

Are Real Estate Firms Sensitive to Climate Change Exposure?

Amal Aouadi

University of Lille

`amal.aouadi@univ-lille.fr`

Selma Boussetta

Bordeaux School of Economics, University of Bordeaux

`selma.boussetta@u-bordeaux.fr`

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Abstract

Using an international sample of real estate firm-year observations from 40 countries, this study investigates how firm-level climate change exposure (FCCE) affects stock liquidity. The findings show that higher FCCE is associated with lower liquidity, with opportunity-related exposure exerting the strongest impact. Importantly, country-level mitigation and adaptation measures moderate this relationship: more stringent environmental policies and higher fossil fuel subsidies amplify the negative liquidity effects of FCCE, whereas greater climate-regulating land coverage and stronger disaster preparedness alleviate them. Additional analyses reveal that sustainability performance enhance liquidity by reducing information asymmetry and reinforcing investor confidence. Overall, the results suggest that FCCE, corporate environmental performance, and national climate governance jointly shape the stock liquidity of real estate firms.

Keywords:

Climate change, climate governance, stock liquidity, mitigation, adaptation, real estate.

JEL Codes:

G32, Q54, R33.

1 Introduction

Climate-related issues affect the financial performance of real estate companies and increase their exposure to equity market risk (Zhu & Fuerst, 2023). These issues create uncertainty about climate events and regulation, influencing investor behavior (Krueger et al., 2024) and complicating firm valuation as extreme weather affects firm performance and market prices (Vestrelli et al., 2024; Wang et al., 2025). Real estate firms, particularly publicly traded real estate investment trusts (REITs), provide an especially suitable setting to examine these dynamics, given their transparent reporting practices, standardized asset-level exposures, and highly liquid market structures (Downs & Zhu, 2022). In this paper, we focus on how firm-level climate change exposure (FCCE), as developed by Sautner et al. (2023) influences stock liquidity in the global real estate sector, thereby offering new insights into how climate-related risks shape financial market functioning.

Recent evidence underscores the materiality of climate exposure in real estate markets (UNEP Finance Initiative, 2021). Nearly 10% of assets held by major real estate firms worldwide are located in high-risk zones, such as coastal areas vulnerable to flooding, with potential annual damages exceeding 1% of replacement value by 2050.¹ Such exposure highlights the growing vulnerability of real estate portfolios to physical climate events and emphasizes the need to understand how these risks influence market perceptions, investor behavior, and financial stability. Stock liquidity closely tracks investor confidence, reflecting information asymmetries and uncertainty about firms. Heightened uncertainty over climate exposures raises trading costs, reduces market participation, and erodes liquidity. Lower liquidity, in turn, signals diminished confidence, elevated perceived risk, and amplified information frictions, which drive up capital costs and depress asset values (Brunnermeier & Pedersen, 2009). Understanding how FCCE influences liquidity dynamics is thus critical for gauging how climate-related information integrates into market prices and affects capital allocation in exposed sectors.

Using an international dataset of real estate firms from 2002 to 2022 across 40 countries, we find that FCCE significantly reduces stock liquidity. This effect is primarily driven by

¹JPMorgan Private Bank (2023), How Climate Risk and Losses Are Creating High Prices for Home Insurance, <https://privatebank.jpmorgan.com/nam/en/insights/markets-and-investing/ideas-and-insights/how-climate-risk-and-losses-are-creating-high-prices-for-home-insurance>

opportunity-related climate issues rather than physical or regulatory risks. The results suggest that markets interpret opportunity-oriented disclosures—such as investments in green technologies, energy-efficient retrofits, or sustainable development projects—as signals of increased uncertainty about firms’ strategic transitions and future profitability. In contrast, physical and regulatory climate exposures show no significant relationship with liquidity. This indicates that investors may view strategic climate opportunities as sources of risk and uncertainty impacting trading behavior and liquidity in these firms. A series of robustness checks, including two-stage least squares (2SLS) estimations, multiple fixed effects, and subsample analyses, support a causal interpretation of the relationship between FCCE and liquidity.

Country-level mitigation and adaptation measures further moderate this effect: stricter environmental policies and higher fossil fuel subsidies amplify the adverse liquidity impact of FCCE, while larger climate-regulating land areas and greater disaster preparedness mitigate it. Notably, the negative FCCE-liquidity relationship weakens in high-emission countries, suggesting that market participants price climate risks differently in highly exposed contexts. Finally, firms with proactive sustainability performance practises—such as earning sustainability awards, monitoring supply-chain impacts, and managing emissions and resources effectively—exhibit higher liquidity, indicating that credible environmental engagement reduces information frictions and improves investor confidence.

The relevance of these findings is particularly timely and significant. As investors increasingly integrate climate risks into their portfolios, understanding how FCCE affects liquidity in the real estate sector carries direct implications for portfolio management, risk pricing, and financial stability. Giglio et al. (2025) report that 81% of ESG investors express strong concern about climate risk, with ethical motives being among the primary drivers of ESG holdings. Given that real estate assets represent over \$100 trillion globally and face substantial physical and transition risks, examining the interplay between FCCE and stock liquidity is crucial for policymakers, investors, and firms. By focusing on real estate firms, our study delivers policy-relevant insights into how climate exposure shapes market behavior, while highlighting the role of transparency, regulatory frameworks, and sustainability strategies in mitigating adverse outcomes.

Our study makes several notable academic and practical contributions. First, it provides the first large-scale, global analysis of the relationship between FCCE and stock liquidity. This contrasts with previous studies limited to single-country settings, for example, China in Qiu et al. (2025) or India in Sahu and Debata (2025) - or short time spans, offering a broader and more generalizable perspective.

Second, unlike Liu et al. (2024), who examine liquidity commonality (i.e., synchronicity between firm-specific and market liquidity) using the Amihud (2002) price impact ratio, our study advances this literature by focusing on firm-specific liquidity. We measure liquidity across two complementary dimensions—transaction costs (Chung & Zhang, 2014; Cumming et al., 2011; Venkataraman, 2001) and price impact (Amihud, 2002), then combine them into a single firm-level liquidity factor via factor analysis with oblique rotation (Daske et al., 2008). This methodology yields a more granular, comprehensive assessment of FCCE's impact on firm-level market functioning.

Third, we disentangle FCCE components and demonstrate that opportunity-related exposures exert the strongest adverse effect on liquidity. This finding reveals investor caution toward firms pursuing long-term sustainability transitions—a mechanism largely overlooked in prior single-country studies. We also show that firm-level environmental initiatives and robust national mitigation/adaptation policies attenuate the negative FCCE–liquidity relationship, whereas weaker frameworks and high-emission contexts amplify it. These results underscore the importance of coordinated corporate and policy actions in stabilizing markets under climate uncertainty.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature and develops the hypotheses. Section 3 presents the data and sample description. Section 4 reports the main empirical results. Section 5 investigates the underlying mechanisms and the moderating roles of climate policies. Section 6 presents additional analyses and Section 7 concludes with key implications for firms, investors, and policymakers.

2 Literature Review and Hypotheses Development

2.1 FCCE and Financial Performance

Firms are increasingly exposed to financial risks induced by climate change, which can affect their asset values, cash flows, and overall performance. For example, Jung et al. (2025) show that climate-related risks undermine the financial stability of banks by increasing expected capital shortfalls through both balance-sheet exposures and market risk positions. The survey evidence from Krueger et al. (2020) indicates that institutional investors view climate risks as financially material, particularly through regulatory channels. Ilhan et al. (2021) document that climate policy uncertainty affects the cost of downside-tail protection, with higher costs for more carbon-intensive firms and sensitivity to spikes in public attention to climate issues. Similarly, Bolton and Kacperczyk (2021) find that firms with higher CO₂ emissions earn higher returns after accounting for standard predictors, suggesting that investors require compensation for bearing carbon-emission risk. Together, these findings highlight how climate risks influence the financial exposures of firms and underscore the importance of effective risk management and adaptive strategies.

