Sea Level Rise Risk and the Cost of Equity Capital

Chris Florackis[1] Yujia Wang[2] Yang Zhao[3]

November 2024

Abstract

Rising sea levels bring significant challenges and uncertainties to firms in low-lying coastal areas. Using a large panel of U.S. public firms, our study reveals that a firm's sea level rise (SLR) risk is significantly and positively associated with its cost of equity after the Paris Agreement, but not before that. The cost of equity of firms with SLR risk is 1.3% higher than that of other firms after the Paris Agreement, confirming the economic impact of SLR risk. Our findings are robust to a battery of robustness tests, including alternative measures of SLR risk and the cost of equity, a propensity score matched sample analysis, a placebo test, and a difference-in-differences analysis. Cross-sectional analyses show that the positive association between SLR risk and the cost of equity is more pronounced among firms with limited ability to relocate and those held by institutional investors. Our findings suggest that the Paris Agreement increased public awareness of climate change and facilitated the pricing of climate change risks in the equity market.

Keywords: Sea Level Rise, Cost of Equity, Climate Change Risk, Paris Agreement

[1] The Management School, University of Liverpool, United Kingdom. E-mail: c.florackis@liverpool.ac.uk
[2] The Management School, University of Liverpool, United Kingdom. E-mail: yujia.wang@liverpool.ac.uk
[3] The Management School, University of Liverpool, United Kingdom. E-mail: yang.zhao3@liverpool.ac.uk

1. Introduction

The rising sea level has attracted increasing attention. The Washington Post (2022) reports that rising seas could swallow millions of U.S. acres within decades. New York Times (2016) highlights that sea level rise, a problem exacerbated by greenhouse gas emissions, could disrupt the lives of more than 13 million people in the United States. The Guardian (2016) shows that businesses with commercial properties or operations in low-lying coastal areas may find it increasingly difficult to insure their assets, making sea level rise (SLR) a relevant long-term business risk. According to the NOAA Sea Level Rise Technical Report (2022), the sea level along the U.S. coastline is projected to rise, on average, 10 – 12 inches in the next 30 years. The rising sea level brings significant challenges and uncertainty to firms with commercial properties or operations in low-lying coastal areas. Not surprisingly, academics are keen to understand the impact of the sea level rise (SLR) risk on financial markets (e.g., Bernstein et al., 2019; Baldauf et al., 2020; Painter, 2020; Goldsmith-Pinkham et al., 2022; Allman, 2022; Bai et al., 2022; Ilhan, 2022; Nguyen et al., 2022). For example, Bernstein et al. (2019) find that homes exposed to sea level rise sell for about 7% less than comparable unexposed properties. Painter (2020) shows that counties more likely to be affected by sea level rise face higher issuance costs for long-term municipal bonds compared to those unlikely to be affected.

In this study, we examine whether SLR risk affects firms' cost of equity. We focus on a firm's cost of equity capital which is a crucial metric that investors, managers, analysts, and other stakeholders use to assess the risk of investing in a company. We explicitly examine the association between SLR risk and the cost of equity in the period before and after the Paris Agreement, as the event significantly increases investors' awareness of climate risks (see Ginglinger and Moreau, 2023; Degryse et al., 2023; Ehlers et al., 2022; Delis et al., 2024; Fahmy, 2022).

How does the SLR risk impact a firm's cost of equity capital? On the one hand, although the impact of SLR may not be immediate, it is potentially catastrophic in the future (Hallegatte et al., 2013). Literature shows that the rising sea level affects the prices of coastal residential real estate (Bernstein et al., 2019; Baldauf et al., 2020; Bakkensen and Barrage, 2022), and the prices of municipal bonds (Painter, 2020; Goldsmith-Pinkham et al., 2023). Firms operating in areas affected by SLR face increased operational costs due to the risk of operational disruptions, relocation and supply chain changes. Furthermore, the risk of sea level rise increases earnings volatility and brings higher uncertainty of future cash flows. Therefore, a firm's exposure to SLR increases its perceived risk, leading to a higher cost of equity capital. On the other hand, the rising sea level is a long-term trend that is usually not visible to individuals. Recent studies document that, unlike other conventional climate risks, the pricing of SLR risk depends on investors' awareness or belief about climate change (e.g., Baldauf et al., 2020; Bernstein et al., 2019; Painter, 2020; Nguyen et al., 2022; Goldsmith-Pinkham et al., 2022). In addition, a few studies show that the equity market does not always incorporate climate change risk efficiently (e.g., Hong et al., 2019). Murfin and Spiegel (2020) fail to detect a significant effect of SLR on property prices. Therefore, the SLR risk of a firm may not be associated with its cost of equity. The long run and uncertain nature of SLR risk makes its pricing in the equity market an empirical question.

In our study, we employ the scientific forecast data on SLR from the National Oceanic and Atmospheric Administration (NOAA) to measure a firm's SLR risk. Specifically, the NOAA SLR database enables us to identify whether an area will be flooded following a 0-10 feet increase in the local sea line. This measurement is commonly used in recent studies (e.g., Bernstein et al., 2019; Nguyen et al., 2022; Goldsmith-Pinkham et al., 2022; Bai et al., 2021; Jiang et al., 2022). We estimate a firm's SLR risk based on its headquarters address, as firms often place their headquarters close to their operations and primary business activities (Pirinsky and Wang, 2006; Chaney et al., 2012). We estimate the cost of equity of a firm from four accounting-based implied cost of equity models (i.e., Claus and Thomas, 2001; Easton, 2004; Gebhardt et al., 2001; Ohlson & Juettner-Nauroth, 2005) and take the average value of the four estimates as our main measure of the cost of equity capital (Cao et al., 2015; Chen et al., 2016; Dhaliwal et al., 2016; Hail and Leuz, 2009; Huynh et al., 2020; Truong et al., 2021). An important advantage of the implied cost of equity models is that they explicitly control for cash flow and growth effects to separate the discount rate effect from a firm's valuation (Gebhardt et al., 2001; Hail and Leuz, 2006).

Based on a sample of 30,155 firm-year observations of U.S. listed firms from 1995 to 2022, we find no evidence that the SLR risk of a firm is related to its cost of equity over the full sample period. However, we find a positive association between SLR risk and the cost of equity following the Paris Agreement in December 2015, suggesting that the SLR risk began to be priced following the Paris Agreement. With an unprecedented level of commitment from 195 parties (194 States plus the European Union), the Paris Agreement increased investors' awareness of climate change and facilitated the pricing of climate change risks. It serves as a "wake-up call" for investors about the SLR risk. Controlling for other firm characteristics, the cost of equity of firms with SLR risk is 1.3% higher than other firms, confirming the economic impact of SLR risk. Our findings are consistent with the recent literature (e.g., Ginglinger and Moreau, 2023; Delis et al., 2019; Degryse et al., 2023), that a significant impact of climate change risk is only observable after the Paris Agreement.

According to the definitions of the US Environmental Protection Agency (EPA),[4] there are two categories of climate risks: physical risks and transition risks. Physical risks are related to the physical impacts of climate change, while transition risks are related to the transition to a lower-carbon economy. Our findings are hard to explain as being due to the transition risk associated with SLR, as firms in low-lying coastal areas do not necessarily have high carbon emissions. Following Ginglinger and Moreau (2023), we show that our findings are robust to excluding firms in the ten largest carbon-emitting industries identified by Ilhan et al. (2021), and are robust to controlling for firms' exposure to transition risk measured by Sautner et al. (2023).

[4] See: https://www.epa.gov/climateleadership/climate-risks-and-opportunities-defined#:~:text=There%20are%20two%20categories%20of,physical%20impacts%20of%20climate%20change.

Therefore, we believe that our findings are more relevant to physical risk rather than transition risk.

Our baseline findings are robust to a battery of robustness tests. First, we show that our results are robust using alternative measures of the cost of equity and SLR risk. Second, we employ a propensity score matching (PSM) and an entropy balancing (EB) approach to mitigate the concern that our findings may be driven by differences in other observable firm characteristics rather than the SLR risk. Third, in order to ensure that our findings are not only driven by firms in Orleans Parish, the county with the highest SLR risk, we exclude firms in Orleans Parish from our sample and find similar results. Fourth, unobserved factors may affect both firms' intention to relocate to (or away from) low-lying coastal areas and their cost of equity, which could lead to an endogeneity issue. To investigate this alternative explanation, we exclude firms that relocate their headquarters during our sample period and confirm the robustness of our main findings. Fifth, we construct a sample of placebo-treated firms that are geographically close to firms with SLR risk but have no SLR risk. We observe no relation between the cost of equity and the hypothetical SLR risk in these placebo-treated firms. The findings of the placebo test confirm that the association between SLR risk and the cost of equity capital is not driven by unobserved local traits (e.g., local economic conditions) that correlate with the SLR risk.

In the extended analysis, we use the Paris Agreement as a shock to investors' awareness of physical climate risks following Ginglinger and Moreau (2023), and investigate the Paris Agreement's effect on the treated and control firms using a difference-in-differences (DID) design. We define treated firms as firms with SLR risk (i.e., firms to be inundated given a 6-foot SLR), and control firms are firms without SLR risk. This test helps us to further mitigate the potential endogeneity problem that unobservable factors drive both a firm's SLR risk and its cost of equity. By comparing the cost of equity of treated and control firms before and after the Paris Agreement, we find that firms with SLR risk experienced an increase in the cost of equity capital by 1.6 % after the Paris Agreement. Dynamic tests show that the treatment effect only manifests post-2015, confirming that our findings are not driven by any pre-existing diverging trends in the cost of equity of the treated and control firms before the Paris Agreement. Our findings suggest that, as a historic climate event, the Paris Agreement enhances investors' awareness of climate change and facilitates the pricing of a firm's SLR risk.

Finally, using a sample of firms in the post Paris Agreement period, we conduct several cross-sectional analysis to check the heterogeneity of our baseline results. Firstly, we expect the impact of SLR risk to be stronger for firms with limited ability to relocate. Consistent with the projection, we find that the impacts of SLR risk are more pronounced for firms in industries that are hard to relocate and for firms with financial constraints. Secondly, literature suggests that stocks with greater institutional ownership are priced more efficiently (Boehmer and Kelley, 2009), and the SLR exposure discount is greatest in markets with sophisticated investors (Bernstein et al. 2019). Thus, we expect the impact of SLR risk is stronger for firms hold by institutional investors. Empirical results confirm our expectations. The association between SLR risk and the cost of equity is stronger for firms with higher institutional ownership and firms with more block institutional shareholders.

