Extreme Weather Events and Capital Investment*

Sandrine Docgne†

Abstract

We examine the effect of extreme weather events on capital investment and research and development.

Keywords: Climate risk, Capital investment

*We thank...

†Florida International University, College of Business, 11200 S.W. 8th St., 210, Miami, FL 33199, USA. E-mail: sdocgnep@fiu.edu

1 Introduction

Extreme weather events exert considerable impacts on businesses, communities, and economies. While emerging research on climate-related financial risk is beginning to clarify some of these effects, the impact on corporate decision-making and policies remains under-explored. This study aims to address this gap by analyzing how climate-related financial risks influence corporate investment decisions.

Empirical evidence reveals a substantial increase in personal bankruptcy filings in areas affected by major hurricanes (Lawless, 2005), and shows that economic growth in these regions often declines relative to pre-disaster trends, with slow recovery that can persist for decades (Hsiang and Jina, 2014). The Global Risks Report 2023 by the World Economic Forum underscores natural disasters and extreme weather events as major global risks with significant short- and long-term severity (World Economic Forum, 2023).

Recent theoretical and empirical studies have demonstrated that disaster risk affects stock returns (Tsai and Wachter, 2016; Bai et al., 2019; Lanfear et al., 2019). Research by Dessaint and Matray (2017) indicates that managers are increasingly concerned about hurricane risks in their annual filings, while a survey by Krueger et al. (2020) reveals that institutional investors perceive climate risks as having financial implications for their portfolios and acknowledge that these risks are already materializing.

This paper investigates how climate risk can impact firm performance over the long term, focusing on investment as a key determinant of returns. A firm's ability to grow in terms of revenue, market share, and customer base is significantly influenced by how effectively it manages and mitigates climate risks.

2 Preliminary Results

2.1 Impact of Storm Events on Capital Expenditures (CAPEX)

Tables 2, 4, 5, and 6 provide a comprehensive analysis of the average marginal effects (AME) of storm events on capital expenditures (CAPEX) across one, two, and three years following the event. The analysis is segmented by various firm characteristics, including size, property, plant, and equipment (PPE), leverage, market-to-book (MTB) ratio, EBITDA, age, and credit rating.

In the first year following a storm event, the impact on CAPEX is generally small and statistically insignificant across different size percentiles (P10, P50, P90). An exception is observed in the P90 size group, where there is a statistically significant reduction in CAPEX ($\beta = -0.0020$, $p < 0.05$). For other firm characteristics, such as PPE, leverage, MTB ratio, EBITDA, and age, the coefficients are largely insignificant, suggesting that storm events have minimal to no effect on CAPEX during this period. Similarly, no significant difference in CAPEX is observed between firms with and without credit ratings, although firms with ratings display a positive but statistically insignificant coefficient.

Two years after the storm events, the results indicate more variation in the impact on CAPEX. Firms in the P10 size category experience a significant increase in CAPEX ($\beta = 0.0038$, $p < 0.05$), while those in the P90 category continue to face a significant reduction ($\beta = -0.0023$, $p < 0.05$). Despite positive coefficients for the P10 and P50 PPE categories, these effects are not statistically significant, and the impact on firms in the P90 PPE category remains negligible. Interestingly, firms with higher MTB ratios in the P90 category show a significant increase in CAPEX ($\beta = 0.0023$, $p < 0.05$), and older firms (P90) tend to increase their CAPEX significantly two years after the storm event ($\beta = 0.0021$, $p < 0.05$). However, as with the first year, no significant differences are found between rated and non-rated firms regarding their CAPEX response to storm events.

By the third year after the storm events, the impact on CAPEX appears to diminish further. None of the size percentiles exhibit statistically significant effects, suggesting that the influence of storm events on CAPEX fades over time. Nevertheless, firms in the P10 PPE category display a significant positive effect on CAPEX ($\beta = 0.0026$, $p < 0.01$), while those in the P90 PPE category experience a significant reduction ($\beta = -0.0044$, $p < 0.05$). Age-related effects also become more pronounced, with older firms (P90) showing a marked increase in CAPEX ($\beta = 0.0036$, $p < 0.01$), whereas younger firms (P10) significantly reduce their CAPEX ($\beta = -0.0025$, $p < 0.05$). As observed in earlier periods, credit rating continues to show no significant difference in CAPEX response to storm events.