Physical climate risks arise from acute events, such as hurricanes, floods, and wildfires, and chronic changes, including rising temperatures and droughts. A growing body of evidence shows that these risks affect firm-level financial performance. Chen et al. (2024) show that extreme weather negatively affects stock returns of A-share listed companies in China, primarily through investor sentiment rather than direct impacts on corporate performance. He and Ma (2021) provide complementary evidence from China, demonstrating that extreme temperatures reduce firm-level stock returns, particularly for smaller, younger, more volatile, less profitable firms, and those with higher intangible assets. Ai and Gao (2023) demonstrate that firm exposure to extreme climate events increases both systematic and idiosyncratic volatility, particularly for firms with greater geographic dispersion or operating in industries where environmental issues are financially material. Huynh et al. (2020) show that severe drought conditions raise firms' cost of equity, although the effect is mitigated for firms that are geographically diversified or maintain higher cash reserves. Finally, Kruttli et al. (2025) show

that firms located in hurricane-affected regions experience large and persistent increases in option-implied volatility, reflecting market underestimation of extreme weather risk. Collectively, these studies illustrate that physical climate risks affect firm-level financial outcomes, including stock returns, volatility, and cost of capital, and that the magnitude of these effects depends on firm characteristics such as size, profitability, geographic dispersion, and industry exposure.

Of the three primary components of climate risk, regulatory risks are regarded as the most immediately relevant by investors and policymakers, since environmental regulations can directly influence firms' operating costs and cash flows (Krueger et al., 2020; Stroebe & Wurgler, 2021). These risks stem from policy, legal, and market changes driven by the transition to a low-carbon economy (Svartzman et al., 2021). Svartzman et al. (2021), who examine the role of central banks, emphasize that such risks are largely systemic and unhedgeable due to radical uncertainty, thereby requiring coordinated policy responses to safeguard financial stability. Moreover, uncertainty about future regulation itself imposes costs on firms and investors (Brogaard & Detzel, 2015; Pindyck, 1993) and can become embedded in the cost of capital even in the absence of new legislation. Consistent with this, Seltzer et al. (2022) find that firms exposed to greater climate regulatory uncertainty face higher bond yield spreads and increased cost of debt, highlighting the tangible financial consequences of regulatory risk for corporate financing decisions. Overall, these findings illustrate that regulatory climate risks are not only a source of uncertainty but also have concrete financial consequences, affecting firms' cost of capital, financing strategies, and investment decisions.

Opportunity-related factors capture the potential for corporate investment in environmental and social activities, such as renewable energy, green infrastructure, or ESG-related innovation. While these strategies may provide long-term resilience and signal managerial foresight, they often require significant upfront investment and can introduce short-term volatility. Albuquerque et al. (2020) find that firms with strong ESG ratings showed greater stock resilience and lower volatility during the COVID-19 crash, suggesting that ESG-oriented investments attract stability-seeking investors. Meanwhile, Krüger (2015) investigates how stock markets react to positive and negative events concerned with a firm's corporate social responsibility (CSR).

The author shows that markets react strongly to CSR events, which can reflect both investor appetite for “goodness” and concern about agency risk. Together, these studies suggest that opportunity-related climate strategies can support long-term value but also entail financial risk and uncertainty.

2.2 FCCE and Stock Liquidity: Evidence from the Real Estate Sector

Empirical evidence suggests that the real estate sector is particularly exposed to climate risk because it relies on fixed, location-specific assets and energy-intensive operations. Physical risks—such as flooding, wildfires, or sea-level rise—can directly damage properties and disrupt cash flows, especially rental income. Regulatory transitions, for instance via carbon pricing or energy-efficiency requirements, may limit investment flexibility and raise compliance costs. At the same time, opportunity-driven initiatives—like energy retrofits or green building certifications—can enhance long-term value but require significant upfront investments and introduce short-term financial uncertainty. Literature on real estate also indicates that REITs and other real estate firms may price in these risks: for example, Kozak et al. (2025) find that property-level climate risk is reflected in REITs’ equity and bond risk premia. These findings highlight the complex ways in which climate risk affects both the valuation and financing of real estate. Given all these financial implications, examining how climate risk translates into stock market activity, particularly through stock liquidity, remains important.

Stock liquidity reflects the ease with which securities can be traded without causing large price fluctuations, capturing both market depth and transaction costs (Amihud, 2002; Easley et al., 2010). High liquidity signals efficient price discovery and strong investor confidence, whereas low liquidity reflects information asymmetry, higher perceived risk, and reduced market participation (Brunnermeier & Pedersen, 2009).

Most prior research on stock liquidity has focused on corporate governance, macroeconomic conditions, and investor characteristics (Ammari et al., 2023; Li et al., 2023), while the potential impact of external environmental risks, such as climate change, has received comparatively little attention (Chung & Zhang, 2014). Some evidence suggests that investor sentiment can influence liquidity under extreme conditions: for instance, Ammari et al. (2023) show that

during the COVID-19 pandemic, the effect of Twitter sentiment on stock liquidity was non-linear and depended on the severity of the pandemic, highlighting how external shocks and perceived uncertainty can affect trading behavior. Theoretically, exposure to climate and environmental risks can generate greater uncertainty about future profitability. This uncertainty could increase risk aversion, reduce trading activity, and widen bid-ask spreads, ultimately impairing liquidity.

Disclosure practices also play a crucial role in shaping liquidity and overall market efficiency. Limited reporting of climate- or sustainability-related exposures exacerbates information asymmetry, which can constrain trading activity and widen bid-ask spreads (Grewal et al., 2021). Evidence from the Sustainability Accounting Standards Board (SASB) standards shows that firms voluntarily disclosing more financially material sustainability information—identified by SASB—exhibit greater price informativeness. In contrast, disclosure of non-SASB information is not associated with informativeness. These effects are more pronounced for firms with higher exposure to sustainability issues, weaker sustainability ratings, greater institutional or socially responsible investment ownership, and coverage by analysts with lower portfolio complexity. Conversely, transparent disclosure of related risks reduces uncertainty and enhances trading efficiency, enabling investors to more accurately price climate risk (Fama, 1970). According to the efficient market hypothesis, security prices in well-functioning markets should fully reflect all available information, allowing firms to make informed investment decisions and investors to allocate capital efficiently. In sectors like real estate, which are particularly exposed to tangible assets and regulatory risks, such transparency may be especially important: clear disclosure of climate-related risks can improve price informativeness and market liquidity by reducing information asymmetry and enabling more precise risk assessment.

The real estate sector is asset- and energy-intensive, making firms particularly sensitive to multiple dimensions of climate risk, including physical hazards such as flooding and operational risks related to energy efficiency (Eichholtz et al., 2012; Fuerst & Warren-Myers, 2021). While current risks (e.g., flood exposure) are often reflected in property valuations, future risks (e.g., sea-level rise) may be underpriced due to limited information, highlighting the sector's

complex climate sensitivity. Physical risks (eg., floods, hurricanes, wildfires, or heatwaves) can damage properties, reduce revenues, and increase operational and insurance costs, introducing uncertainty in future cash flows. Empirical evidence indicates that capital markets do not fully anticipate these impacts, suggesting that firms with higher physical exposure may exhibit lower stock liquidity (Pankratz et al., 2023). Regulatory and transition risks, including carbon pricing, green building standards, and emission reporting requirements, create uncertainty about future regulations and business opportunities. Investors may perceive these risks as potential costs, which can reduce trading activity and affect liquidity or financing costs (Cepni et al., 2024; Painter, 2020). Opportunity-related initiatives, such as investments in renewable energy, green certifications, or sustainable retrofits, can enhance long-term value and signal managerial foresight. However, these initiatives often involve upfront costs and uncertain short-term pay-offs, which can increase information asymmetry, heighten investor uncertainty, and potentially reduce trading activity (Albuquerque et al., 2020; Krüger, 2015).