This paper contributes to the literature that examines the impact of climate change risk on companies, especially the SLR risk. A growing number of studies examine the impacts of climate change risk on firms, such as drought risk (Huynh et al., 2020), carbon risk (e.g., Bolton and Kacperczyk, 2023; Ilhan et al., 2021), extreme temperatures (Addoum et al., 2023), and wildfires (Griffin et al., 2023). Different from the climate change risk mentioned above, SLR risk is a long-term business risk that has a devastating impact on business in the long run but not in the short run. Recent literature suggests that the pricing of SLR risk depends on investor awareness or belief about climate change in the real estate market (Baldauf, et al., 2020; Bernstein et al., 2019; Bakkensen and Barrage, 2022; Nguyen et al., 2022; Giglio et al., 2021). A few studies show that SLR risk also affects the prices of municipal bonds (Painter, 2020; Goldsmith-Pinkham et al., 2022). While the impact of sea level rise risk has attracted a lot of attention in the literature, limited studies provide evidence on the impact on companies facing SLR risk. Bai et al. (2022) show that firms with higher exposure to sea-level rise tend to acquire firms that are less affected by sea-level rise. Jiang et al. (2022) find that firms' cost of long-term loans increases with their SLR exposure, and the loan spread increases with media attention. Allman (2022) finds that corporate bonds bear an SLR risk premium upon issuance. Du et al. (2024) find that firms with higher SLR risk engage less in future-oriented activities such as lower R&D investment. Our study contributes to this strand of literature by exploring whether and how the SLR risk of a firm is priced in the equity market.

Our study also contributes to the literature on the determinants of the cost of equity capital. Literature shows that the implied cost of equity of a firm is associated with its corporate reputation (Cao et al., 2015), directors' and officers' liability insurance (Chen et al., 2016), customer-concentration risk (Dhaliwal et al., 2016), customer satisfaction (Truong et al., 2021), climate risk disclosures (Matsumura et al., 2022) and so on. A limited number of studies examine the impact of climate change risk on the cost of equity. Huynh et al. (2020) find that investors demand a higher rate of return on firms exposed to droughts. Nguyen et al., (2020) show that firms with high carbon emissions experience a substantial increase in the costs of debt and equity after the Kyoto Protocol ratification in Australia. Our study extends the literature by underlining an important but neglected climate change risk, SLR risk, in determining firms' cost of equity. We show that investors require an increased cost of equity on firms with SLR risk after the Paris Agreement.

Our work further contributes to people's understanding of how the Paris Agreement enhances investors' awareness of climate risk. There is currently a strong set of results highlighting the tangible effects of the Paris Agreement on raising awareness and attention to climate risks, both transition risks and physical risks, among all stakeholders (e.g., Seltzer et al., 2022; Bolton & Kacperczyk, 2021; Bolton and Kacperczyk, 2023; Ginglinger and Moreau, 2023; Ehlers et al., 2022; Delis et al., 2024; Degryse et al., 2023). For example, Bolton and Kacperczyk (2023) find a significant increase in the carbon premium after the Paris Agreement. Ehlers et al. (2022) examine the pricing of carbon risk in the syndicated loan market and find a premium for climate risk after the Paris Agreement. Ginglinger and Moreau (2023) underline that the Paris Agreement has been important in reshaping companies' and investors' beliefs about physical climate risk, and they find that greater physical climate risk leads to lower leverage in the post-2015 period. Consistent with the literature, our findings suggest that investors' awareness of climate change has increased since the Paris Agreement. They demand for a higher risk premium subsequently.

The remainder of this paper is structured as follows. Section 2 introduces the data and empirical methods. Section 3 presents the main results and the robustness tests. We examine how the impact of SLR risk on the cost of equity varies with firm characteristics in Section 4. Section 5 concludes the paper.

2. Data and empirical methods

2.1. Measure of sea level rise risk

Following Bernstein et al. (2019) and Nguyen et al. (2022), we employ the scientific forecast data on sea level rise from the National Oceanic and Atmospheric Administration (NOAA) to measure a company's SLR risk.[5] The NOAA's calculations account for regional tidal variation and other geographic factors that affect the impact of global oceanic volume increases on local SLR. The NOAA SLR database identifies regions that will be inundated following a zero to ten feet increase in the local sea line on top of local mean higher high water (MHHW)[6]. For example, Figure 1 shows the projected sea level rise in Miami Florida. The light blue layers in Graph B indicate the regions that will be inundated following a 6 feet increase in the local sea line.

[5] The data can be accessed here: https://coast.noaa.gov/slrdata/

[6] Mean higher high water (MHHW) is the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch.

Following Huynh et al. (2020) and Javadi and Masum (2021), we use the location of a firm's headquarters to determine its exposure to SLR risk. Prior research shows that firms' headquarters locations are often close to their operations and core business activities (e.g., Pirinsky and Wang, 2006; Chaney et al., 2012). The latitude and longitude information of companies' headquarters is obtained from the Bill-Mcdonald data library.[7] We define a firm's SLR risk exposure as a dummy variable, *SLR Risk 6ft*, which takes the value of one if a firm's headquarters would be inundated given a 6 feet rise in the sea level and zero otherwise. Among the 30,155 firm-year observations in our baseline, 1,610 firm-year observations' headquarters would be underwater if the sea level rose by 6 feet. The dots in Figure 2 show the headquarters addresses of US listed companies in our baseline sample. The blue dots are headquarters which would be underwater if the sea level rises by 6 feet, while the red dots are headquarters which would not be affected. Among the 30,155 firm-years observations in our baseline sample, 5.34% of the observation would be underwater if the sea level rises by 6 feet.

Alternative SLR measures are also used in the robustness checks. First, instead of defining a firm's SLR risk based on a 6 feet rise in sea level, we also consider an alternative sea level rise projection at 3 feet. We define *SLR Risk 3ft* as the value of one if the firm's headquarters would be inundated by 3 feet of SLR and zero otherwise. Second, we define a firm's SLR risk (*SLR Risk County*) based on the estimated GDP loss of the county in which a company is located due to SLR. Specifically, Hallegatte et al. (2013) estimate a city's expected annual loss relative to the local GDP, assuming a 40 cm (roughly equivalent to 1.31 feet) rise in sea level while the city adapts maximum protection to the rise in sea level. Following Painter (2020), counties within each city area are grouped together and assigned the same SLR risk value. Appendix II presents the table provided by Painter (2020), reporting the SLR risk of all U.S. cities and their assigned counties included in Hallegatte et al. (2013).

2.2. Implied cost of equity capital

[7] https://www3.nd.edu/~mcdonald/

The cost of equity of a company is estimated using the ex-ante cost of equity implied by stock prices and analysts' earnings forecasts at the end of June of each year. Specifically, the cost of equity is computed as the internal rate of return that equates the current stock price to the present value of all expected future cash flows to common shareholders (Gebhardt et al., 2001). To measure a firm's cost of equity, we follow prior research (e.g., Cao et al., 2015; Chen et al., 2016; Dhaliwal et al., 2016; Hail and Leuz, 2009; Truong et al., 2021) and use the average estimates from the four commonly used implied cost of equity (*COE*) models i.e., Claus and Thomas (2001)(*COE_CT*), Gebhardt, Lee, and Swaminathan (2001) (*COE_GLS*), Easton (2004)(*COE_MPEG*), and Ohlson and Juettner-Nauroth (2005)(*COE_OJ*), as our measure of cost of equity.

In this study, we focus on a company's implied cost of equity instead of its realized returns. One important advantage of the implied cost of equity models is that they explicitly control for cash flow and growth effects in order to separate the discount rate effect from a firm's valuation (Hail & Leuz, 2006). On the contrary, realized returns not only capture the variations in a firm's cost of equity but also reflect the variations in expected cash flows and growth opportunities. A number of studies (e.g., Elton, 1999; Stulz, 1999; Gebhardt et al., 2001; and Pástor et al., 2008) show that implied cost of equity is a more useful proxy for expected return than realized stock returns.

2.3. Control variables

We include a comprehensive list of control variables that are known determinants of the cost of equity capital. Following recent studies (e.g., Chen et al., 2016; Dhaliwal et al., 2016; Goh et al., 2016), we include the following variables in the baseline regressions: market risk (*Market Beta*); firm specific risk (*Idiosyncratic Volatility*); stock return over the previous 12 months (*Momentum*); book value of equity divided by market value of equity (*Book-to-Market*); market value of equity at the end of the fiscal year (*Market Value of Equity*); debt to asset ratio (*Leverage*); the dispersion of analysts' estimates (*Forecast Dispersion*); the bias of analysts' estimates (*Forecast Bias*); long-term earnings growth rate (*Long-Term Growth*). To handle outliers, we winsorize all continuous variables at their 1st and 99th percentiles. The detailed definitions of these variables are reported in Appendix I.

2.4. Empirical models

To examine the relation between SLR risk and the cost of equity, we estimate the following ordinary least squares (OLS) regression:

$$Cost\ of\ Equity_{i,t} = \alpha + \beta_1 SLR\ Risk\ 6ft_{i,t} + \boldsymbol{\beta_2} Control\ Variables_{i,t} + \sum \beta_n Fixed\ Effects + \varepsilon_{i,t} \qquad (1)$$

where the dependent variable $Cost\ of\ Equity_{i,t}$ is the average annualized cost of equity (estimated from Claus and Thomas (2001), Gebhardt et al., (2001), Easton (2004), and Ohlson and Juettner-Nauroth (2005)) in excess of the risk-free rate for firm *i* in year *t*. $SLR\ Risk\ 6ft_{i,t}$, is a dummy variable, which takes the value of one if firm *i*'s headquarters in year *t* would be inundated by 6-foot sea level rise and zero otherwise. We follow previous studies and control for firms' characteristics, including the market value of equity, book-to-market, idiosyncratic volatility, leverage, market betas, forecast dispersion, forecast bias, long-term growth, and momentum. The regression model also includes industry-by-year fixed effects to control for time-varying heterogeneity across industries. Industries are defined using the Fama French 30 industry classification. Besides, we further add county fixed effect to control for time-invariant county-level characteristics.

As the Paris Agreement significantly increases investors' attention and awareness of climate change risk (see Degryse et al., 2023; Fahmy, 2022; Ginglinger and Moreau 2023), we examine the association between SLR risk and the cost of equity before and after the Paris Agreement by dividing our baseline sample into the period before and after 2015 and estimate model (1) for each period separately.

3. Main findings

3.1. Sample and descriptive statistics

Our baseline sample includes all U.S. public firms with data available from 1995 to 2022. Our sample starts from 1995 due to the availability of 10-K header data in the Bill Mcdonald dataset. Financial firms (SIC codes 6000–6999) and utility firms (SIC codes 4900–4949) are excluded from the sample. The final sample includes 30,155 firm-year observations that cover 4,601 unique firms. All continuous variables in our sample are winsorized at the 1% and 99% levels.

Table 1 presents summary statistics of our key variables in the sample. The average value of the implied cost of equity *(COE)* is 6.937%, and the median is 5.622%, which are comparable with those reported in prior studies (e.g., Rjiba et al., 2021 and Matsumura et al., 2022). In our sample, about 5.3% of firm-years are exposed to sea level rise risk. The median of firm size (i.e., *Market Value of Equity*) is $1,405 million USD.[8] Summary statistics of the other control variables indicate that, on average, our sample firms have a book-to-market ratio of 0.448 and leverage of 0.223. The average stock return over the fiscal year (i.e., *Momentum*) is 17.40%, and the mean of idiosyncratic volatility is 10.99%.