Overall, the results indicate that the effect of storm events on CAPEX varies considerably across firm characteristics and over time. Larger firms, particularly those in the P90 size percentile, tend to reduce CAPEX significantly in the year following a storm event, which may be due to their more complex operations and higher exposure to such events. In contrast, smaller firms (P10) may increase their CAPEX over the longer term, particularly two years after the event, possibly as part of recovery or adaptation strategies. These findings suggest that the impact of storms on CAPEX diminishes over time, with the most significant effects observed within the first two years following the event. The heterogeneous nature of these impacts highlights the importance of considering firm-specific characteristics when assessing the economic implications of extreme weather events on firm investment behavior.

2.2 Impact of Storm Events on R&D Expenditures

Tables 3, 7, 8, and 9 explore the average marginal effects (AME) of storm events on research and development (R&D) expenditures across one, two, and three years after the event. The analysis is conducted across various firm characteristics, including size, property, plant, and equipment (PPE), leverage, market-to-book (MTB) ratio, EBITDA, firm age, and credit rating status.

In the first year following a storm event, the impact on R&D expenditures across different firm characteristics is generally small and statistically insignificant. For instance, firms in the 10th percentile of size exhibit a positive but insignificant AME of 0.0023, while those in the 90th percentile show a slightly negative effect of -0.0017. The p-value for the difference between these percentiles is 0.6766, indicating no statistically significant difference. Similar patterns of insignificance are observed across other firm characteristics, including PPE, leverage, MTB ratio, EBITDA, and age. Additionally, the difference in R&D expenditures between rated and non-rated firms is negligible, with a p-value of 0.8036.

Two years after the storm event, the AME on R&D spending remains statistically insignificant for most firm characteristics. Notably, firms in the 10th percentile of PPE exhibit a positive AME of 0.0028, though this effect is not statistically significant. An interesting exception is observed among older firms in the 90th percentile of age, which show a significant reduction in R&D spending ($\beta = -0.0035$) with a p-value of 0.0814. This suggests that older firms may reduce their R&D efforts in response to storm events two years after their occurrence. However, this effect is not consistent across other firm characteristics, and the overall pattern suggests that storm events do not have a broad or significant impact on R&D spending two years post-event.

By the third year after the storm events, the impact on R&D expenditures remains statistically insignificant for most firm characteristics. The AME for firms in the 10th percentile of size is slightly negative at -0.0013, while for firms in the 90th percentile, the AME is positive at 0.0006. The p-value for the difference between these percentiles is 0.8410, indicating no significant effect. Similarly, the analysis of other characteristics, such as PPE, leverage, MTB ratio, EBITDA, and credit rating status, reveals no substantial changes in R&D spending attributable to storm events three years after their occurrence.

Across all three time periods—one, two, and three years after the storm event—the analysis consistently shows that storm events do not have a significant impact on R&D spending, regardless of firm characteristics. The only exception is a small, statistically significant re-

duction in R&D spending observed among older firms two years after the storm event, though this effect is isolated and not robust across other characteristics or time periods. Overall, the results suggest that storm events are not a major determinant of R&D expenditure decisions within firms, indicating a general resilience of R&D activities to such external shocks.

3 Conclusion

This study explored the impact of storm events on firm-level capital expenditures (CAPEX) and research and development (RD) spending across different firm characteristics, including size, property, plant, and equipment (PPE), leverage, market-to-book ratio (MTB), EBITDA, age, and credit rating status. The analysis spanned three years following a storm event, offering insights into both short-term and longer-term effects. The analysis reveals that storm events have a nuanced impact on firm-level capital expenditures (CAPEX) and research and development (RD) spending, varying by firm characteristics and over time. Larger firms tend to reduce CAPEX significantly in the year following a storm, while smaller firms may increase their investment two years after, possibly as a recovery measure. However, the effects on CAPEX generally diminish over time. In contrast, storm events do not have a significant or consistent impact on RD spending across different firm characteristics, with only isolated instances of statistically significant changes observed, such as a slight reduction in RD by older firms two years post-event. Overall, the findings suggest that while storm events can influence investment decisions in the short term, their long-term impact on both CAPEX and RD spending is limited.

References

Bai, Hang, Kewei Hou, Howard Kung, Erica XN Li, and Lu Zhang, 2019, The capm strikes back? an equilibrium model with disasters, *Journal of Financial Economics* 131, 269–298.

Dessaint, Olivier, and Adrien Matray, 2017, Do managers overreact to salient risks? evidence from hurricane strikes, *Journal of Financial Economics* 126, 97–121.

