of trades linked to substantial inflows or outflows. The resulting selling pressure calculation is standardized by the market capitalization of stock j at time t, $\text{Market Capitalisation}_{j,t}$, which adjusts the net selling pressure relative to the size of the stock in the market.

Additionally, the sign of the Selling Pressure provides insights into the market sentiment towards stock j during period t. A positive selling pressure indicates that the selling activity out-

weighs buying activity, leading to a net sell-off. This usually suggests that investors are inclined to offload the stock, potentially due to concerns about its future performance or other market factors affecting its desirability. Conversely, a negative selling pressure indicates that the buying activity surpasses the selling, resulting in a net purchase. This can be interpreted as a positive valuation of the stock, suggesting that investors are inclined to buy it, possibly due to optimistic expectations of the stock's future performance or confidence in the company's fundamentals. Generally, a smaller (or more negative) Selling Pressure is considered more favourable as it indicates stronger buying interest relative to selling, which can signal investor confidence and potential upward momentum in the stock's price.

For $Flow_{i,t}$, it is calculated semi-annually in $Eq.(B.9)$ and $Eq.(B.10)$:

$$FLOW_{i,t} = TNA_{i,t} - TNA_{i,t-1} \times (1 + R_{i,t}), \tag{B.9}$$

$$Flow_{i,t} = \frac{FLOW_{i,t}}{TNA_{i,t-1}}, \tag{B.10}$$

where $TNA_{i,t}$ is the total net assets value of funds i at the end of the semi-annual period t, and $R_{i,t}$ is the return rate during that period.

B.4.2. Net Inflow Scope Indicator

The second indicator evaluates the difference between the number of funds experiencing inflows and outflows for stock j within the same semi-annual period in $Eq.(B.11)$:

$$\textit{Net Inflow Scope}_{j,t} = \text{Inflows}_{j,t} - \text{Outflows}_{j,t}, \tag{B.11}$$

the $\textit{Net Inflow Scope}_{j,t}$ quantifies the net balance between mutual fund inflows ($\text{Inflows}_{j,t}$) and outflows ($\text{Outflows}_{j,t}$) for stock j during the semi-annual period t. A positive value indicates that inflows exceed outflows, suggesting a higher potential for stock purchases and reflecting positive sentiment, which could exert upward pressure on the stock's price. Conversely, a negative value indicates more outflows than inflows, reflective of negative sentiment and suggesting potential downward price movement, driven by significant mutual fund trading activities.

B.5. Reputation

Following Guan and Zhang (2019), we construct the reputation score for firm j at time t using $Eq.(B.12)$:

$$\text{Reputation}_{j,t} = \sum_{k=1}^{K} \omega_k f_{k,j,t}, \tag{B.12}$$

where $f_{k,j,t}$ is the kth factor score for firm j at time t and ω_k is its corresponding weight. The factor scores $f_{k,j,t}$ (for $k = 1, \ldots, K$) are obtained from a factor analysis on the following variables: Asset Ranking, Revenue Ranking, Net Profit Ranking, Value Ranking, Debt-to-Asset Ratio, Long-Term Debt Ratio, Earnings Per Share, Independent Director Ratio, Pre-Tax Cash Dividend Per Share, Sustainable Growth Rate, Current Ratio, and whether audited by a Big Four accounting firm. Finally, firms are grouped into deciles (scores 1–10) based on their reputation scores.

APPENDIX C

INSTRUMENTAL VARIABLE MEASUREMENT - CLIMATE PHYSICAL RISK INDEX (CPRI) FOR CHAPTER IV

We construct the Climate Physical Risk Index (CPRI) for China following Guo et al. (2024)'s method. Although the underlying station-level data are downloaded from the National Oceanic and Atmospheric Administration (NOAA) in the United States, we focus exclusively on the subset of stations located within China to compute city-level results. Specifically, we first utilize historical station-level daily data within China (from 1973 to 1992) to establish our "extreme" thresholds for four types of climate indicators. Let $T10_i$ and $T90_i$ be the 10th and 90th percentiles of the daily average temperature at station i during the historical period. Similarly, let $R95_i$ be the 95th percentile of daily precipitation, and $H5_i$ be the 5th percentile of daily relative humidity. These thresholds capture the lower and upper bounds beyond which climate conditions become potentially hazardous in the Chinese context.