3.2. Baseline regression results

We first test the association between SLR risk and the cost of equity over the full sample. Table 2 Panel A tabulates the results from estimating our baseline model (i.e., Model 1). The results under all specifications show that the coefficient on *SLR Risk 6f is* insignificant. These results are robust to controlling for time-varying heterogeneity across industries, and the county fixed effects. Hence, on average, the SLR risk of a firm is not associated with its cost of equity capital. The results regarding the control variables are in line with prior literature (e.g., Chen et al.,

[8] The median of market value of equity is estimated as $e^{7.248} = 1405.29$

2016; Dhaliwal et al., 2016; Goh et al., 2016; Matsumura et al.,2022; Huynh et al., 2020;). Specifically, the cost of equity is negatively associated with price momentum but positively associated with book-to-market, leverage, market beta, idiosyncratic volatility, and long-term growth.

As the Paris Agreement significantly increases investors' attention and awareness of climate change risk (see Ginglinger and Moreau, 2023; Degryse et al., 2023; Ehlers et al., 2022; Fahmy, 2022;), investors may start considering the risks associated with a firm's SLR risk after the event. In Table 2 Panel B, we split our sample into two periods: from 1995 to 2015 (Before PA) and from 2016 to 2022 (After PA).[9] In Column (1) and Column (2), we find that before the Paris Agreement, the SLR risk of a firm is not associated with its cost of equity. Interestingly, in Column (3), we find that firms with SLR risk have significantly higher cost of equity. In Column (4), we further control for industry-by-year fixed effects and find similar results. Controlling for other firm characteristics, the cost of equity of firms with SLR risk is 1.3% higher than other firms on average after 2015, confirming the economic impact of SLR risk after the Paris Agreement.

Is the rising sea level a physical risk or a transition risk to firms? According to the definitions of the US Environmental Protection Agency (EPA), physical risks are risks related to the physical impacts of climate change, while transition risks are risks related to the transition to a lower-carbon economy. As firms in low-lying coastal areas do not necessarily have high carbon emissions, it is unlikely that our findings are solely driven by the transition risk associated with the rising sea level. To provide additional empirical evidence, following Ginglinger and Moreau (2023), in Table 3 Column (1) and Column (2), we add the transition risk measured by Sautner et al. (2023) into Model (1) and reestimate the model. We show that the impact of SLR risk on the cost of equity is significant after the Paris Agreement after controlling for firms'

[9] As the Paris Agreement was in December 2015, while the cost of equity for the year 2015 is estimated in June 2015, the cost of equity for the year 2015 is estimated before the Paris Agreement.

exposure to transition risk. In addition, In Column (3) and Column (4), we show that our findings are robust to excluding firms in the 10 largest carbon-emitting industries identified in Ilhan et al. (2021). We thus conclude that our findings account for physical risks rather than transition risks associated with SLR.

3.3. Robustness checks

3.3.1. Alternative measures of SLR risk

We examine whether our findings are robust to alternative measures of SLR risk. Firstly, we use an alternative threshold of SLR projection (i.e., 3ft). *SLR Risk 3ft* is a dummy variable that takes value one if a firm will be inundated given a three-feet sea level rise according to NOAA and zero otherwise. Secondly, we measure SLR risk at a different dimension. Rather than measuring SLR risk at firm-level used in our main specifications, we construct an alternative measure of SLR risk at the county level and define a firm's SLR risk (*SLR Risk County*) as the relative GDP loss of the county in which the firm located due to SLR. We follow Painter (2020) and measure the SLR risk at the county level as the expected annual loss relative to the local GDP, assuming a 40-centimeter rise in sea level while the city adapts maximum protection. One limitation of the variable is that it only measures SLR risk for a limited number of coastal cities, so we have to assume zero SLR risk for other cities following Painter (2020) and Jiang et al. (2023).

In Table 4 Panel A, we re-estimate Model (1) but replace the measure of SLR risk using *SLR Risk 3ft* and *SLR Risk County*. The results indicate that our finding is robust to those alternative measures of SLR risk. The SLR risk of a firm is positive associated with its cost of equity capital, but only in the period after the Paris Agreement.

3.3.2 Alternative measures of the cost of equity

We next examine whether our main findings hold when we use the alternative measures of cost of equity. Instead of using the average of the four individual implied cost of equity estimates as in our baseline analysis, we use each of the four individual implied cost of equity capital as alternative measures of the cost of equity, namely *COE_GLS*, *COE_CT*, *COE_MPEG*, and *COE_OJ,* which are estimated using the model of Gebhardt et al. (2001), Claus and Thomas (2001), Easton (2004), and Ohlson and Juettner-Nauroth (2005), respectively. We re-estimate Model (1) using each of the four measures of the cost of equity capital and present the results in Table 4 Panel B. Our findings are robust to those alternative cost of equity measures.

3.3.3. Covariate balance

In this subsection, we use the propensity score matching (PSM) approach and entropy balancing (EB) approach to alleviate the concern that our findings may be driven by the differences in other characteristics of the treated and control firms rather than differences in SLR risk. We define treated firms as firms with SLR risk (i.e., firms to be inundated given a 6-foot SLR), and control firms are firms without SLR risk.

Firstly, we use PSM to identify control firms without SLR risk but are otherwise comparable to the treated firms in terms of observable firm characteristics. Specifically, we use a logit model to estimate the propensity score of being a treated firm; that is, we regress the treatment indicator (*SLR Risk 6ft*) on relevant firm-level covariates. The matching covariates include all firm characteristics in the baseline model (Model (1)). We then match treated firms with control firms using a one-to-five nearest neighbour (caliper = 0.1) matching based on the propensity scores with replacement.

In Panel A of Table 5, we compare the means of firm characteristics between the treated and control firms after the matching. We find no significant differences in the firm characteristics between the two groups of firms, showing that our PSM sample has achieved a covariate balance between the treated and control firms. In Panel B of Table 5, we reestimate our baseline model using the propensity score matched sample. Consistent with the baseline results, we continue to observe the SLR risk of a firm to be positively associated with its cost of equity capital in the period after the Paris Agreement.

Secondly, we use the entropy balancing approach to show that our baseline result persists when treated and control firms are balanced on higher moments of their distributions. We re-weight each control observation so that post-weighting distributional properties of matching variables of treated and control observations are virtually identical, thereby ensuring covariate balance. The matching variables we use here are the full set of firm-level control variables in our baseline analysis in Table 2, and we ensure that the first three moments (i.e., mean, standard deviation, and skewness) of the matching variables are balanced between the treated and control firms. Table 5 Panel C tabulates the diagnostic statistics of the differences in observable firm-level characteristics between the treatment and control groups. It confirms that there are almost no differences in the firm characteristics between the two groups of firms, showing that the entropy-balanced sample has achieved a covariate balance between the treated and control firms. Panel D presents the regression results using the entropy-balanced sample. The results further confirm the robustness of our baseline findings.

3.3.4. Excluding firms in Orleans Parish and firms with headquarters change

One possible concern when interpreting our baseline findings is that a few counties with relatively high climate risk are driving the results (Painter, 2022). To address this concern, we exclude firms in Orleans Parish, the county with the highest SLR risk, from our sample and reestimate Model (1). We report the results in Table 6 Column (1) and Column (2). Consistent with our baseline results, we find that the SLR risk of a firm to be positive associated with its cost of equity capital in the period after the Paris Agreement.

Firms could relocate their headquarters, and the SLR risk of firms could change as a result. This could lead to an endogeneity problem, as unobserved factors may affect both the firms' intention to relocate and their cost of equity. To address this possibility, we exclude firms that relocate their headquarters during our sample period and confirm the robustness of our main findings. The results are reported in Table 6 Column (3) and Column (4).

3.4. Placebo tests

To alleviate another concern that the association between SLR risk and the cost of equity is driven by unobserved local traits (e.g., local economic conditions) that correlate with the SLR risk, we carry out a placebo test based on geographical distance. Following Painter (2020) and Jiang et al. (2022), we assume that firms with the closest geographical distance share similar economic conditions. We define treated firms as firms with SLR risk (i.e., firms to be inundated given a 6-foot SLR), and control firms are firms without SLR risk. For each treated firm, we identify one placebo firm that is closest in geographic distance to the treatment firm but without SLR risk. We then assign the SLR risk of a treatment firm to its placebo firm. We re-estimate Model (1) using pseudo-samples of treated and control firms and present the results of the placebo tests in Table 7. We find no treatment effect using the placebo sample in either the period before or period after the Paris Agreement. The coefficient on the *Pseudo SLR Risk 6ft* is insignificant across both specifications, implying that unobserved local conditions are not driving our baseline findings.

3.5. SLR risk and the Paris Agreement

In our study, the SLR risk of a firm is determined by the location of its headquarters. Unobserved factors could affect both the firms' location choice and their cost of equity, leading to an endogeneity problem. In Section 3.4, we already show that our findings are unlikely to be driven by unobserved geographical conditions. To further mitigate the potential endogeneity problem, in this subsection, we use the Paris Agreement as a shock to investors' awareness of physical climate risks following Ginglinger and Moreau (2023) and investigate the effect of the Paris Agreement on firms with different SLR risks. We use a difference-in-differences (DID) design to investigate the effect of the Paris Agreement on treated firms and control firms. The treated firms are firms with SLR risk (i.e., firms to be inundated given a 6-foot SLR), and control firms are firms without SLR risk. Specifically, we estimate the following model:

$$Cost\ of\ Equity_{i,t} = \alpha + \beta_1 SLR\ Risk\ 6ft_{i,t} * Post_t + \beta_2 SLR\ Risk\ 6ft_{i,t} + \beta_3 Post_t + \beta_4 Control\ Variables_{i,t} + \sum \beta_n Fixed\ Effects + \varepsilon_{i,t} \qquad (2)$$

$Post_t$ is a dummy variable, which takes the value of one if the cost of equity of a firm is estimated post the Paris Agreement (12 December 2015) and zero otherwise. Other variables are the same as those defined in Model (1).

Table 8 tabulates the results from estimating our Model 2. The results under all specifications show that the coefficient on *SLR Risk 6ft* × *Post* is positive and significant at the 1% level. These results are robust to controlling for different combinations of time-varying heterogeneity across industries and counties of headquarters. Overall, the findings are consistent with our expectations. Results suggest that the cost of equity capital of firms with SLR risk increases after the Paris Agreement. Investors reacted to the Paris Agreement by requiring an increased cost of equity on firms with SLR risk.

The validity of our DID approach is based on the assumption that trends in the cost of equity of treated and control firms should be parallel in the absence of the Paris Agreement. To evaluate the parallel trends assumption, we follow Bertrand and Mullainathan (2003) and estimate the dynamic effects of the Paris Agreement on the cost of equity. If pretreatment trends exist (i.e., a violation of the parallel trends assumption), we should observe a significant change in the cost of equity even before the Paris Agreement. In Table 9, we replace the *Post* indicator in Model (2) with six time indicators, namely, $Before^{2+}$, $Before^{2}$, $Before^{1}$, $Post^{1}$,

$Post^2$, and $Post^{2+}$, to estimate the dynamic effects of the Paris Agreement. These six indicators are equal to one if the cost of equity of a firm is estimated for more than two years before the Paris Agreement (i.e., 2013 and before), the second year before the Paris Agreement (i.e., 2014), the first year before the Pairs Agreement (i.e., 2015),[10] the first year after the Pairs Agreement (i.e., 2016), the second year after the Pairs Agreement (i.e., 2017), and more than two years after the Pairs Agreement (i.e., 2018 and later), respectively, and zero otherwise.