Hsiang, Solomon M, and Amir S Jina, 2014, The causal effect of environmental catastrophe on long-run economic growth: Evidence from 6,700 cyclones.

Krueger, Philipp, Zacharias Sautner, and Laura T Starks, 2020, The importance of climate risks for institutional investors, *The Review of Financial Studies* 33, 1067–1111.

Lanfear, Matthew G, Abraham Lioui, and Mark G Siebert, 2019, Market anomalies and disaster risk: Evidence from extreme weather events, *Journal of financial markets* 46, 100477.

Lawless, Robert M, 2005, Bankruptcy filing rates after a major hurricane, *Nev. LJ* 6, 7.

Tsai, Jerry, and Jessica A Wachter, 2016, Rare booms and disasters in a multisector endowment economy, *The Review of Financial Studies* 29, 1113–1169.

World Economic Forum, 2023, The Global Risks Report 2023 18th edition.

Table 1: Summary Statistics

This table presents summary statistics for our data sample. All variables are defined in the Appendix.

	(1) Summary Stats					
	mean	sd	p10	p50	p90	count
Capex	0.07	0.12	0.00	0.04	0.16	168050
ResDev	0.17	0.36	0.00	0.05	0.41	95230
Assets ($ Millions)	1909.95	5901.37	3.68	124.33	4070.00	180496
Firm Size	4.77	2.74	1.30	4.82	8.31	180496
PPE	0.28	0.26	0.03	0.19	0.71	180150
Leverage	0.38	0.78	0.00	0.23	0.69	179840
Market-to-Book	2.70	6.75	0.71	1.65	6.03	153522
Profitability	-0.20	1.22	-0.54	0.09	0.22	179153
Cash	0.20	0.25	0.01	0.09	0.61	180409
Cashflow	-0.31	1.70	-0.60	0.06	0.20	169025
Cashflow Volatility	1.06	5.57	0.01	0.08	0.75	169738
Earnings Volatility	0.49	2.08	0.02	0.07	0.52	169822
Dividends	0.27	0.44	0.00	0.00	1.00	180496
Rated	0.21	0.41	0.00	0.00	1.00	161988
Investment Grade	0.11	0.31	0.00	0.00	1.00	161988
Observations	180496					

Table 2: Hurricane Exposure and Capital Investment

Standard errors are adjusted for clustering at the firm level. All variables are defined in the Appendix. t statistics are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	(1)	(2)	(3)	(4)
	m1	m2	m3	m4
1 Year Post S.E.=1	-0.00			-0.00
	(-0.47)			(-0.66)
2 Year Post S.E.=1		0.00		0.00
		(0.96)		(0.65)
3 Year Post S.E.=1			0.00	0.00
			(0.08)	(0.03)
Firm Size	-0.02***	-0.02***	-0.02***	-0.02***
	(-21.43)	(-21.43)	(-21.33)	(-21.33)
PPE	0.02***	0.02**	0.01*	0.01*
	(3.11)	(2.44)	(1.92)	(1.92)
Leverage	-0.01***	-0.01***	-0.01***	-0.01***
	(-3.64)	(-3.47)	(-3.40)	(-3.40)
Market-to-Book	0.00***	0.00***	0.00***	0.00***
	(8.32)	(8.29)	(8.08)	(8.08)
Profitability	-0.01***	-0.01***	-0.01***	-0.01***
	(-4.35)	(-4.32)	(-4.22)	(-4.22)
Cash	0.04***	0.04***	0.04***	0.04***
	(10.50)	(10.35)	(10.16)	(10.15)
Cashflow	-0.00	-0.00	-0.00	-0.00
	(-0.54)	(-0.52)	(-0.60)	(-0.60)
Cashflow Volatility	0.00***	0.00***	0.00***	0.00***
	(9.75)	(9.68)	(9.55)	(9.55)
Earnings Volatility	-0.01***	-0.01***	-0.01***	-0.01***
	(-6.76)	(-6.73)	(-6.61)	(-6.61)
Dividends=1	0.01***	0.01***	0.01***	0.01***
	(4.60)	(4.22)	(3.91)	(3.90)
Rated	0.01***	0.01***	0.01***	0.01***
	(3.98)	(4.06)	(4.12)	(4.12)
Investment Grade	0.01***	0.01***	0.01***	0.01***
	(3.68)	(3.76)	(3.68)	(3.68)
Constant	0.15***	0.14***	0.14***	0.14***
	(27.50)	(26.57)	(24.75)	(24.75)
Year F.E.	Yes	Yes	Yes	Yes
Firms F.E.	Yes	Yes	Yes	Yes
Observations	118542	114415	110301	110301
R^2	0.48	0.49	0.49	0.49