Empirical evidence indicates that real estate firms and REITs facing higher physical and transition climate risks tend to exhibit lower market valuations and higher risk premia (Qiu et al., 2025). Although direct evidence on stock liquidity remains limited, existing research indicates that liquidity commonality—the tendency for liquidity to co-move across REITs or with broader markets—can amplify climate risks’ impact on trading conditions. Hoesli et al. (2017) demonstrate that liquidity commonality is particularly pronounced during periods of market stress and is driven by demand-side factors, implying that climate-related shocks may propagate across REIT markets and further constrain liquidity. Accordingly, we propose the following hypothesis:

H1. *FCCE is negatively associated with stock liquidity in the real estate sector.*

Given that opportunity-oriented initiatives introduce short-term ambiguity despite their long-term benefits, theoretical and empirical work suggests that these factors may play a primary role in driving the negative liquidity effect. Therefore, we propose the following hypothesis:

H2. *The negative relationship between FCCE and stock liquidity in the real estate sector is primarily driven by opportunity-related issues.*

2.3 On the Moderating Role of Climate Mitigation and Adaptation Policies

National climate mitigation policies—captured by environmental taxes, fossil fuel subsidies, and climate-regulating land coverage—constitute regulatory frameworks and associated carbon costs that can influence investor perceptions and market behavior (Cepni et al., 2024; Lee & Alam, 2024; Rentschler et al., 2017). Stricter mitigation policies can influence firm incentives toward low-carbon investment, affect capital allocation, and alter perceived risk. For example, higher environmental taxes may encourage firms to adopt greener technologies, increasing short-term uncertainty about costs but providing clearer long-term regulatory signals to investors (Lee & Alam, 2024). Similarly, fossil fuel subsidies can slow the transition to low-carbon activities, affecting both operational risk and market expectations (Rentschler et al., 2017). Climate-regulating land coverage, such as protected areas or managed forests, can shape local environmental conditions and provide more predictable contexts for real estate development, thereby affecting perceived market stability.

Adaptation policies—proxied by the frequency of climate-related disasters—reflect a country’s capacity to manage physical climate shocks (Barrios, 2023; Pagano et al., 2021). Firms operating in countries with lower disaster frequency or stronger adaptive capacity may face reduced operational uncertainty, which can influence trading activity and liquidity. Evidence indicates that investors respond to both the presence and effectiveness of adaptation strategies: firms with higher preparedness or operating in more resilient regions tend to experience smaller stock price declines during climate-related events (Carleton et al., 2022; Hsiang & Jina, 2014). Empirical studies show that greater adaptive capacity reduces the economic and financial losses associated with climate disasters, thereby stabilizing market reactions (Pagano et al., 2021). Accordingly, this evidence suggests that mitigation and adaptation policies can moderate the relationship between firm-level climate change exposure and stock liquidity by either mitigating or amplifying its effects. Accordingly, we hypothesize:

H3. *Country-level climate mitigation and adaptation policies moderate the relationship between FCCE and stock liquidity.*

3 Data and Sample Description

In this section, we describe the data sources and the sample selection process. We then explain how we construct the key variables, including our main measures of firm-level climate change exposure, stock liquidity, and firm-level control variables. Finally, we present descriptive statistics for all variables used in the empirical analysis.

3.1 Data Sources and Sample Selection

Our primary sample includes publicly listed firms from the Sautner et al. (2023) database, which provides firm-level climate change exposure (FCCE) data. Using our dataset of International Securities Identification Numbers (ISINs) for international equity markets, we extract financial and stock market data from LSEG database. We then merge these datasets and focus on firms within the Real Estate sector, distinguishing between industries: Real Estate Investment Trusts (REITs) and Real Estate Investment & Services, due to their direct exposure to climate-related risks and heightened vulnerability to environmental shocks. We also extract data on greenhouse gas (GHG) and carbon dioxide (CO₂) emissions, specifically for real estate sector and collect information on countries' climate mitigation and adaptation strategies from the International Monetary Fund (IMF) for further analyses. We complement this dataset with additional firm-level sustainability performance information from LSEG ESG. All continuous variables are winsorized at the 1st and 99th percentiles to limit the influence of outliers. Our final sample consists of 3,330 firm-year observations covering 530 firms across 40 countries from 2002 to 2022.

3.2 Measures of FCCE

We use the FCCE data as proposed by Sautner et al. (2023). This proxy aggregates all three key dimensions of climate change exposure: opportunity, regulatory, and physical. The values range from zero to one, and the higher values indicate greater exposure to climate change at the firm level (Choi, 2024). FCCE appears as a meaningful indicator of firms' involvement in the low-carbon transition (Sautner et al., 2023). Firms with higher exposure are more likely to invest in green technologies, engage in sustainable innovation, and develop environmentally

oriented patents. In addition, these measures provide information on market expectations, as they are associated with the pricing of equities and options, reflecting investor assessment of climate-related financial risks (Liu et al., 2024).

3.3 Measures of Stock Liquidity

To capture multiple dimensions of stock liquidity, we employ two complementary measures reflecting both the price impact of trades and the implicit cost of trading. The first measure is based on the Amihud illiquidity ratio (Amihud, 2002), which quantifies the daily price response to trading volume. It is calculated as the ratio of the absolute stock return to dollar trading volume for each trading day and then averaged over the year for each stock:

$$\text{Amihud}_{i,t} = \frac{1}{D_{i,t}} \sum_{d=1}^{D_{i,t}} \frac{|R_{i,d,t}|}{VOLD_{i,d,t}} \quad (1)$$

where $R_{i,d,t}$ is the return of stock i on day d of year t , $VOLD_{i,d,t}$ is the corresponding dollar trading volume, and $D_{i,t}$ is the number of trading days in year t with non-zero volume. Smaller values of Amihud's ratio indicate higher liquidity, as prices are less sensitive to trades. To enhance interpretability, we take the natural logarithm of the scaled Amihud ratio and multiply it by -1 , yielding our first liquidity proxy, Inv_Amihud , where higher values correspond to higher liquidity.

The second measure, the relative spread (RSPD), is commonly used in the literature to approximate the cost of executing market orders (Chung & Zhang, 2014; Cumming et al., 2011; Venkataraman, 2001). It is defined as the difference between the best ask and bid prices relative to the midpoint price, averaged over the trading days of a year:

$$\text{RSPD}_{i,t} = \frac{1}{D_{i,t}} \sum_{d=1}^{D_{i,t}} \frac{\text{Ask}_{i,d,t} - \text{Bid}_{i,d,t}}{(\text{Ask}_{i,d,t} + \text{Bid}_{i,d,t})/2} \quad (2)$$

Similar to the Amihud ratio, we take the natural logarithm of RSPD and multiply by -1 to obtain Inv_RSPD , where higher values indicate greater liquidity.

To reduce measurement error and provide a comprehensive measure of stock liquidity, we combine Inv_Amihud and Inv_RSPD into a single liquidity factor using factor analysis with oblique rotation (Daske et al., 2008). This factor serves as the main dependent variable in

our analyses, with higher values indicating better stock liquidity. A detailed description of all variables is provided in Appendix A.