The results show that the coefficients on *SLR Risk 6ft* × $Before^1$, *SLR Risk 6ft* × $Before^2$, and *SLR Risk 6ft* × $Before^{2+}$ are largely statistically insignificant, indicating our findings are unlikely to be driven by pre-treatment trends. We therefore conclude that the parallel trends assumption is likely to be satisfied. On the other hand, the coefficients on *SLR Risk 6ft* × $Post^{2+}$, *SLR Risk 6ft* × $Post^2$, and *SLR Risk 6ft* × $Post^1$ are significant and positive, consistent with our baseline results. This finding shows that investors require higher returns on equity for firms with SLR exposure immediately after the Paris Agreement but not before that. The positive effect of the Paris Agreement on the cost of equity appears to be persistent beyond two years post the Paris Agreement as the coefficient on *SLR Risk 6ft* × $Post^{2+}$ remains economically and statistically significant, which suggests that the increased COE is not a short-term investor response to the Paris Agreement.

4. Cross-sectional variation

To this point, we have established a positive association between SLR risk and the cost of equity in the period after the Paris Agreement. In the cross-sectional analysis, we test the heterogeneity of our baseline results. As we do not find SLR risk influence the cost of equity before the Paris Agreement, we only include the period after the Paris Agreement in our cross-sectional variation tests.

4.1. SLR risk and the ability to relocate

[10] As the Paris Agreement was in December 2015, while the cost of equity for the year 2015 is estimated in June 2015, the cost of equity for the year 2015 is estimated before the Paris Agreement.

While SLR brings significant challenges and uncertainty to firms with commercial properties and operations in low-lying coastal areas, firms could relocate to highlands to reduce their exposure to the risk via relocation. Therefore, firms that can easily relocate are less exposed to the SLR risk. In Table 10, we analyse how the impact of SLR risk varies with a firm's ability to relocate. Firstly, firms in heavy industry[11] have high relocation costs due to the large and heavy equipment and facilities. These firms have a limited ability to relocate. In addition, the ability of a firm to relocate is also dependent on its financial position, and financial constraints firms may not be able to fund its relocation. In Column (1) and Column (2), we divide our firms in the post Paris Agreement period into two groups based on the firms' industry and estimate Model (1). We show that the impacts of SLR risk are more pronounced for firms in heavy industries. We test the significance of the difference in the coefficients on *SLR Risk 6ft* in Column (1) and Column (2) using simulation test following Cleary (1999), Du et al., (2023), and Liu et al., (2023). The p-value suggests that the impact of SLR risk on firms in heavy industry is significantly stronger than those in other industries. In Columns (3) and (4), we divide firms into two groups based on the firms' financial constraints measured using *HP Index* (Hadlock and Pierce, 2010).[12] Consistent with our expectations, we find that the impact of SLR risk is stronger among firms with financial constraints.

4.2. SLR risk and institutional ownership

Bernstein et al. (2019) find that in the real estate market, the SLR exposure discount is greatest in markets with sophisticated investors. Besides, literature suggests that stocks with greater institutional ownership are priced more efficiently (Boehmer and Kelley, 2009). Thus, we expect the impact of SLR risk on the cost of equity to be stronger for firms with more institutional ownership. In Table 11, we divide our sample in the post Paris Agreement period into two groups based on institutional ownership. Institutional ownership is measured using the percentage of the company's shares hold by institutional investors (*Institutional Ownership*) in Column (1) and Column (2), and the number of institutional block owners with more than 5% ownership (*Num of Blockholders*) in Column (3) and Column (4). Column (1) (Column(2))

[11] Heavy industry is an industry that uses large machines to produce either materials, such as steel, or large goods, such as ships or trains. In our study, heavy industries are defined based on the Fama-French 30 industry classifications and include: Chemicals; Construction and Construction Materials; Steel Works Etc; Fabricated Products and Machinery; Automobiles and Trucks; Aircraft, Ships, and Railroad Equipment; Precious Metals, Non-Metallic, and Industrial Metal Mining; Coal; Petroleum and Natural Gas; Utilities; Business Equipment.

[12] Our findings are similar if we measure a firm's financial constraints using WW Index (Whited and Wu, 2006).

are firms with *Institutional Ownership* below (above) the yearly median. Column (3) (Column(4)) are firms with *Num of Blockholders* below (above) the yearly median. Detailed variable definitions are provided in Appendix I. We show that, consistent with our expectation, the impact of SLR risk is stronger for firms hold by institutional investors.

5. Conclusion

This study examines the impact of SLR risk on firms' implied cost of equity. Employing a sample of U.S. public firms from 1995 to 2022, we find that investors begin to require a higher investment return (i.e., cost of equity) on firms with SLR risk only after the Paris Agreement. The results are robust to a battery of robustness tests, including alternative measures of SLR risk, alternative measures of equity cost, propensity score matching approach, entropy balancing matching approach, excluding firms in Orleans Parish, excluding firms with headquarters change, and placebo test. To mitigate the potential endogeneity issues, we conduct an additional test in a difference-in-differences setting by using the 2015 Paris Agreement as a shock to investors' awareness of climate risks. We show that investors reacted to the Paris Agreement by requiring an increased cost of equity on firms with SLR risk. Cross-sectional analysis shows that our baseline findings are more pronounced for firms with limited ability to relocate and firms hold by institutional investors.

Our study contributes to the literature that explores the impact of climate change risks on firms, particularly SLR risk. We also contribute to the literature on the determinants of the cost of equity capital by showing that SLR risk increases firms' financing costs in the equity market. Our findings highlight the tangible effects of the Paris Agreement on raising investors' awareness of climate risks. The increase in awareness allows investors to reevaluate existing information and adjust their required rate of returns on firms with SLR risk.

Our findings offer several practical implications. For managers, we underscore the impact of SLR risk, which has a devastating impact on business in the long run but not in the short run, on the firms' financing cost. Managers need to take the rising sea level into consideration when choosing the location of their headquarters and other facilities. Firms expose to significant SLR risk may opt for other locations or strategies to decrease their financing cost. For investors, our findings highlight the importance of incorporating SLR risks into investment strategies. As the market increasingly recognizes the financial implications of climate risks, investing in companies that exhibit resilience and adaptability to climate-related challenges may present more stable and lower-risk opportunities.

References

Addoum, J. M., Ng, D. T., & Ortiz-Bobea, A. (2020). Temperature shocks and establishment sales. *The Review of Financial Studies*, *33*(3), 1331-1366.

Addoum, J. M., Ng, D. T., & Ortiz-Bobea, A. (2023). Temperature shocks and industry earnings news. *Journal of Financial Economics*, *150*(1), 1-45.

Allman, E. (2022). Pricing climate change risk in corporate bonds. *Journal of Asset Management,* 23(7), 596-618.

Bai, J., Chu, Y., Shen, C., & Wan, C. (2022). Managing climate change risks: Sea level rise and mergers and acquisitions.

Bakkensen, L. A., & Barrage, L. (2022). Going underwater? Flood risk belief heterogeneity and coastal home price dynamics. *The Review of Financial Studies*, *35*(8), 3666-3709.

Baldauf, M., Garlappi, L., and Yannelis, C. (2020): Does climate change affect real estate prices? Only if you believe in it, *Review of Financial Studies* 33, 1256–1295.

Barrot, J. N., & Sauvagnat, J. (2016). Input specificity and the propagation of idiosyncratic shocks in production networks. *The Quarterly Journal of Economics*, *131*(3), 1543-1592.

Bernstein, A., Gustafson, M. T., and Lewis, R. (2019): Disaster on the horizon: The price effect of sea level rise, *Journal of Financial Economics* 134, 253–272.

Boehmer, E. and Kelley, E.K., 2009. Institutional investors and the informational efficiency of prices. The *Review of Financial Studies*, 22(9), pp.3563-3594.

Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk?. *Journal of Financial Economics*, *142*(2), 517-549.

Bolton, P., & Kacperczyk, M. (2023). Global pricing of carbon‐transition risk. *The Journal of Finance*, 78(6), 3677-3754.

Burke, M., Hsiang, S. M., & Miguel, E. (2015). Global non-linear effect of temperature on economic production. *Nature*, *527*(7577), 235-239.

Bertrand, M., & Mullainathan, S. (2003). Enjoying the quiet life? Corporate governance and managerial preferences. *Journal of political Economy*, 111(5), 1043-1075.

Cao, Y., Myers, J. N., Myers, L. A., & Omer, T. C. (2015). Company reputation and the cost of equity capital. *Review of Accounting Studies*, *20*, 42-81.

Chava, S. (2014). Environmental externalities and cost of capital. *Management Science*, *60*(9), 2223-2247.

Choi, D., Gao, Z., & Jiang, W. (2020). Attention to global warming. The *Review of Financial Studies*, 33(3), 1112-1145.

Chen, Z., Li, O. Z., & Zou, H. (2016). Directors′ and officers′ liability insurance and the cost of equity. *Journal of Accounting and Economics*, *61*(1), 100-120.

Claus, J., & Thomas, J. (2001). Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stock markets. *The Journal of Finance*, *56*(5), 1629-1666.

Chan, J. Y. F. (2022). Climate change information and analyst expectations (Doctoral dissertation).

Chaney, T., Sraer, D., Thesmar, D., 2012. The collateral channel: how real estate shocks affect corporate investment. *American Economic Review*. 102, 2381–2409.

Cleary, S., 1999. The relationship between firm investment and financial status. *The Journal of Finance*, 54(2), pp.673-692.

Cuculiza, C., Kumar, A., Xin, W., & Zhang, C. (2021). Climate change, analyst forecasts, and market behavior. Analyst Forecasts, and Market Behavior (February 18, 2021).

Da, Z., Engelberg, J., & Gao, P. (2011). In search of attention. *The Journal of Finance*, 66(5), 1461-1499.

Delis, M. D., Greiff, K., Iosifidi, M., & Ongena, S. (2024). Being stranded with fossil fuel reserves? Climate policy risk and the pricing of bank loans. Financial Markets, Institutions & Instruments, 1–27.

Degryse, H., Goncharenko, R., Theunisz, C., & Vadasz, T. (2023). When green meets green. *Journal of Corporate Finance*, 78, 102355.

Dhaliwal, D., Judd, J. S., Serfling, M., & Shaikh, S. (2016). Customer concentration risk and the cost of equity capital. *Journal of Accounting and Economics*, *61*(1), 23-48.

Du, J., Li, C., & Wang, Y. (2023). Shadow banking of non-financial firms: Arbitrage between formal and informal credit markets in China. *Journal of Financial Intermediation*, 55, 101032.

Du, Q., Tsang, A., & Wang, Y. (2024). Flood risk and corporate future orientation: Evidence from sea level rise risk. *Journal of Business Finance & Accounting*, *51*(1-2), 555-594.