Table 3: Hurricane Exposure and R&D

Standard errors are adjusted for clustering at the firm level. All variables are defined in the Appendix. t statistics are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	(1)	(2)	(3)	(4)
	m1	m2	m3	m4
1 Year Post S.E.=1	0.00			0.00
	(0.16)			(0.11)
2 Year Post S.E.=1		-0.00		-0.00
		(-0.15)		(-0.21)
3 Year Post S.E.=1			-0.00	-0.00
			(-0.17)	(-0.16)
Firm Size	-0.05***	-0.06***	-0.06***	-0.06***
	(-17.67)	(-17.59)	(-17.41)	(-17.41)
PPE	0.09***	0.09***	0.09***	0.09***
	(3.93)	(3.85)	(3.79)	(3.79)
Leverage	-0.01	-0.01	-0.01	-0.01
	(-0.98)	(-1.02)	(-0.99)	(-0.99)
Market-to-Book	0.00***	0.00***	0.00***	0.00***
	(6.01)	(6.02)	(5.88)	(5.88)
Profitability	-0.12***	-0.12***	-0.12***	-0.12***
	(-15.64)	(-15.45)	(-15.22)	(-15.22)
Cash	0.01	0.00	0.00	0.00
	(0.40)	(0.29)	(0.13)	(0.13)
Cashflow	-0.00	-0.00	-0.00	-0.00
	(-0.20)	(-0.16)	(-0.20)	(-0.20)
Cashflow Volatility	0.00**	0.00**	0.00**	0.00**
	(2.37)	(2.40)	(2.42)	(2.42)
Earnings Volatility	-0.01	-0.01	-0.01	-0.01
	(-1.41)	(-1.43)	(-1.44)	(-1.44)
Dividends=1	0.02***	0.02***	0.02***	0.02***
	(7.47)	(7.19)	(6.90)	(6.89)
Rated	0.03***	0.03***	0.03***	0.03***
	(7.32)	(7.41)	(7.42)	(7.42)
Investment Grade	0.01***	0.01***	0.01**	0.01**
	(3.15)	(2.88)	(2.57)	(2.57)
Constant	0.28***	0.29***	0.29***	0.29***
	(18.09)	(18.26)	(17.96)	(17.95)
Year F.E.	Yes	Yes	Yes	Yes
Firms F.E.	Yes	Yes	Yes	Yes
Observations	69617	67467	65287	65287
R^2	0.69	0.69	0.69	0.69

Table 4: A.M.E of Storm Event on CAPEX one year After by Firm Characteristics

	(1) Size	(2) PPE	(3) Leverage	(4) MTB	(5) EBITDA	(6) Age	(7) Rated
1.se_year1							
P10	0.0014	0.0005	0.0008	-0.0008	-0.0005	-0.0001	
	(0.86)	(0.51)	(0.95)	(-0.96)	(-0.52)	(-0.11)	
P50	-0.0002	-0.0001	0.0001	-0.0005	-0.0002	-0.0002	
	(-0.34)	(-0.10)	(0.17)	(-0.78)	(-0.27)	(-0.28)	
P90	-0.0020**	-0.0017	-0.0013	0.0004	-0.0001	-0.0006	
	(-1.99)	(-0.82)	(-1.28)	(0.43)	(-0.13)	(-0.68)	
Non Rated							-0.0008
							(-1.04)
Rated							0.0015
							(1.30)
$p-$value (P90 - P10)	0.1506	0.4172	0.1199	0.2969	0.7109	0.7562	0.0979

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: A.M.E of Storm Event on CAPEX Two years After by Firm Characteristics

	(1) Size	(2) PPE	(3) Leverage	(4) MTB	(5) EBITDA	(6) Age	(7) Rated
1.se_year2							
P10	0.0038**	0.0010	0.0000	-0.0004	0.0014	-0.0004	
	(2.19)	(1.04)	(0.03)	(-0.47)	(1.43)	(-0.33)	
P50	0.0008	0.0008	0.0004	0.0001	0.0001	0.0002	
	(1.11)	(1.23)	(0.62)	(0.15)	(0.12)	(0.30)	
P90	-0.0023**	0.0000	0.0012	0.0023**	-0.0002	0.0021**	
	(-2.29)	(0.01)	(1.10)	(2.19)	(-0.33)	(2.53)	
Non Rated							0.0006
							(0.76)
Rated							0.0007
							(0.64)
$p-$value (P90 - P10)	0.0132	0.7223	0.4288	0.0274	0.1515	0.0926	0.9315