3.4 Firm-Level Control Variables

Following prior research (Brogaard et al., 2017; Goyal & Wang, 2013), we include a comprehensive set of firm-level controls to account for observable characteristics that may influence stock liquidity. Market capitalization (Market Cap) is measured as the natural logarithm of the firm's market value at the end of the previous year, capturing firm size effects on liquidity. Market-to-book ratio (M/B) represents the ratio of market to book value of equity, reflecting growth opportunities. Return on equity (ROE) is defined as net income divided by total equity, capturing profitability. Leverage is the ratio of total debt to total assets, indicating financial risk and potential constraints on firm operations. Momentum is calculated as the average of monthly returns over the past year, controlling for return dynamics that may affect trading activity. Capital expenditures are divided by total assets, reflecting investment intensity. Property, plant, and equipment (Ln(PPE)) is the natural logarithm of PPE, capturing asset tangibility. Beta measures the stock's sensitivity to systematic risk relative to the overall market, and Volatility is defined as the standard deviation of daily stock returns over the year, both controlling for risk-related impacts on liquidity. Sales growth is included as proxy for firm performance and EPS growth are expected future profitability, which may influence investor attention and trading activity. Detailed definitions of all control variables are provided in Appendix A.

3.5 Descriptive Statistics

Table 1 presents the descriptive statistics of our main variables. The mean of FCCE exposure (FCCE) is 0.639 with a standard deviation of 1.127, indicating substantial heterogeneity across real estate companies in our sample. This variation suggests that not all firms are equally exposed to climate-related risks and opportunities. Concerning liquidity measures, the average values of *Inv_RSPD* and *Inv_Amihud* are 6.244 and 8.669, respectively, which are in line with prior studies on stock liquidity (Brockman et al., 2009; Chung et al., 2010).

In Table 2, we present further details about the distribution of our sample by country, reporting the number of firm-year observations, the average value of FCCE, the average value of the

Liquidity Factor, and the average values of *Inv_Amihud* and *Inv_RSPD*. The first two columns show that sample coverage is higher in developed markets, particularly in the United States, Canada, the United Kingdom, and Australia. The United States exhibits the largest representation, with 207 firms and 1,534 firm-year observations, followed by Canada (56 firms, 324 observations). The third column highlights that FCCE varies considerably across countries. Real estate firms in emerging or environmentally vulnerable economies such as the Philippines, Chile, and South Africa exhibit higher FCCE, while those in developed markets such as the United States, Canada, and the United Kingdom display relatively lower exposure. The fourth column presents the sample mean of the Liquidity Factor and indicates notable cross-country differences: highly developed markets such as Japan, the United Kingdom, and the United States exhibit higher liquidity, whereas smaller or less liquid markets such as Malaysia and Argentina display weaker liquidity conditions. *Inv_Amihud* and *Inv_RSPD* show a similar pattern, reflecting variations in trading costs and market depth across markets. Overall, these descriptive statistics underscore substantial cross-country heterogeneity in both FCCE and stock liquidity. They suggest that developed financial markets generally provide higher liquidity, while firms in emerging or environmentally sensitive economies tend to face greater climate-related risks. These patterns provide a solid foundation for examining the impact of FCCE on stock liquidity in the real estate sector at the firm level.

Table 3 presents the correlation coefficients among the main variables used in this study. The correlation between FCCE and the Liquidity Factor is -0.034 , providing preliminary support for H1. This negative association suggests that higher FCCE is associated with slightly lower stock liquidity in the real estate sector, consistent with the notion that firms facing greater environmental risks may experience reduced trading activity. Other firm characteristics, such as market capitalization (0.123) and leverage (-0.069), display only weak correlations with FCCE, indicating that the latter captures a dimension of firm risk largely independent of firm size or financial structure. Overall, these descriptive statistics offer an initial indication of the relationship between FCCE and stock liquidity in the real estate sector. The next section investigates this relationship more rigorously using multiple regression models that control for firm size, profitability, leverage, and other relevant characteristics.

4 Baseline Regression Results

4.1 FCCE and Stock liquidity

In this section, we conduct regression analyses to examine the relationship between the stock liquidity and FCCE, while controlling for various other factors known to be correlated with stock liquidity. Specifically, we estimate the following baseline model:

$$\text{Liquidity Factor}_{i,t} = \alpha + \beta \cdot \text{FCCE}_{i,t} + \gamma \cdot \text{Controls}_{i,t} + \text{Fixed Effects} + \epsilon_{i,t} \quad (3)$$

where $\text{Liquidity Factor}_{i,t}$ is the dependent variable that aggregates the *Inv_Amihud* and *Inv_RSPD* for firm i in year t , and $\text{FCCE}_{i,t}$ is the measure of FCCE for firm i in year t which is our main explanatory variable. $\text{Controls}_{i,t}$ is a vector of control variables including market capitalization, market-to-book ratio, return on equity (ROE), leverage, momentum, capital expenditures to total assets, the natural logarithm of plant, property & equipment (PPE), beta, volatility, sales growth, and EPS growth. The variable descriptions are presented in Appendix A. We include *Year*, *Industry*, and *Country* fixed effects to control for time-specific, industry specific and country-specific unobserved heterogeneity, respectively. These fixed effects are implemented to isolate the impact of FCCE on stock liquidity by accounting for potential confounding factors. The standard errors are robustly clustered. We begin by estimating the baseline regression model to examine the relationship between FCCE and stock liquidity in real estate firms. Table 4 reports the results. Consistent with Hypothesis H1, we find a statistically significant negative relationship between FCCE and stock liquidity. Specifically, a one standard deviation increase in FCCE corresponds to an approximate 2.5% decline in the standard deviation of stock liquidity. This finding suggests that higher exposure to climate-related risks—whether physical, regulatory, or opportunity-related—heightens investor uncertainty and information asymmetry, thereby reducing trading activity and impairing market efficiency in the real estate sector.

In columns (2) to (4), we decompose FCCE into its three components—opportunity-related (FCOE), regulatory-related (FCRE), and physical risk-related (FCPE)—to identify which dimension drives the negative association with stock liquidity. The results show that opportunity-related exposure (FCOE) has a statistically significant negative impact on liquidity, while reg-

ulatory (FCRE) and physical (FCPE) exposures do not show significant effects. This indicates that firms engaging more actively in climate-related opportunities may face greater investor uncertainty, leading to wider bid-ask spreads and reduced trading activity. Overall, the baseline regression results support the first two hypotheses: FCCE is negatively associated with stock liquidity (H1), and this negative effect is primarily reflected in the opportunity-related component of FCCE (H2).

4.2 Addressing Endogeneity: Instrumental Variable Approach

Reverse causality may be a concern in our setting, as firms with lower liquidity might increase their climate-related discourse to attract institutional investors or enhance market perception. Similarly, omitted variable bias could arise from unobservable firm characteristics—such as governance quality or strategic orientation—that affect both FCCE and liquidity. To address potential endogeneity, we estimate a two-stage least squares (2SLS) regression using environmental products (Env. products) as an instrumental variable (IV) for FCCE. This instrument captures whether a firm reports at least one product line or service with positive environmental effects, making it relevant for determining FCCE while plausibly exogenous to stock liquidity. The 2SLS approach isolates the exogenous variation in FCCE related to firms' engagement in environmentally oriented product development.

As shown in Table 5, the first-stage regression confirms that Env. products is positively and significantly associated with FCCE, and the F-statistic indicates the instrument is sufficiently strong. In the second stage, the coefficient of the instrumented FCCE remains negative and statistically significant, reinforcing the baseline finding that higher FCCE reduces stock liquidity. This provides stronger evidence of a causal relationship, supporting Hypothesis 1. Even after accounting for potential reverse causality, firms with greater exposure to climate-related topics exhibit lower stock liquidity, highlighting climate risk as an important determinant of market efficiency in the real estate sector.

4.3 Robustness check

To ensure the robustness of our main findings, we conduct several additional tests using alternative subsamples. First, given the high representation of U.S. firms in our dataset, we

examine whether the results hold when focusing exclusively on U.S. firms (Column 1) or when excluding U.S. observations (Column 2). The results of Table 6 show that the negative relationship between FCCE and stock liquidity remains consistent when U.S. firms are excluded, while the coefficient is smaller and not statistically significant when considering only U.S. firms. This indicates that the main effect is not driven solely by the large U.S. sample and is relevant across different markets. Second, to address potential distortions from extreme market conditions, we further exclude data from the years 2008–2009 and re-estimate the regression analysis (Column 3). The results remain largely unchanged, confirming that our baseline findings are not driven by the unusual market conditions of 2008–2009 financial crisis. Overall, these robustness checks reinforce the validity of our conclusions: higher FCCE is associated with lower stock liquidity in real estate firms, and this effect is broadly consistent across subsamples and market conditions.