Easton, P. D. (2004). PE ratios, PEG ratios, and estimating the implied expected rate of return on equity capital. *The Accounting Review*, *79*(1), 73-95.

Ehlers, T., Packer, F., & de Greiff, K. (2022). The pricing of carbon risk in syndicated loans: Which risks are priced and why?. *Journal of Banking & Finance*, *136*, 106180.

Elton, E. J. (1999). Presidential address: expected return, realized return, and asset pricing tests. *The Journal of Finance*, *54*(4), 1199-1220.

Faiella, I., & Natoli, F. (2018). Natural catastrophes and bank lending: the case of flood risk in Italy. *Bank of Italy Occasional Paper*, (457).

Gebhardt, W. R., Lee, C. M., & Swaminathan, B. (2001). Toward an implied cost of capital. *Journal of Accounting Research*, *39*(1), 135-176.

Giglio, S., Maggiori, M., Rao, K., Stroebel, J., & Weber, A. (2021). Climate change and long-run discount rates: Evidence from real estate. *The Review of Financial Studies*, *34*(8), 3527-3571.

Ginglinger, E., & Moreau, Q. (2023). Climate risk and capital structure. *Management Science*, 69(12), 7492-7516.

Goh, B. W., Lee, J., Lim, C. Y., & Shevlin, T. (2016). The effect of corporate tax avoidance on the cost of equity. *The Accounting Review*, 91(6), 1647-1670.

Goldsmith-Pinkham, P., Gustafson, M. T., Lewis, R. C., & Schwert, M. (2022). Sea level rise exposure and municipal bond yields (No. w30660). National Bureau of Economic Research.

Griffin, P. A., Jiang, Y., & Sun, E. Y. (2023). Threatened by wildfires: What do firms disclose in their 10-Ks?. *Journal of Business Finance & Accounting*, 50(5-6), 895-942.

Hail, L., & Leuz, C. (2006). International differences in the cost of equity capital: Do legal institutions and securities regulation matter?. *Journal of Accounting Research*, *44*(3), 485-531.

Hail, L., & Leuz, C. (2009). Cost of capital effects and changes in growth expectations around US cross-listings. *Journal of Financial Economics*, 93(3), 428-454.

Hauer, M. E., Evans, J. M., and Mishra, D. R. (2016). Millions are projected to be at risk from sea-level rise in the continental United States. Nature Climate Change, 6(7), 691-695.

Hadlock, C. J., & Pierce, J. R. (2010). New evidence on measuring financial constraints: Moving beyond the KZ index. *The review of Financial Studies*, *23*(5), 1909-1940.

Hugon, A., & Law, K. (2019). Impact of climate change on firm earnings: Evidence from temperature anomalies. *Available at SSRN 3271386*.

Huynh, T. D., & Xia, Y. (2021). Climate change news risk and corporate bond returns. *Journal of Financial and Quantitative Analysis*, *56*(6), 1985-2009.

Huynh, T. D., Nguyen, T. H., & Truong, C. (2020). Climate risk: The price of drought. *Journal of Corporate Finance*, *65*, 101750.

Ilhan, E. (2020). Sea level rise and portfolio choice. *Available at SSRN 3743046.*

Ilhan, E., Sautner, Z., & Vilkov, G. (2021). Carbon tail risk. *The Review of Financial Studies*, 34(3), 1540-1571.

Javadi, S., & Masum, A. A. (2021). The impact of climate change on the cost of bank loans. *Journal of Corporate Finance*, *69*, 102019.

Jiang, Feng and Li, Wei and Qian, Yiming, (2022) Do Costs of Corporate Loans Rise with Sea Level?. Available at SSRN: https://ssrn.com/abstract=4351883 or http://dx.doi.org/10.2139/ssrn.4351883

Hallegatte, S., Green, C., Nicholls, R. J., & Corfee-Morlot, J. (2013). Future flood losses in major coastal cities. *Nature Climate Change*, 3(9), 802-806.

Kruttli, M. S., Roth Tran, B., & Watugala, S. W. (2021). Pricing Poseidon: Extreme weather uncertainty and firm return dynamics.

Li, S. (2010). Does mandatory adoption of International Financial Reporting Standards in the European Union reduce the cost of equity capital?. *The Accounting Review*, *85*(2), 607-636.

Liu, X., Wu, Y., & Zhang, H. (2023). Collateral-based monetary policy and corporate employment: Evidence from Medium-term Lending Facility in China. *Journal of Corporate Finance*, 78, 102333.

Leiserowitz, A. A. (2005). American risk perceptions: Is climate change dangerous?. *Risk Analysis: An International Journal*, 25(6), 1433-1442.

Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2022). Climate-risk materiality and firm risk. *Review of Accounting Studies*, 1-42.

Murfin, J. and Spiegel, M. (2020). Is the risk of sea level rise capitalized in residential real estate?, *Review of Financial Studies* 33, 1217–1255.

New York Times (2016) "Rising Seas May Disrupt Millions in U.S., Study Says." New York Times, 15 Mar. 2016. https://go-gale-com.liverpool.idm.oclc.org/ps/i.do?p=STND&u=livuni&id=GALE|A446274410&v=2.1&it=r&sid=bookmark-STND&asid=d0fd5d25. Accessed 3 May 2024.

Nordhaus, W. D. (2007). A review of the Stern review on the economics of climate change. *Journal of Economic Literature*, *45*(3), 686-702.

Nguyen, J. H., Truong, C., & Zhang, B. (2020). The price of carbon risk: Evidence from the kyoto protocol ratification. *Available at SSRN 3669660.*

NOAA (2022). Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD, 111 pp.

Nguyen, D. D., Ongena, S., Qi, S., & Sila, V. (2022). Climate change risk and the cost of mortgage credit. *Review of Finance*, 26(6), 1509-1549.

Ohlson, J. A., & Juettner-Nauroth, B. E. (2005). Expected EPS and EPS growth as determinantsof value. *Review of Accounting Studies*, *10*, 349-365.

Painter, M. (2020). An inconvenient cost: The effects of climate change on municipal bonds. *Journal of Financial Economics*, *135*(2), 468-482.

Pankratz, N., & Schiller, C. (2021). Climate change and adaptation in global supply-chain networks. In *Proceedings of Paris December 2019 Finance Meeting EUROFIDAI-ESSEC, European Corporate Governance Institute–Finance Working Paper* (No. 775).

Pankratz, N., Bauer, R., & Derwall, J. (2023). Climate change, firm performance, and investor surprises. *Management Science*.

Pástor, Ľ., Sinha, M., & Swaminathan, B. (2008). Estimating the intertemporal risk–return tradeoff using the implied cost of capital. *The Journal of Finance*, *63*(6), 2859-2897.

Pirinsky, C., Wang, Q., 2006. Does corporate headquarters location matter for stock returns? *Journal of Finance*. 61, 1991–2015.

Rjiba, H., Saadi, S., Boubaker, S., & Ding, X. S. (2021). Annual report readability and the cost of equity capital. *Journal of Corporate Finance*, *67*, 101902.

Seltzer, L. H., Starks, L., & Zhu, Q. (2022). *Climate regulatory risk and corporate bonds* (No. w29994). National Bureau of Economic Research.

Stern, N. H. (2007). The economics of climate change: the Stern review. Cambridge University press.

Stulz, R. M. (1999). Golbalization, corporate finance, and the cost of capital. *Journal of Applied Corporate Finance*, *12*(3), 8-25.

Truong, C., Nguyen, T. H., & Huynh, T. (2021). Customer satisfaction and the cost of capital. *Review of Accounting Studies*, *26*, 293-342.

The Guardian (2016). "Sea-level rises: why flooding is the next big business risk" The Guardian, 18 Mar. 2016. https://www.theguardian.com/sustainable-business/2016/mar/18/sea-level-rises-flooding-business-household-risk-uk. Accessed 3 May 2024.

The Washington Post (2022). "Rising seas could swallow millions of U.S. acres within decades." Washingtonpost.com, 8 Sept. 2022. https://go-gale-com.liverpool.idm.oclc.org/ps/i.do?p=STND&u=livuni&id=GALE|A716588316&v=2.1&it=r&sid=bookmark-STND&asid=34a2e3ba. Accessed 3 May 2024.

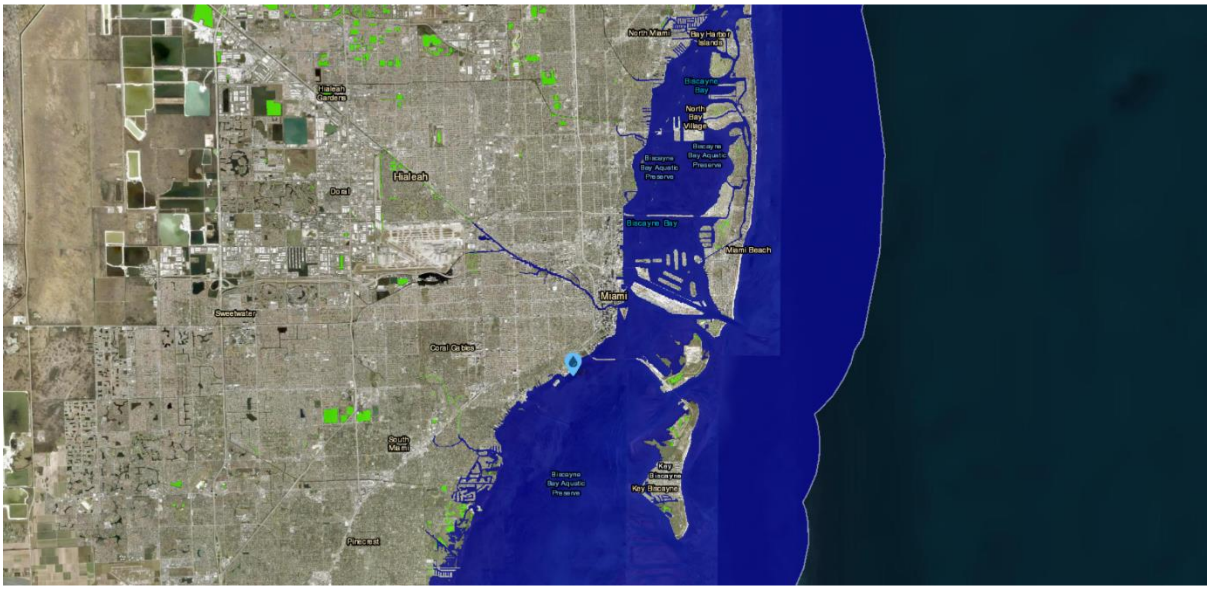
Whited, T. M., & Wu, G. (2006). Financial constraints risk. *The Review of Financial Studies*, *19*(2), 531-559.

Zerbib, O. D. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking & Finance*, *98*, 39-60.

Figure 1. Projected Sea Level Rise in Miami Florida

This figure shows the projected sea level rise in Miami Florida. The figure is from the Sea Level Rise Viewer provided by the NOAA Office for Coastal Management. Graph A shows the map of Miami Florida with zero-foot SLR layer. Graph B shows the map of Miami Florida with 6-foot SLR layer. The light blue layers in Graph B indicate the regions that will be inundated following a 6 feet increase in the local sea line on top of local Mean Higher High Water (MHHW).