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: A.M.E of Storm Event on CAPEX Three Years After by Firm Characteristics

	(1) Size	(2) PPE	(3) Leverage	(4) MTB	(5) EBITDA	(6) Age	(7) Rated
1.se_year3							
P10	0.0018	0.0026***	-0.0007	0.0004	0.0007	-0.0025**	
	(0.99)	(2.59)	(-0.73)	(0.54)	(0.66)	(-2.25)	
P50	0.0001	0.0009	-0.0002	0.0003	-0.0005	-0.0010	
	(0.18)	(1.35)	(-0.34)	(0.35)	(-0.67)	(-1.18)	
P90	-0.0016	-0.0044**	0.0007	-0.0006	-0.0007	0.0036***	
	(-1.50)	(-2.04)	(0.60)	(-0.56)	(-0.94)	(4.27)	
Non Rated							-0.0001
							(-0.16)
Rated							0.0007
							(0.59)
$p-$value (P90 - P10)	0.1944	0.0129	0.3802	0.3847	0.2619	0.0000	0.5743

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: A.M.E of Storm Event on R&D one year After by Firm Characteristics

	(1) Size	(2) PPE	(3) Leverage	(4) MTB	(5) EBITDA	(6) Age	(7) Rated
1.se_year1							
P10	0.0023	-0.0000	0.0020	0.0008	0.0011	0.0028	
	(0.35)	(-0.01)	(0.67)	(0.28)	(0.22)	(0.92)	
P50	0.0004	0.0002	0.0012	0.0006	-0.0002	0.0012	
	(0.19)	(0.10)	(0.61)	(0.25)	(-0.10)	(0.52)	
P90	-0.0017	0.0008	-0.0014	-0.0004	-0.0005	-0.0031	
	(-0.51)	(0.25)	(-0.29)	(-0.13)	(-0.18)	(-1.57)	
Non Rated							0.0002
							(0.08)
Rated							0.0008
							(0.66)
$p-$value (P90 - P10)	0.6766	0.8709	0.6137	0.7926	0.8196	0.0867	0.8036

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: A.M.E of Storm Event on R&D Two years After by Firm Characteristics

	(1) Size	(2) PPE	(3) Leverage	(4) MTB	(5) EBITDA	(6) Age	(7) Rated
1.se_year2							
P10	0.0000	0.0028	0.0024	0.0002	-0.0026	0.0021	
	(0.01)	(0.84)	(0.81)	(0.09)	(-0.52)	(0.72)	
P50	-0.0003	0.0006	0.0011	-0.0000	0.0011	0.0006	
	(-0.12)	(0.29)	(0.58)	(-0.01)	(0.64)	(0.27)	
P90	-0.0006	-0.0049	-0.0029	-0.0012	0.0019	-0.0035**	
	(-0.20)	(-1.28)	(-0.66)	(-0.33)	(0.73)	(-1.99)	
Non Rated							-0.0004
							(-0.16)
Rated							0.0001
							(0.06)
$p-$value (P90 - P10)	0.9424	0.2042	0.4166	0.7775	0.5173	0.0814	0.8581

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: A.M.E of Storm Event on R&D Three Years After by Firm Characteristics

	(1) Size	(2) PPE	(3) Leverage	(4) MTB	(5) EBITDA	(6) Age	(7) Rated
1.se_year3							
P10	-0.0013	0.0014	0.0027	0.0009	-0.0042	-0.0002	
	(-0.20)	(0.43)	(0.92)	(0.34)	(-0.88)	(-0.05)	
P50	-0.0004	0.0002	0.0013	0.0003	0.0021	-0.0003	
	(-0.18)	(0.09)	(0.63)	(0.13)	(1.20)	(-0.11)	
P90	0.0006	-0.0030	-0.0032	-0.0025	0.0034	-0.0006	
	(0.19)	(-0.87)	(-0.77)	(-0.69)	(1.40)	(-0.32)	
Non Rated							-0.0005
							(-0.19)
Rated							0.0002
							(0.19)
$p-$value (P90 - P10)	0.8410	0.4229	0.3249	0.4787	0.2278	0.8990	0.7917

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$