5 Possible Channels: Country-Level Climate Mitigation and Adaptation Policies

To better understand the FCCE–liquidity relationship, we examine the moderating effect of national climate strategies through two distinct channels. The first channel captures climate mitigation efforts, proxied by three indicators: (1) environmental taxes—taxes based on physical units with proven environmental impact, expressed as a percentage of GDP; (2) fossil fuel subsidies—the extent to which consumer fuel prices fail to reflect their full financial and social costs, also expressed as a percentage of GDP; and (3) land area—changes in land cover over time, classified as climate-influencing, climate-regulating, or climate-neutral. These IMF-defined mitigation indicators reflect the regulatory environment and the strength of policy signals that guide investors’ expectations and pricing of climate-related risks. The second channel captures climate adaptation initiatives, proxied by the total number of natural disasters and storm-related disasters exacerbated by climate change. These IMF-defined adaptation indicators reflect a country’s exposure to and resilience against climate shocks. Examining both channels enables us to assess whether the broader institutional and environmental context mitigates or amplifies the negative effect of FCCE on stock liquidity, as proposed in H3. The

relationship is estimated using the following model:

$$\begin{aligned} \text{Liquidity Factor}_{i,t} = & \alpha + \beta_1 \cdot \text{FCCE}_{i,t} + \beta_2 \cdot \text{Moderator}_{i,t} \\ & + \beta_3 \cdot \text{FCCE}_{i,t} \times \text{Moderator}_{i,t} + \gamma \text{Controls}_{i,t} + \text{Fixed Effects} + \epsilon_{i,t} \quad (4) \end{aligned}$$

where the *Moderator* variables represent country-level mitigation or adaptation measures. Equation 4 includes the same controls as the baseline model and incorporates year, industry, and country fixed effects, with standard errors robustly clustered. The coefficient β_3 is the key parameter of interest, capturing how country-level policies moderate the relationship between FCCE and liquidity.

Panel A of Table 7 presents the results for country-level climate mitigation strategies. We find that higher environmental taxes are positively and significantly associated with stock liquidity, suggesting that stronger fiscal measures which supports environmental protection contribute to more liquid real estate markets. However, the interaction term between FCCE and environmental taxes is negative and significant at the 5% level, indicating that the adverse effect of FCCE on liquidity is more pronounced in countries with more stringent environmental taxes. Similarly, Fossil Fuel Subsidies exhibit a weakly positive direct effect on liquidity, but the negative and significant interaction with FCCE shows that in countries with large fossil fuel subsidies—where the transition toward low-carbon activities is slower—the negative impact of climate exposure on liquidity is stronger. By contrast, Land Area Coverage has a positive direct effect on liquidity, and the FCCE $\times$ Land Area interaction is also positive and significant, suggesting that more extensive or better-managed land coverage partially mitigates the adverse effect of FCCE by providing a more stable and transparent environment for investors.

Panel B reports the results for climate adaptation strategies, proxied by the frequency of natural disasters and storm-related events. The positive and significant interactions with FCCE indicate that in countries more frequently affected by climate-related disasters, the negative impact of firm-level climate exposure on liquidity is partially alleviated. However, when examining disaggregated disaster categories—such as droughts, floods, or wildfires—these interactions are not significant, implying that only broader or recurrent events meaningfully influence

investor behavior. Overall, while adaptation measures help reduce liquidity pressures, they do not fully offset the risks associated with high FCCE.

Taken together, these findings show that country-level climate policies shape the financial consequences of firm-level climate exposure supporting evidence to H3 but in distinct ways: mitigation measures (environmental taxes and fossil fuel subsidies) tend to amplify the adverse liquidity effects for highly exposed firms, whereas adaptation measures provide partial relief by increasing market resilience in countries accustomed to recurring climate shocks.

6 Additional Analysis

6.1 The Role of Environmental Emissions in the Real Estate Sector

Country-sector environmental emissions provide important context for understanding the financial implications of FCCE. We focus on two key measures—GHG emissions and CO₂ emissions in the real estate sector—which capture the overall environmental performance of the sector. These indicators reflect the extent to which firms operate in more carbon-intensive environments, potentially shaping investors’ assessment of climate-related risks.

Panel A of Table 8 reports the interaction between FCCE and environmental emissions. In both specifications, the direct effects of GHG and CO₂ emissions on liquidity are statistically insignificant, indicating that aggregate sector-level emissions alone do not directly drive differences in stock liquidity. However, the interaction terms between FCCE and both GHG and CO₂ emissions are positive and highly significant at the 1% level. This suggests that in more carbon-intensive country-sector contexts, the negative effect of FCCE on stock liquidity is partially mitigated. A possible explanation is that in high-emission economies, investors and institutions are more accustomed to integrating climate-related risks and regulatory developments into their valuations. Consequently, they may better assess firm-level climate exposure, reducing uncertainty and alleviating the liquidity pressures typically associated with FCCE. Alternatively, firms operating in these environments may face more established disclosure frameworks or stronger policy expectations, enhancing transparency and investor confidence despite higher national emissions.

Taken together, these findings indicate that while FCCE continues to exert a negative impact

on liquidity, this effect is attenuated in high-emission real estate sectors, suggesting that investor behavior and market dynamics are shaped by how familiar or adaptive a country-sector is to carbon-related risks. These results underscore the importance of accounting for both firm-level climate exposure and the broader country-sector environmental context when evaluating the financial implications of climate change in the real estate sector.

6.2 The role of sustainability performance

To complement our main analysis on FCCE, we examine the effect of firm-level sustainability performance, distinct from climate change exposure, on stock liquidity. Specifically, we use alternative variables reflecting a company's environmental management practices and overall sustainable performance. The first variable, corporate responsibility awards, measures the number of external sustainability or CSR awards received by a firm, signaling strong non-financial performance and a visible commitment to environmental and social responsibility. The second variable, environmental supply chain monitoring, captures the extent to which a firm tracks the environmental performance of its supply chain, including emissions, resource use, and supplier compliance, thereby reflecting upstream environmental management. The third, environmental resource impact control, measures a firm's internal processes to assess and manage the environmental impact of resources such as energy, water, and materials, indicating operational efficiency and environmental stewardship. We also include two quantitative indicators: the emission score, which assesses a company's commitment and effectiveness in reducing environmental emissions in its operations, and the resource use score, which reflects its performance and capacity to reduce the use of materials, energy, and water, and to implement more eco-efficient solutions through supply chain management.

Table 9 presents the relationship between these environmental practices and stock liquidity in the real estate sector. Across various specifications, we find a consistently positive and significant association between firms' environmental initiatives and liquidity. Firms receiving corporate responsibility awards exhibit higher liquidity, suggesting that visible recognition of sustainability and corporate responsibility is valued by investors. Similarly, firms that actively monitor their environmental supply chains or implement resource impact controls show im-

proved liquidity, highlighting investor confidence in proactive operational environmental management. Moreover, environmental performance scores—both for emissions reduction and resource use efficiency—are positively associated with liquidity, indicating that measurable improvements in environmental performance translate into tangible market benefits.

Overall, these results suggest that investors reward proactive firm-level sustainability performance, whether through formal recognition, operational management, or quantifiable performance gains, and that such initiatives can help alleviate liquidity constraints in the real estate sector.