Graph A.



Graph B.

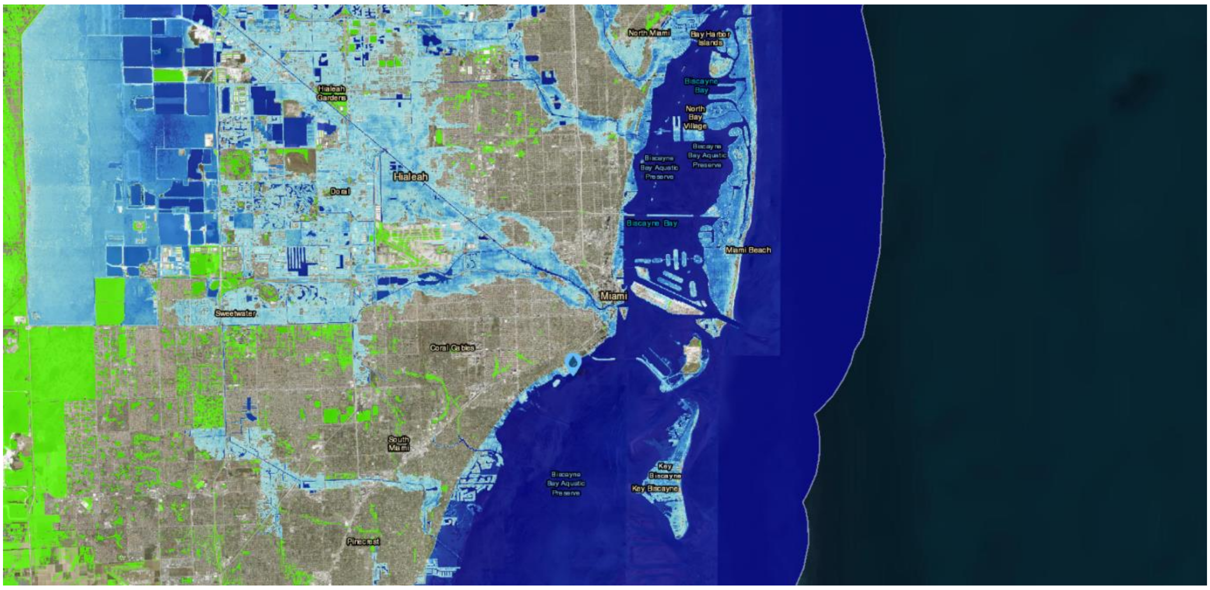


Figure 2. US Company Headquarters and SLR Risk

This figure reports the location of the US company's headquarters in our baseline sample. The blue dots are headquarters of companies which would be underwater if sea level rise by 6 feet, while the red dots are headquarters of companies which would not be affected.

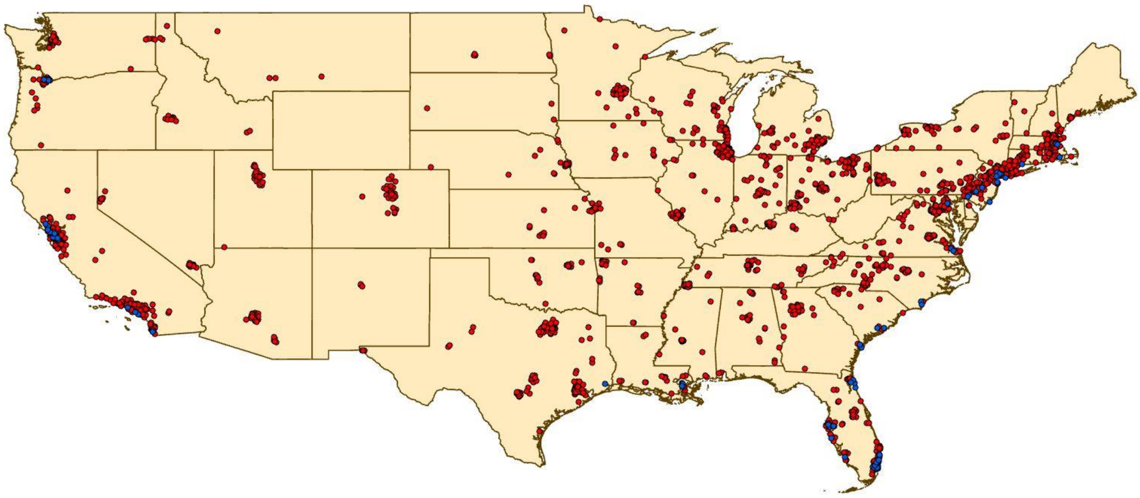


Table 1. Summary Statistics

This table reports the variables used in our baseline sample over the period between 1995 and 2022. Panel A presents the number of observations, mean, standard deviation, 25th percentile, 50th percentile, and 75th percentile of the variables. Panel B reports the Spearman correlation coefficients for the variables. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Definitions of the variables are presented in Appendix I.

Panel A. Summary Statistics

Variables	N	Mean	Sd.	p25	p50	p75
COE	30,155	6.937	7.945	3.438	5.622	8.183
SLR Risk 6ft	30,155	0.053	0.225	0.000	0.000	0.000
Market Beta	30,155	1.184	0.677	0.724	1.088	1.521
Idiosyncratic Volatility	30,155	10.993	5.166	7.216	9.891	13.548
Momentum	30,155	17.397	46.914	−11.800	11.034	36.581
Book-to-Market	30,155	0.448	0.301	0.236	0.381	0.586
Market Value of Equity	30,155	7.369	1.740	6.135	7.248	8.477
Leverage	30,155	0.223	0.179	0.054	0.213	0.346
Forecast Dispersion	30,155	0.092	0.204	0.015	0.032	0.077
Long-Term Growth	30,155	16.304	8.607	11.000	15.000	20.000
Forecast Bias	30,155	1.041	4.859	-0.245	0.000	0.706

Panel B. Spearman Correlation

	COE	SLR Risk 6ft	Market Beta	Idiosyncratic Volatility	Momentum	Book-to-Market	Market Value of Equity	Leverage	Forecast Dispersion	Long-Term Growth	Forecast Bias
COE	1										
SLR Risk 6ft	−0.009	1									
Market Beta	0.130***	0.083***	1								
Idiosyncratic Volatility	0.146***	0.074***	0.428***	1							
Momentum	−0.166***	0.022***	0.027***	0.108***	1						
Book-to-Market	0.209***	−0.011*	0.031***	0.120***	−0.189***	1					
Market Value of Equity	−0.122***	0.013**	−0.085***	−0.523***	0.005	−0.403***	1				
Leverage	0.106***	−0.079***	−0.098***	−0.185***	−0.047***	0.059***	0.124***	1			
Forecast Dispersion	0.194***	0.002	0.143***	0.209***	−0.119***	0.178***	−0.169***	0.033***	1		
Long-Term Growth	0.038***	0.065***	0.228***	0.428***	0.186***	−0.163***	−0.201***	−0.185***	0.079***	1	
Forecast Bias	0.492***	−0.006	0.062***	0.149***	−0.158***	0.134***	−0.158***	0.049***	0.217***	0.058***	1

Table 2. SLR Risk on the Cost of Equity

This table presents the regression results of the relation between the SLR risk and the cost of equity capital. The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The main independent variable, *SLR Risk 6ft*, is a dummy variable that takes value one if a firm will be inundated given a six-feet sea level rise according to NOAA and zero otherwise. The definitions of other control variables are presented in Appendix I. In Panel A, the sample period is 1995–2022. In Panel B, the sample period for Column (1) and Column (2) is 1995– 2015, while that for Column (3) and Column (4) is 2016 – 2022. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Full Sample

	Full Sample	
	(1)	(2)
	COE	COE
SLR Risk 6ft	0.009	0.052
	(0.02)	(0.13)
Market Beta	0.931***	0.400***
	(8.54)	(3.17)
Idiosyncratic Volatility	0.095***	0.153***
	(5.05)	(6.25)
Momentum	−0.013***	−0.014***
	(−13.86)	(−14.34)
Book-to-Market	3.395***	2.846***
	(10.67)	(8.73)
Market Value of Equity	0.245***	−0.051
	(3.79)	(−0.70)
Leverage	3.820***	3.461***
	(7.91)	(6.89)
Forecast Dispersion	1.740***	1.159***
	(4.84)	(3.19)
Long-Term Growth	0.025***	0.044***
	(2.92)	(5.12)
Forecast Bias	0.686***	0.687***
	(23.60)	(23.94)
_cons	−0.437	1.813**
	(−0.61)	(2.31)
Industry * Year Fixed Effects	No	Yes
County Fixed Effects	Yes	Yes
Adjusted R^2	0.353	0.418
Obs.	30155	30,155

Panel B. Before and After the Paris Agreement (PA)

	Before PA		After PA	
	(1)	(2)	(3)	(4)
	COE	COE	COE	COE
SLR Risk 6ft	−0.368	−0.308	1.300***	1.305***
	(−0.75)	(−0.64)	(2.84)	(2.90)
Market Beta	0.792***	0.300**	1.337***	1.169***
	(6.71)	(2.21)	(6.80)	(5.13)
Idiosyncratic Volatility	0.106***	0.148***	0.243***	0.209***
	(5.32)	(5.69)	(4.77)	(3.75)
Momentum	−0.012***	−0.014***	−0.020***	−0.021***
	(−11.43)	(−12.29)	(−11.92)	(−11.70)
Book-to-Market	3.113***	2.480***	5.624***	5.219***
	(8.76)	(6.84)	(9.87)	(8.55)
Market Value of Equity	0.186**	−0.063	0.191**	0.073
	(2.49)	(−0.79)	(2.25)	(0.71)
Leverage	3.430***	3.641***	3.406***	3.054***
	(5.82)	(6.25)	(6.29)	(5.65)
Forecast Dispersion	1.468***	1.175***	1.810***	0.793
	(3.60)	(2.87)	(2.98)	(1.36)
Long-Term Growth	0.021*	0.052***	0.022**	0.025**
	(1.84)	(4.57)	(2.44)	(2.57)
Forecast Bias	0.713***	0.708***	0.469***	0.496***
	(23.62)	(23.70)	(5.73)	(5.90)
_cons	0.107	1.785**	−1.276	0.507
	(0.13)	(2.04)	(−1.17)	(0.39)
Industry * Year Fixed Effects	No	Yes	No	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.353	0.414	0.519	0.567
Obs.	25289	25,289	4824	4,821