Next, for each station i in year n (covering 1993–2023 in our sample for China), we count the total number of days that meet the extreme criteria. Specifically, let:

$$\mathrm{LTD}_{i,n} = \sum_{t=1}^{365} \mathrm{LT}_{i,n,t}, \quad \mathrm{LT}_{i,n,t} = \begin{cases} 1, & \text{if } T_{i,n,t} < T10_i, \\ 0, & \text{otherwise,} \end{cases} \tag{C.1}$$

where $\mathrm{LTD}_{i,n}$ measures the number of "extreme low temperature days" at station i in year n, and

$T_{i,n,t}$ is the daily average temperature on day t. In a similar manner, we obtain:

$$\mathrm{HTD}_{i,n} = \sum_{t=1}^{365} \mathrm{HT}_{i,n,t}, \qquad \mathrm{HT}_{i,n,t} = \begin{cases} 1, & \text{if } T_{i,n,t} > T90_i, \\ 0, & \text{otherwise,} \end{cases} \tag{C.2}$$

$$\mathrm{ERD}_{i,n} = \sum_{t=1}^{365} \mathrm{ER}_{i,n,t}, \qquad \mathrm{ER}_{i,n,t} = \begin{cases} 1, & \text{if } R_{i,n,t} > R95_i, \\ 0, & \text{otherwise,} \end{cases} \tag{C.3}$$

$$\mathrm{EDD}_{i,n} = \sum_{t=1}^{365} \mathrm{ED}_{i,n,t}, \qquad \mathrm{ED}_{i,n,t} = \begin{cases} 1, & \text{if } H_{i,n,t} < H5_i, \\ 0, & \text{otherwise.} \end{cases} \tag{C.4}$$

Here, $\mathrm{HTD}_{i,n}$ denotes "extreme high temperature days," $\mathrm{ERD}_{i,n}$ denotes "extreme rainfall days," and $\mathrm{EDD}_{i,n}$ denotes "extreme drought days."

We then aggregate station-level extremes to the city level by taking the arithmetic mean across all stations within the same city m. Let $\mathrm{LTD}_{m,n}$ be the average number of extreme low temperature days in city m for year n:

$$\mathrm{LTD}_{m,n} = \frac{1}{M} \sum_{j=1}^{M} \mathrm{LTD}_{j,n}, \tag{C.5}$$

where M is the total number of stations in that city. The same aggregation step applies to $\mathrm{HTD}_{m,n}$, $\mathrm{ERD}_{m,n}$, and $\mathrm{EDD}_{m,n}$.

Because these raw counts can have different scales across various cities and event types, we use a min–max standardization to normalize the four sub-indicators into the $[0, 100]$ range:

$$\mathrm{LTD}^{*}_{m,n} = \frac{\mathrm{LTD}_{m,n} - \min\left\{\mathrm{LTD}_{p,l}\right\}}{\max\left\{\mathrm{LTD}_{p,l}\right\} - \min\left\{\mathrm{LTD}_{p,l}\right\}} \times 100, \tag{C.6}$$

where the minimum and maximum are taken over all cities p in China and all sample years l. Analogous transformations are applied to $\mathrm{HTD}_{m,n}$, $\mathrm{ERD}_{m,n}$, and $\mathrm{EDD}_{m,n}$ to obtain the standardized

$\text{HTD}^*_{m,n}$, $\text{ERD}^*_{m,n}$, and $\text{EDD}^*_{m,n}$.

Finally, we combine these four standardized measures (extreme low temperature, extreme high temperature, extreme rainfall, and extreme drought) to derive a single composite index of climate physical risk for each Chinese city:

$$\text{CPRI}_{m,n} = \omega_1 \,\text{LTD}^*_{m,n} + \omega_2 \,\text{HTD}^*_{m,n} + \omega_3 \,\text{ERD}^*_{m,n} + \omega_4 \,\text{EDD}^*_{m,n}, \tag{C.7}$$

where we set $\omega_1 = \omega_2 = \omega_3 = \omega_4 = 0.25$ by default (EW). $\text{CPRI}_{m,n}$ thus provides a single numerical measure that reflects the physical risk of extreme weather events in each Chinese city m and year n. Larger values indicate higher overall climate-related physical risk in that city.

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