7 Conclusion

This study examines the relationship between FCCE and stock liquidity using an international sample of real estate firms from 2002 to 2022. The results reveal a persistent and statistically significant negative association between FCCE and stock liquidity, suggesting that higher climate exposure increases information asymmetry and investor uncertainty, thereby reducing market efficiency. Among FCCE components, opportunity-related factors exert the strongest effect, indicating that investors perceive climate-related opportunities as complex and difficult to price in the short term. These findings are robust across alternative specifications, including firm fixed effects and instrumental variable estimations, supporting a causal interpretation. Subsample analyses show that the negative FCCE–stock liquidity relationship is not driven solely by US markets or extreme events such as the 2008–2009 financial crisis.

Further analyses underscore the pivotal role of environmental and institutional contexts in shaping the FCCE–liquidity relationship. Mitigation and adaptation policies act asymmetrically: stronger mitigation frameworks, like environmental taxes, tend to increase the perceived costs of climate exposure, while adaptation capacity and experience with climate-related disasters mitigate adverse liquidity effects by fostering investor familiarity and resilience. At the country-sector level, higher GHG and CO₂ emissions weaken the negative FCCE–liquidity relationship, suggesting that investors in more carbon-intensive environments are better equipped to assess and price climate risks.

Complementary evidence from firm-level environmental and climate-related practices of-

fers additional insights into how proactive sustainability can ease liquidity constraints in the real estate sector. Firms receiving external sustainability or CSR awards, actively monitoring environmental performance across supply chains, or implementing internal environmental controls demonstrate higher liquidity. Likewise, stronger emission reductions and resource efficiency are associated with improved market liquidity. These results indicate that credible, measurable environmental actions reduce information asymmetry, boost investor confidence, and enhance market access, thus linking sustainability efforts directly to financial performance in real estate firms.

Overall, the findings contribute to the growing literature on climate change's financial consequences by showing that FCCE affects not only valuation and risk but also secondary market functioning. While climate exposure reduces liquidity, institutional adaptation and firm-level environmental engagement can counterbalance this effect. For firms, integrating climate considerations into strategy and operations improves liquidity profiles and lowers capital costs. For investors, incorporating FCCE and environmental performance metrics enhances portfolio resilience. For policymakers, strengthening disclosure standards and supporting transparent practices reduces market frictions and promotes financial stability.

In conclusion, climate change poses environmental, regulatory, and financial challenges that directly impact market mechanisms like liquidity. By integrating firm-level exposure, policy contexts, and corporate practices, this study provides a comprehensive view of climate risk-response interactions in real estate. Future research could extend this framework to other sectors or examine evolving disclosure standards and regulations' effects on liquidity over time.

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Table 1: Summary statistics

Variable	N	Mean	sd	p25	Median	p75
FCCE	3,330	0.639	1.127	0.082	0.279	0.693
FCOE	3,330	0.150	0.458	0.000	0.000	0.135
FCRE	3,330	0.045	0.192	0.000	0.000	0.000
FCPE	3,330	0.009	0.054	0.000	0.000	0.000
Inv_rspd	3,330	6.244	1.313	5.258	6.296	7.310
Inv_amihud	3,330	8.669	2.561	7.449	8.883	10.110
Liquidity Factor	3,330	0.443	0.831	-0.080	0.531	1.070
Market cap	3,330	15.201	1.737	14.132	14.983	16.058
Market-to-book	3,330	1.875	2.330	0.890	1.240	2.060
ROE	3,330	0.292	2.172	0.081	0.123	0.202
Leverage	3,330	0.418	0.160	0.320	0.421	0.512
Momentum	3,330	0.009	0.027	-0.000	0.009	0.018
Capitalexpend	3,330	7.241	9.299	1.780	4.200	9.210
LnPPE	3,330	15.031	2.050	14.196	15.079	16.020
Beta	3,330	0.967	0.559	0.583	0.890	1.250
Volatility	3,330	0.081	0.091	0.048	0.064	0.092
Salesgrowth	3,330	0.002	6.327	-0.107	0.001	0.101
EPSgrowth	3,330	0.618	7.867	-0.355	0.000	0.386

This table reports summary statistics for the 3,330 firm-year observations in the sample, covering the period 2002–2022. The variables are defined in Appendix A. For each variable, the table shows the mean, standard deviation, 25th percentile (P25), median, and 75th percentile (P75), providing an overview of the distribution and variability of the main measures used in the analysis.

Table 2: Summary statistics of climate change exposure and liquidity by market

Market	N	Mean (FCCE)	Mean (Liquidity Factor)	Mean(Inv_Amihud)	Mean(Inv_RSPD)
Argentina	2	0.135	-1.421	3.095	3.954
Australia	215	1.118	-0.470	7.841	4.227
Austria	16	0.712	0.157	7.359	6.107
Belgium	14	0.345	0.264	7.838	6.164
Bermuda	18	0.623	-0.113	7.599	5.283
Brazil	59	0.336	0.122	8.504	5.476
Canada	324	0.478	-0.305	6.953	5.079
Cayman Islands	42	0.691	0.486	9.857	5.797
Chile	7	2.221	0.508	12.945	4.403
China	6	0.687	0.830	10.421	6.438
Finland	25	0.423	-0.157	6.470	5.698
France	77	0.804	0.361	8.026	6.331
Germany	97	0.818	-1.287	1.611	5.005
Hong Kong	72	0.775	0.802	10.859	6.159
India	58	0.300	0.676	10.023	6.222
Ireland	3	1.890	-0.502	6.660	4.700
Israel	17	0.405	0.331	8.121	6.206
Italy	28	0.392	-0.112	7.276	5.437
Japan	94	1.438	1.301	13.721	6.128
Jersey	8	0.482	-0.641	5.182	5.027
Luxembourg	25	0.547	-1.226	2.618	4.694
Malaysia	1	0.420	-2.089	1.350	3.016
Mexico	47	1.025	0.174	9.142	5.312
Netherlands	21	0.619	0.319	7.746	6.351
New Zealand	40	0.866	-0.655	6.295	4.469
Norway	6	0.766	-0.012	7.674	5.513
Philippines	13	3.376	0.515	11.152	5.266
Poland	4	1.385	-0.872	5.328	4.351
Qatar	1	0.000	-0.393	7.573	4.558
Russia	3	1.142	0.792	9.947	6.561
Singapore	87	0.507	0.153	8.857	5.392
South Africa	17	1.882	0.323	9.127	5.711
Spain	19	0.708	0.268	7.155	6.495
Sweden	36	1.526	0.673	9.602	6.411
Switzerland	39	0.605	0.474	8.134	6.578
United Arab Emirates	7	0.580	0.144	9.309	5.154
United Kingdom	248	0.886	1.050	11.802	6.370
United States	1534	0.450	0.805	8.879	7.099
Total	3330	0.639	0.443	8.669	6.244

This table reports the summary statistics of firm-level climate change exposure (FCCE) and liquidity measures by market. The sample includes 3,330 firm-year observations from 2002 to 2022. For each market, the table presents the number of observations (N), the mean FCCE, and the mean values of the liquidity measures (Liquidity Factor, Inv_Amihud, and Inv_RSPD), providing an overview of cross-country variation in climate exposure and market liquidity within the real estate sector.

Table 3: Correlation Matrix

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	
Liquidity Factor	[1]	1.000												
FCCE	[2]	-0.034	1.000											
Market cap	[3]	0.538	0.123	1.000										
Market-to-book	[4]	0.210	-0.030	0.087	1.000									
ROE	[5]	-0.039	-0.014	-0.068	0.057	1.000								
Leverage	[6]	0.024	-0.069	-0.207	0.159	0.000	1.000							
Momentum	[7]	0.096	-0.001	0.086	0.026	-0.008	-0.051	1.0000						
Capitalexpend	[8]	0.067	-0.050	-0.116	-0.009	-0.036	0.116	0.098	1.000					
LnPPE	[9]	0.384	0.139	0.725	-0.117	-0.146	0.039	-0.017	-0.004	1.000				
Beta	[10]	0.061	-0.049	-0.025	-0.020	0.096	0.014	0.031	-0.126	-0.129	1.000			
Volatility	[11]	-0.159	-0.033	-0.131	0.006	0.060	0.045	-0.104	-0.093	-0.106	0.150	1.000		
Salesgrowth	[12]	-0.005	-0.002	0.010	-0.006	-0.002	-0.003	0.014	0.012	0.006	-0.016	-0.015	1.000	
EPSgrowth	[13]	0.005	-0.016	0.016	0.008	-0.005	-0.040	0.0128	-0.006	0.013	0.018	0.002	0.005	1.000

This table reports the correlation coefficients among the main variables used in the study, including the Liquidity Factor, firm-level climate change exposure (FCCE), and key control variables from the baseline regression model. Variable definitions are provided in Appendix A.