Table 3. Control For Transition Risk

This table presents the regression results of the relation between the SLR risk and the cost of equity capital. The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The main independent variable, *SLR Risk 6ft*, is a dummy variable that takes value one if a firm will be inundated given a six-feet sea level rise according to NOAA and zero otherwise. In Column (1) and Column (2), we control for transition risk, measured by Sautner et al. (2020) regulatory risk exposure in addition to the control variables used in the baseline model in Table 2. In Column (3) and Column (4), we exclude the 10 largest carbon-emitting industries identified in Ilhan et al. (2021) from our baseline sample. The sample period for Column (1) and Column (3) is 1995– 2015, while that for Column (2) and Column (4) is 2016 – 2022. The definitions of other control variables are presented in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Control for Regulatory Risk Exposure		Exclude Carbon-Emitting Industries	
	Before PA	After PA	Before PA	After PA
	(1)	(2)	(3)	(4)
	COE	COE	COE	COE
SLR Risk 6ft	−0.060	1.297***	0.122	1.343***
	(−0.09)	(2.87)	(0.31)	(2.91)
Regulatory Risk Exposure	2.124	3.892		
	(0.18)	(0.44)		
Other Control Variables in	Yes	Yes	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.422	0.574	0.406	0.528
Obs.	13,576	4,699	22,691	4,428

Table 4. Robustness Check I: Alternative Measures of SLR Risks and the Cost of Equity

This table presents the regression results of the relation between the SLR risk and the cost of equity capital. In Panel A, SLR risk is measured using *SLR Risk 3ft* and *SLR Risk County* respectively. *SLR risk 3ft* is a dummy variable that takes value one if a firm will be inundated given a three-feet sea level rise according to NOAA and zero otherwise. *SLR Risk County* is the estimated mean annual loss as a percentage of a city's GDP, assuming a 40-centimeter rise in sea level while the city adapts a protection level to its optimistic bound. The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The sample period for Column (1) and Column (3) is 1995– 2015, while that for Column (2) and Column (4) is 2016 – 2022. In Panel B, the dependent variable is the cost of equity calculated based on Gebhardt et al. (2001) (COE_GLS) in Column (1) and Column (2), Claus and Thomas (2001) (COE_CT) in Column (3) and Column (4), Easton (2004) (COE_MPEG) in Column (5) and Column (6), and Ohlson and Juettner-Nauroth (2005) (COE_OJ) in Column (7) and Column (8). The main independent variable is *SLR Risk 6ft*. The sample period for Column (1), Column (3), Column (5), and Column (7) is 1995– 2015, while that for Column (2), Column (4), Column (6), and Column (8) is 2016 – 2022. The definitions of other control variables are presented in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Alternative Measures of SLR Risk

	Before PA	After PA	Before PA	After PA
	(1)	(2)	(3)	(4)
	COE	COE	COE	COE
SLR Risk 3ft	−0.222	1.381***		
	(−0.29)	(2.69)		
SLR Risk County			−2.208*	5.309***
			(−1.74)	(3.08)
Other Control Variables in	Yes	Yes	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	No	No
Adjusted R^2	0.414	0.566	0.347	0.463
Obs.	25,289	4,821	25,296	4,859

Panel B. Alternative Measures of the Cost of Equity

	Before PA	After PA	Before PA	After PA	Before PA	After PA	Before PA	After PA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COE_GLS	COE_GLS	COE_CT	COE_CT	COE_MPEG	COE_MPEG	COE_OJ	COE_OJ
SLR Risk 6ft	−0.041	0.626**	−0.473	1.449***	−0.270	1.334**	−0.373	1.688***
	(−0.16)	(2.28)	(−0.73)	(2.69)	(−0.53)	(2.46)	(−0.83)	(3.09)
Other Control Variables in	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.482	0.662	0.371	0.530	0.422	0.525	0.392	0.496
Obs.	25,289	4,821	25,289	4,821	25,289	4,821	25,289	4,821

Table 5. Robustness Check II: Propensity Score Matched Sample and Entropy Balancing Approach

This table presents the regression results of the relation between the SLR risk and the cost of equity capital using the propensity score matched sample in Panel A and Panel B, and using the Entropy Balancing approach in Panel C and Panel D. We identify treated firms as firms with SLR Risk and control firms as firms without SLR risk. SLR risk of firms are measured using *SLR Risk 6ft* as in our baseline model. In Panel A and Panel B, we estimate the propensity scores using the full set of firm-level control variables in our baseline analysis in Table 2 and using the logit model. In addition, we match each treated firm to five control firms with replacement. The matching is based on the closest propensity score within a caliper of 0.1. Panel A tabulates the diagnostic statistics of difference in observable firm-level characteristics between the treatment and control groups. Panel B presents the regression results based on the propensity score-matched sample. The sample period for Column (1) is 1995–2015, while that for Column (2) is 2016 – 2022. In Panel C and Panel D, we weight each control observation so that post-weighting distributional properties of matching variables of treated and control observations are virtually identical, thereby ensuring covariate balance. The matching variables we use here are the full set of firm-level control variables in our baseline analysis in Table 2, and we ensure that the first three moments (i.e., mean, standard deviation, and skewness) of the matching variables are balanced between the treated and control firms. Panel C tabulates the diagnostic statistics of difference in observable firm-level characteristics between the treatment and control groups. Panel D presents the regression results using the entropy-balanced sample. The sample period for Column (1) is 1995– 2015, while that for Column (2) is 2016 – 2022. Detailed variable definitions are provided in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Diagnostic Statistics of Difference in Variables using Propensity Score Matched Sample

Variable	Treated	Control	p-value
Market Beta	1.420	1.420	0.999
Idiosyncratic Volatility	12.597	12.581	0.942
Momentum	21.639	21.543	0.961
Book-to-Market	0.434	0.435	0.939
Market Value of Equity	7.462	7.443	0.758
Leverage	0.163	0.162	0.824
Forecast Dispersion	0.094	0.095	0.945
Long-Term Growth	18.672	18.793	0.724
Forecast Bias	0.918	0.999	0.614

Panel B: Regressions with the Propensity Score-Matched Sample

	Before PA	After PA
	(1)	(2)
	COE	COE
SLR Risk 6ft	−0.313	1.292***
	(−0.65)	(2.74)
Other Control Variables in Table 2	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes
County Fixed Effects	Yes	Yes
Adjusted R^2	0.440	0.694
Obs.	6,857	1,210

Panel C: Diagnostic Statistics of Difference in Variables using Entropy Balancing Approach

	Treated	Control	Difference
Market Beta	1.420	1.419	0.001
Idiosyncratic Volatility	12.600	12.590	0.010
Momentum	21.640	21.630	0.010
Book-to-Market	0.434	0.434	0.000
Market Value of Equity	7.462	7.462	0.000
Leverage	0.164	0.164	0.000
Forecast Dispersion	0.094	0.094	0.000
Long-Term Growth	18.670	18.670	0.000
Forecast Bias	0.918	0.918	0.000

Panel D: Regressions with the Entropy-balanced Sample

	Before PA	After PA
	(1)	(2)
	COE	COE
SLR Risk 6ft	0.098	1.495***
	(0.23)	(3.56)
Other Control Variables in Table 2	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes
County Fixed Effects	Yes	Yes
Adjusted R^2	0.439	0.665
Obs.	25,289	4,821

Table 6. Robustness Check III: Exclude Firms with Relocation and Exclude Firms in Orleans Parish

This table presents the regression results of the relation between the SLR risk and the cost of equity capital. The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The main independent variable, *SLR Risk 6ft*, is a dummy variable that takes value one if a firm will be inundated given a six-feet sea level rise according to NOAA and zero otherwise. In Column (1) and Column (2), we exclude firms located in Orleans Parish from our baseline sample. In Column (3) and Column (4), we exclude firms which changed the address of their headquarters over our baseline sample period from our baseline sample. The sample period for Column (1) and Column (3) is 1995– 2015, while that for Column (2) and Column (4) is 2016 – 2022. The definitions of other control variables are presented in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Exclude Firms in Orleans Parish		Exclude Relocation Firms	
	Before PA	After PA	Before PA	After PA
	(1)	(2)	(3)	(4)
	COE	COE	COE	COE
SLR Risk 6ft	−0.308	1.305***	−0.023	1.870***
	(−0.64)	(2.90)	(−0.04)	(2.59)
Other Control Variables in	Yes	Yes	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.414	0.567	0.480	0.710
Obs.	25,268	4,821	14,349	2,635

Table 7. Placebo Test

This table presents the results from placebo tests. We identify treated firms as firms with SLR Risk and control firms as firms without SLR risk. SLR risk of firms are measured using *SLR Risk 6ft* as in our baseline model. We identify pseudo treated firms based on geographical distance. Specifically, in each year, for each treated firm, we calculate the geographical distance between the treated firm and all control firms. We assign SLR risk of the treated firm to the closest control firms (i.e., *Pseudo SLR Risk 6ft*). This table presents the regression results of the relation between the *Pseudo SLR Risk 6ft* and the cost of equity capital. The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The sample period for Column (1) is 1995– 2015, while that for Column (2) is 2016 – 2022. Detailed variable definitions are provided in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Before PA	After PA
	(1)	(2)
	COE	COE
Pseudo SLR Risk 6ft	−0.072	−0.470
	(−0.21)	(−1.56)
Other Control Variables in Table 2	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes
County Fixed Effects	Yes	Yes
Adjusted R^2	0.414	0.565
Obs.	25,289	4,821

Table 8. The Effects of the Paris Agreement

This table presents coefficients estimated from the difference-in-differences regression of cost of equity on the indicators of *SLR Risk 6ft* and *Post* over the period between 1995 and 2022. The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The main independent variable is the interaction between *SLR Risk 6ft* (i.e., a dummy variable takes value one if a firm will be inundated given a six-feet sea level rise according to NOAA and zero otherwise) and *Post* (i.e., a time dummy taking the value one for years after the Paris Agreement in December 2015 and zero otherwise). Detailed variable definitions are provided in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)
	COE	COE
SLR Risk 6ft × Post	1.489***	1.641***
	(3.05)	(3.50)
SLR Risk 6ft	−0.299	−0.264
	(−0.64)	(−0.58)
Post	1.294***	
	(8.30)	
Market Beta	0.874***	0.410***
	(8.02)	(3.24)
Idiosyncratic Volatility	0.111***	0.153***
	(5.93)	(6.24)
Momentum	−0.013***	−0.014***
	(−13.67)	(−14.34)
Book-to-Market	3.460***	2.851***
	(10.90)	(8.74)
Market Value of Equity	0.178***	−0.051
	(2.68)	(−0.70)
Leverage	3.355***	3.460***
	(6.66)	(6.89)
Forecast Dispersion	1.640***	1.163***
	(4.58)	(3.21)
Long-Term Growth	0.023***	0.044***
	(2.78)	(5.14)
Forecast Bias	0.688***	0.687***
	(23.67)	(23.94)
_cons	−0.164	1.797**
	(−0.23)	(2.29)
Industry * Year Fixed Effects	No	Yes
County Fixed Effects	Yes	Yes
Adjusted R^2	0.357	0.418
Obs.	30155	30,155