Table 4: Firm-level climate change exposure and stock liquidity

	Liquidity factor (1)	Liquidity factor (2)	Liquidity factor (3)	Liquidity factor (4)
FCCE	-0.025*** (-3.32)			
FCOE		-0.028*** (-4.68)		
FCRE			-0.015 (-1.36)	
FCPE				0.007 (1.56)
Market Cap	0.754*** (50.06)	0.755*** (50.22)	0.755*** (50.21)	0.755*** (50.43)
Market-to-book	0.008 (0.92)	0.008 (0.94)	0.008 (0.91)	0.008 (0.89)
ROE	0.016*** (2.85)	0.016*** (2.90)	0.016*** (2.86)	0.015*** (2.84)
Leverage	0.047*** (5.07)	0.048*** (5.12)	0.046*** (4.98)	0.047*** (5.04)
Momentum	-0.010 (-1.13)	-0.010 (-1.04)	-0.011 (-1.16)	-0.010 (-1.11)
Capital Exp	0.006 (0.89)	0.007 (0.99)	0.006 (0.91)	0.007 (0.95)
LnPPE	-0.003 (-0.20)	-0.004 (-0.27)	-0.003 (-0.20)	-0.004 (-0.31)
Beta	0.031*** (3.06)	0.031*** (3.14)	0.031*** (3.17)	0.032*** (3.23)
Volatility	-0.051*** (-4.69)	-0.051*** (-4.69)	-0.051*** (-4.68)	-0.050*** (-4.67)
Sales Growth	0.003 (0.71)	0.003 (0.71)	0.003 (0.71)	0.003 (0.72)
EPS Growth	-0.005 (-1.09)	-0.004 (-1.06)	-0.004 (-1.08)	-0.004 (-1.06)
Intercept	0.001 (0.12)	0.001 (0.12)	0.001 (0.12)	0.001 (0.12)
Year-Industry-Country FE	Yes	Yes	Yes	Yes
<i>N</i>	3328	3328	3328	3328
Adj. <i>R</i> ²	0.876	0.876	0.875	0.875

This table presents the main findings on the relationship between firm-level climate change exposure and stock liquidity. It uses four distinct proxies to capture various aspects of firm-level climate change exposure: the overall firm-level climate change exposure (FCCE), as well as three more granular proxies—operational (FCOE), regulatory (FCRE), and physical (FCPE). FCCE measures the overall firm's climate change exposure, while FCOE captures opportunity-related exposure, FCRE represents regulatory-related exposure by measuring the frequency of words related to climate change regulations and FCPE focuses on exposure to physical climate risks by examining the frequency of words related to natural disasters and climate change. All variables are standardized for easier interpretation. Variable descriptions and data sources are provided in Table A. We control for year, industry, and country fixed effects. T-statistics, computed using clustered robust standard errors, are shown in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 5: **Instrumental variable approach**

	<i>1st Stage</i>	<i>2nd Stage</i>
	FCCE	Liquidity_factor
	(1)	(2)
Env. products	0.125*** (5.99)	
FCCE		-0.294** (-2.42)
Market Cap	-0.053 (-1.51)	0.361*** (14.24)
Market-to-book	0.024 (1.17)	0.088*** (5.85)
ROE	0.002 (0.14)	0.004 (0.33)
Leverage	-0.061*** (-2.64)	-0.007 (-0.39)
Momentum	0.004 (0.13)	-0.026 (-1.05)
Capital Exp	-0.015 (-0.68)	0.036** (2.17)
LnPPE	0.149*** (4.64)	0.066** (2.15)
Beta	-0.025 (-1.11)	0.062*** (3.75)
Volatility	0.013 (0.34)	-0.309*** (-10.68)
Sales Growth	-0.006 (-0.32)	-0.010 (-0.80)
EPS Growth	-0.013 (-0.75)	-0.012 (-0.92)
Intercept	0.214*** (4.67)	-0.717*** (-16.90)
Year-Industry-Country FE	Yes	Yes
Observations	2552	2552
Adjusted R^2	0.047	0.435
First-stage F-statistics	35.598 (Prob > F = 0.000)	N/A
Wu-Hausman F(1,2537)		= 3.595 (p = 0.058)

This table presents the results of the instrumental variable (IV) two-stage least squares (2SLS) regression estimation. The instrument used is Environmental Products defined as whether the company reports on at least one product line or service designed to have positive environmental effects. Detailed descriptions and data sources for these variables are provided in Table A. All variables are standardized for easier interpretation. Variable descriptions and data sources are provided in Table A. We control for year, industry, and country fixed effects. T-statistics, computed using clustered robust standard errors, are shown in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 6: **Robustness check**

	the US (1)	Exclude the U.S (2)	Exclude GFC period (3)
FCCE	0.003 (0.35)	-0.024*** (-2.66)	-0.024*** (-3.14)
Market Cap	0.728*** (36.85)	0.745*** (35.46)	0.748*** (48.66)
Market-to-book	0.002 (0.29)	0.019 (0.85)	0.004 (0.42)
ROE	0.185* (1.80)	0.011*** (2.81)	0.014*** (3.04)
Leverage	0.016* (1.67)	0.078*** (4.80)	0.044*** (4.43)
Momentum	-0.005 (-1.17)	-0.047** (-2.17)	-0.010 (-1.11)
Capital Exp	0.007 (0.99)	0.007 (0.61)	0.003 (0.38)
LnPPE	0.014 (0.75)	-0.002 (-0.09)	-0.005 (-0.36)
Beta	0.021* (1.79)	0.064*** (4.01)	0.037*** (3.62)
Volatility	-0.051*** (-5.29)	-0.089** (-2.41)	-0.046*** (-6.55)
Sales Growth	-0.054 (-0.94)	0.008*** (2.72)	0.005 (1.31)
EPS Growth	-0.003 (-0.96)	0.027* (1.87)	-0.010 (-0.55)
Intercept	0.541*** (58.86)	-0.433*** (-31.01)	0.011* (1.77)
Year-Industry-Country FE	Yes	Yes	Yes
Observations	1534	1794	3097
Adjusted R^2	0.855	0.884	0.877

This table reports regression results using alternative subsamples. Specifically, Column 1 focuses exclusively on U.S. firms, while Column 2 excludes observations from the U.S. In Column 3, we remove observations from the Global Financial Crisis (GFC) period and re-estimate the regression. All variables are standardized for easier interpretation. Variable descriptions and data sources are provided in Table A. We control for year, industry, and country fixed effects. T-statistics, computed using clustered robust standard errors, are shown in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 7: **The Role of Country-level Climate Mitigation and Adaptation Strategies**

Panel A: Country-level Climate Mitigation Strategies			
	Liquidity_factor (1)	Liquidity_factor (2)	Liquidity_factor (3)
FCCE	-0.013** (-2.12)	-0.024*** (-2.60)	-0.015** (-2.14)
Environmental Taxes	0.188** (2.41)		
FCCE $\times$ Environmental Taxes	-0.015** (-2.08)		
Fossil Fuel Sub		0.076* (1.91)	
FCCE $\times$ Fossil Fuel Sub		-0.018*** (-3.21)	
Land Area			3.691*** (3.06)
FCCE $\times$ Land Area			0.021*** (3.02)
Intercept	0.050*** (7.30)	0.002 (0.28)	0.001 (0.11)
Country-Year-Industry FE	Yes	Yes	
Observations	2635	2114	3188
Adjusted R^2	0.880	0.903	0.876
Panel B: Country-level Climate Adaptation Strategies			
	Liquidity_factor (1)	Liquidity_factor (2)	
FCCE	-0.017*** (-2.68)	-0.012* (-1.75)	
Total Disasters NB	-0.030 (-1.52)		
FCCE $\times$ Total Disasters NB	0.020*** (2.87)		
Nb Storm Disasters		0.047* (1.86)	
FCCE $\times$ Nb Storm Disasters		0.019*** (2.83)	
Intercept	0.034*** (5.43)	0.100*** (14.30)	
Country-Year-Industry FE	Yes	Yes	
Observations	2969	2560	
Adjusted R^2	0.884	0.882	

This table presents the moderating effect of countries' mitigation and adaptation strategies on the relationship between FCCE and stock liquidity. In Panel A, countries' mitigation strategies are measured through Environmental Taxes, Fossil Fuel Subsidies and Land Area. In Panel B, countries' adaptation strategies are measured through Climate-related disaster frequency and storm disaster frequency. Although omitted from the table for brevity, the results include control variables as shown in Table 4. All variables are standardized for easier interpretation. Variable descriptions and data sources are provided in Table A. We control for year, industry, and country fixed effects. T-statistics, computed using clustered robust standard errors, are shown in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 8: **The Role of Environmental Emissions in the Real Estate Sector**

	Liquidity_factor (1)	Liquidity_factor (2)
FCCE	-0.015** (-2.19)	-0.015** (-2.21)
GHG Emissions	0.080 (0.72)	
FCCE $\times$ GHG Emissions	0.027*** (3.38)	
CO2 Emissions		0.091 (0.81)
FCCE $\times$ CO2 Emissions		0.026*** (3.36)
Intercept	0.005 (0.82)	0.005 (0.81)
Country-Year-Industry FE	Yes	Yes
Observations	3260	3260
Adjusted R^2	0.876	0.876

This table presents the role of environmental emissions in the real estate sector on the relationship between FCCE and stock liquidity. The environmental emissions are measured through GHG emissions and CO2 emissions. GHG emissions (CO2 emissions) represent annual greenhouse gas emissions (CO2 emissions) resulting from each region's economic activity for buildings and other sectors. Although omitted from the table for brevity, the results include control variables as shown in Table 4. All variables are standardized for easier interpretation. Variable descriptions and data sources are provided in Table A. We control for year, industry, and country fixed effects. T-statistics, computed using clustered robust standard errors, are shown in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 9: **Alternative Independent Variables: Firm-level Environmental and Climate-related Practices**

	Liquidity_factor (1)	Liquidity_factor (2)	Liquidity_factor (3)	Liquidity_factor (4)	Liquidity_factor (5)
Corporate responsibility awards					
Corporate Responsibility Awards	0.022*** (3.01)				
Environmental management and operational practices					
Environmental Supply Chain Monitori		0.025*** (4.29)			
Environmental resource Impact Contr			0.006*** (7.83)		
Environmental performance scores					
Emission Score				0.018** (2.04)	
Resource Use Score					0.029*** (3.53)
Intercept	0.058*** (8.05)	-0.320*** (-12.69)	0.056*** (7.82)	0.059*** (8.03)	0.060*** (8.20)
Country-Year-Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	2550	487	2557	2556	2556
Adjusted R ²	0.888	0.905	0.887	0.888	0.888

This table presents alternative firm-level environmental and climate-related practices as independent variables. Corporate Responsibility Awards measures the number of external sustainability or CSR awards received, signaling strong non-financial performance and commitment to environmental and social responsibility. Environmental Supply Chain Monitoring captures the extent to which a firm tracks the environmental performance of its suppliers, including emissions, resource use, and compliance, reflecting upstream environmental management. Environmental Resource Impact Control measures internal processes to assess and manage the environmental impact of resources such as energy, water, and materials, indicating operational efficiency and stewardship. Emission Score assesses a firm's effectiveness in reducing operational emissions, while Resource Use Score reflects its performance in reducing energy, material, and water use, including eco-efficient supply chain practices. Controls are included as in Table 4 but omitted here for brevity. All variables are standardized. T-statistics, computed with clustered robust standard errors, are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Variable definitions and data sources are provided in Table A.

Appendix A: Variable names and definitions

Variables	Description	Sources
Panel A: Climate change exposure measures		
FCCE	The firm-level climate change exposure measure developed by Sautner et al. (2023a) employs a machine-learning approach. It assesses the relative frequency of climate change-related bigrams in corporate discussions during earnings conference calls. Multiplied by 1000 for clarity.	Sautner et al. (2023)
FCOE	Opportunity-related measure capturing frequency of bigrams about climate change opportunities. Multiplied by 1000 for exposition.	Sautner et al. (2023)
FCRE	Regulatory-related measure capturing frequency of bigrams about regulatory aspects of climate change. Multiplied by 1000 for exposition.	Sautner et al. (2023)
FCPE	Physical-related measure capturing frequency of bigrams about physical aspects of climate change. Multiplied by 1000 for exposition.	Sautner et al. (2023)
Panel B: Liquidity measures		
Liquidity Factor	Aggregation of liquidity proxies into a single factor using factor analysis. Higher values indicate lower liquidity.	Authors' calculations
Inv_RSPD	Inverse of the relative spread: difference between best ask and bid quotes as a fraction of the midpoint price.	LSEG
Inv_Amihud	Inverse of Amihud's illiquidity measure (absolute return divided by volume).	LSEG
Panel C: Controls		
Market capitalization	Logarithm of the firm's market capitalization (year N-1).	LSEG
Market-to-Book	Ratio of market to book value (year N-1).	LSEG
ROE	Net income divided by total equity (year N-1).	LSEG
Leverage	Total debt to total assets (year N-1).	LSEG
Momentum	Average of monthly returns over the last year.	LSEG
Capital expenditures	Capital expenditures to total assets (year N-1).	LSEG
Ln(PPE)	Logarithm of property, plant & equipment (year N-1).	LSEG
Beta	Stock's volatility relative to the market (year N-1).	LSEG
Volatility	Standard deviation of stock returns (year N-1).	LSEG
Sales growth	Sales growth rate (year N-1).	LSEG
EPS growth	Earnings per share growth (year N-1).	LSEG
Panel D: Additional variables		
Environmental products	Whether the company reports at least one product or service with a positive environmental impact.	LSEG
Environmental Taxes	Tax based on a physical unit with negative environmental impact, as % of GDP.	IMF
Fossil Fuel Subsidies	Extent to which fossil fuel prices do not reflect full costs, as % of GDP.	IMF
Land Area	Changes in land cover over time, grouped into climate influencing, regulating, and neutral types.	IMF
Climate disasters	Number of natural disasters exacerbated by climate change.	IMF
Storm Climate disasters	Number of storm disasters exacerbated by climate change.	IMF
GHG emissions	Annual GHG emissions from buildings and other sectors.	IMF
CO2 emissions	Annual CO2 emissions from buildings and other sectors.	IMF
Corporate Responsibility Awards	Counts of sustainability or CSR awards received by a firm.	LSEG
Environmental Supply Chain Monitoring	Extent to which a firm monitors environmental performance of its supply chain.	LSEG
Environmental resource Impact Control	Captures firm's processes to assess/manage environmental impact of resources.	LSEG
Emission Score	Company's commitment and effectiveness in reducing environmental emissions.	LSEG
Resource Use Score	Company's performance and capacity to reduce materials, energy, or water use.	LSEG