Table 9. Dynamic Effects of the Paris Agreement

This table reports the dynamic effects of the Paris Agreement on the cost of equity over the period between 1995 and 2022. The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The variable *SLR Risk 6ft* is an indicator variable equal to one if a firm will be inundated given a six-feet sea level rise according to NOAA. $Before^{1}$is an indicator variable set to one if a firm-year is one year before the Paris Agreement, and zero otherwise; $Before^{2}$is an indicator variable set to one if a firm-year is two years before the Paris Agreement, and zero otherwise; $Before^{2+}$is an indicator variable set to one if a firm-year is more than two years before the Paris Agreement, and zero otherwise. $Post^{1}$is an indicator variable set to one if a firm-year is one year after the Paris Agreement, and zero otherwise; $Post^{2}$is an indicator variable set to one if a firm-year is two years after the Paris Agreement, and zero otherwise; $Post^{2+}$is an indicator variable set to one if a firm-year is more than two years after the Paris Agreement, and zero otherwise; The definitions of other control variables are presented in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1) COE
SLR Risk 6ft × $Post^{2+}$	1.465***
	(3.10)
SLR Risk 6ft × $Post^{2}$	1.254**
	(2.07)
SLR Risk 6ft × $Post^{1}$	1.233*
	(1.95)
SLR Risk 6ft × $Before^{1}$	0.501
	(1.27)
SLR Risk 6ft × $Before^{2}$	0.407
	(0.85)
SLR Risk 6ft × $Before^{2+}$	−0.323
	(−0.68)
Other Control Variables in Table 2	Yes
Industry * Year Fixed Effects	Yes
County Fixed Effects	Yes
Adjusted R^2	0.418
Obs.	30,155

Table 10. Cross-sectional Variation I: Ability to Relocate

This table presents tests on how the association between SLR risk and the cost of equity varies with firms' ability to relocate. We only include sample period after the Paris Agreement (i.e., 2016 to 2022). The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The main independent variable, *SLR Risk 6ft*, is a dummy variable that takes value one if a firm will be inundated given a six-feet sea level rise according to NOAA and zero otherwise. In Column (1) and Column (2), we divide the sample into two groups depending on if a firm is in heavy industry. Column (1) (Column(2)) are firms with *Heavy Industry Dummy* equals to zero (one). In Column (3) and Column (4), we divide the sample into two groups based on the financial constraints of firms measured using *HP Index*. Column (3) (Column(4)) are firms with *HP Index* below (above) the yearly median. Detailed variable definitions are provided in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The empirical p-values, which test the significance of differences in the estimated coefficients on *SLR Risk 6ft* of different subsamples, are determined using the simulation procedure described in Cleary (1999).

	Heavy Industry		Financial Constraint	
	No	Yes	Low	High
	(1)	(2)	(3)	(4)
	COE	COE	COE	COE
SLR Risk 6ft	0.785	1.769***	0.236	1.666***
	(1.21)	(3.20)	(0.31)	(2.63)
Other Control Variables in Table 2	Yes	Yes	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.555	0.647	0.653	0.601
Obs.	3,126	1,681	2,402	2,374
Empirical p-value	0.00		0.00	

Table 11. Cross-sectional Variation II: Institutional Ownership

This table presents the tests on how the association between SLR risk and the cost of equity varies with firms' institutional ownership. We only include sample period after the Paris Agreement (i.e., 2016 to 2022). The dependent variable *COE* is the cost of equity capital (proxied by the average estimate from the methods of Gebhardt et al. (2001), Easton (2004), Claus and Thomas (2001), and Ohlson and Juettner-Nauroth (2005)). The main independent variable, *SLR Risk 6ft*, is a dummy variable that takes value one if a firm will be inundated given a six-feet sea level rise according to NOAA and zero otherwise. In Column (1) and Column (2), we divide the sample into two groups based on the institutional ownership of firms measured using *Institutional Ownership*. Column (1) (Column(2)) are firms with *Institutional Ownership* below (above) the yearly median. In Column (3) and Column (4), we divide the sample into two groups based on the institutional ownership of firms measured using *Num of Blockholders*. Column (3) (Column(4)) are firms with *Num of Blockholders* below (above) the yearly median. Detailed variable definitions are provided in Appendix I. Robust t-statistics are reported in parentheses, calculated based on robust standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The empirical p-values, which test the significance of differences in the estimated coefficients on *SLR Risk 6ft* of different subsamples, are determined using the simulation procedure described in Cleary (1999).

	Institutional Ownership		Num of Blockholders	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
	COE	COE	COE	COE
SLR Risk 6ft	0.806	1.694**	0.627	2.330***
	(1.65)	(2.22)	(1.54)	(2.71)
Other Control Variables in Table 2	Yes	Yes	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.573	0.632	0.534	0.674
Obs.	2380	2395	2818	1913
Empirical p-value	0.01		0.00	

Appendix I. Variable Definition

Variable	Definitions	Data Source
Implied cost of equity		
COE	The average implied cost of equity capital in excess of the risk-free rate in percentage. COE = (COE GLS + COE CT + COE MPEG + COE OJ) / 4. The risk-free rate is measured by the yield of a 10-year US Treasury bond.	I/B/E/S, CRSP, Compustat, and Federal Reserve Economic Data (FRED)
COE CT	The implied cost of equity capital in excess of the risk-free rate as a percentage, calculated following Claus and Thomas (2001), at the end of June of each year. The risk-free rate is measured by the yield of a 10-year US Treasury bond.	I/B/E/S, CRSP, Compustat, and FRED
COE GLS	The implied cost of equity capital in excess of the risk-free rate as a percentage, calculated following Gebhardt et al. (2001), at the end of June of each year. The risk-free rate is measured by the yield of a 10-year US Treasury bond.	I/B/E/S, CRSP, Compustat, and FRED
COE MPEG	The implied cost of equity capital in excess of the risk-free rate as a percentage, calculated using the modified price-earnings growth ratio model in Easton (2004), at the end of June of each year. The risk-free rate is measured by the yield of a 10-year US Treasury bond.	I/B/E/S, CRSP, Compustat, and FRED
COE OJ	The implied cost of equity capital in excess of the risk-free rate as a percentage, calculated following Ohlson and Juettner-Nauroth (2005) and Gode and Mohanram (2003), at the end of June of each year. The risk-free rate is measured by the yield of a 10-year US Treasury bond.	I/B/E/S, CRSP, Compustat, and FRED
Sea level rise risk		
SLR Risk 6feet	A dummy variable equals one if a firm's headquarter would be inundated if sea level rise by 6 feet, and zero otherwise.	NOAA and Bill Mcdonald Dataset
SLR Risk 3feet	A dummy variable equals one if a firm's headquarter would be inundated if sea level rise by 3 feet, and zero otherwise.	NOAA and Bill Mcdonald Dataset
SLR Risk County	The estimated expected mean annual loss as a percentage of a city's GDP, assuming a 40-centimeter rise in sea level. Counties within each city area are grouped together and assigned the same SLR risk value. See Appendix II for detail.	Hallegatte et al. (2013)
Pseudo SLR Risk 6ft	The Pseudo SLR Risk of a firm as defined in Table 7.	NOAA and Bill Mcdonald Dataset
Firm-level variables (baseline controls)		
Book-to-Market	The ratio of the book value of equity to the market value of equity measured at the fiscal year end.	Compustat
Forecast Bias	The difference between the one-year-ahead forecasted EPS and actual EPS, scaled by share price in percentage. When the actual EPS is missing from I/B/E/S, the actual EPS from Compustat is used.	I/B/E/S and Compustat
Forecast Dispersion	The standard deviation of the one-year-ahead earning per share (EPS) analyst forecasts divided by the average one-year-ahead EPS forecast.	I/B/E/S
Idiosyncratic Volatility	The standard deviation of the residuals from regressing monthly stock returns as a percentage on the value-weighted market returns as a percentage. Monthly returns in the 60 months before the month in which we compute the cost of equity are used in the regression (with a minimum of 24 return observations).	CRSP
Leverage	The sum of long-term debt and debt in current liabilities scaled by the value of total assets measured at the fiscal year end.	Compustat
Long-Term Growth	The long-term earnings growth rate forecast as a percentage.	I/B/E/S
Market Beta	Estimated for each firm-year observation at the end of June by regressing monthly stock returns on the value-weighted market returns. Monthly returns in the 60 months before the month in which we compute the cost of equity are used in the regression (with a minimum of 24 return observations).	CRSP
Market Value of	The logarithm of a firm's market value of equity measured at the fiscal year end.	Compustat

Equity		
Momentum	Momentum measured by the stock return over the 12 months before the month in which we compute the cost of equity.	CRSP
Variables used in additional analysis		
Heavy Industry Dummy	A dummy variable equals one if the industry of a company belongs to heavy industry, and zero otherwise. Heavy industries are defined based on the Fama-French 30 industry classifications and include: Chemicals; Construction and Construction Materials; Steel Works Etc; Fabricated Products and Machinery; Automobiles and Trucks; Aircraft, Ships, and Railroad Equipment; Precious Metals, Non-Metallic, and Industrial Metal Mining; Coal; Petroleum and Natural Gas; Utilities; Business Equipment.	Compustat
HP Index	HP Index is constructed following Hadlock and Pierce (2010) as $-0.737\, Size + 0.043\, Size^2 - 0.040\, Age$, where Size equals the log of inflation-adjusted Compustat item at (in 2004 dollars), and Age is the number of years the firm is listed with a nonmissing stock price on Compustat. In calculating the index, we follow Hadlock and Pierce and cap Size at (the log of) $4.5 billion and Age at 37 years.	Compustat, CRSP, and FRED
Institutional Ownership	The percentage of the company's shares held by institutional investors.	Institutional (13f) Holdings
Num of Blockholders	The number of institutional block owners with more than 5% ownership	Institutional (13f) Holdings
Post	A dummy variable taking the value of one if the implied cost of equity of a company is estimated after the Paris Agreement in December 2015 and zero otherwise.	
Regulatory Risk Exposure	Firm-level regulatory risk exposure as measured by the variable $CCExposureReg$ ($\times\ 10^2$) in Sautner et al. (2023). It measures the relative frequency with which bigrams that capture regulatory shocks related to climate change occur in earnings calls.	Sautner et al. (2023)

Appendix II. County-level SLR Risk Measure

This table is provided by Painter (2020), reporting the SLR risk of the U.S. cities and their associated counties included in Hallegatte et al. (2013). All counties not included in this table are assigned a SLR risk of zero.

City	County	Mean annual loss (MM$)	Climate risk (%)
New Orleans, LA	Orleans	1940	1.479
Miami, FL	Miami Dade	2964	0.420
Tampa/St. Petersburg, FL	Hillsborough, Pinellas	948	0.324
Virginia Beach, VA	Virginia Beach	328	0.173
Boston, MA	Suffolk	849	0.149
Baltimore, MD	Baltimore	299	0.104
LA/Long Beach/Santa Ana, CA	Los Angeles, Orange	217	0.097
New York, NY/Newark, NJ	Bronx, Kings, New York, Queens,	2159	0.089
Providence, RI	Providence	135	0.083
Philadelphia, PA	Philadelphia	309	0.044
San Francisco/Oakland, CA	San Francisco, Alameda	185	0.042
Houston, TX	Walker, Montgomery, Liberty, Waller, Austin Harris, Chambers, Colorado, Wharton, Fort Bend, Galveston, Brazoria, Matagorda	214	0.038
Seattle, WA	King	90	0.023
Washington D.C.	Washington	91	0.016
San Diego, CA	San Diego	14	0.004
Portland, OR	Multnomah	4	0.002
San Jose, CA	Santa Clara	2	0.001