Climate Risk and Financial Engineering in Florida's Insurance Market

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Abstract: This paper examines whether financial risk strategies can stabilize Florida's homeowner insurance market or delay the corrections as climate change intensifies. Using a case study approach, it analyzes how increasing hurricane severity and reliance on financial tools influence long and short-term market resilience. The findings indicate that while these instruments provide short-term success, and expand the underwriting capacity, they do not reduce core vulnerability. Instead, the risk is temporarily displaced through capital markets, which creates a conditional stability that can weaken when the losses exceed expectations. This reflects a similar deferment to the 2008 financial crisis.

Keywords: Climate risk, insurance market stability, financial risk transfer, systemic vulnerability

1. Introduction

Florida's homeowners' insurance market is experiencing increasing instability as climate-related extreme weather events grow more severe. This places financial pressure on private insurers and public risk carriers. The objective of this paper is to examine whether current risk mitigation strategies, specifically reinsurance, catastrophe bonds, and weather derivatives, help stabilize the insurance market, or simply defer this correction under this increasing climate risk. This work is focused as a case study on Florida, analyzing how rising hurricane intensity, concentrated coastal exposure, and reliance on post-event financial mechanisms affect long-term economic viability.

The relevance of this research is rooted in Florida's growing exposure to catastrophic weather, which is driven by changing climate patterns and intensifying storms. With multiple insurer insolvencies and an increasing number of policies transferred to government backed programs, it is critical to understand whether financial risk mitigation tools can support this market stability. The methodology of this paper consists of a comprehensive literature review across climate science, insurance economics, and financial risk management, followed by analysis synthesizing findings from academic and industry perspectives to assess vulnerability,

The analysis suggests that while mitigation instruments provide short-term solvency protection, they may not reduce the underlying exposure. Instead, they risk replicating the deferred solutions of the 2008 financial crisis, through historical risk assumptions and external capital.

This paper is organized as follows: Section 2 provides contextual background on Florida's risk environment and insurance structure. Section 3 presents the literature review. Section 4

delivers the analysis of risk mitigation and market vulnerability. Section 5 concludes with key implications, and the future of policies and research.

2. Background Review

2.1 Climate and Geographic Exposure

Florida has been in turmoil over the past century with the rise of major storms, hurricanes, and floods. Scientists are seeing that the timing of hurricanes is not increasing, rather, the severity of them is. Over 79% of Florida's population lives in coastal counties, making them extra vulnerable to these storms. In the past, insurers have treated these storms as low-probability outliers, yet recent storm patterns indicate that there is a change to the system. This contributes to the underestimation of expected losses and a higher systemic vulnerability. This further results in Florida's insurance market to be highly sensitive to large-scale catastrophes.

2.2 Hurricane Andrew Case Study

Hurricane Andrew (1992) caused over $36 billion in insured losses (2025 USD), leading to 16 insurer failures and forcing insurers to withdraw from Florida. Because of this, many insurers, including several large national carriers, minimized their exposure in the Florida market, or fully withdrew their business from the state. In response, Florida established Citizens Property Insurance Corporation in 2002. This was made as a state-backed insurer of last resort to provide insurance coverage to people who could not find private market coverage. Parallel to this time, the Florida Hurricane Catastrophe Fund (FHCF) was expanded to offer help to insurers by offering state-managed reinsurance protection designed specifically for the aftermath of these large-scale disasters.

Over time, the market in Florida has shifted to private, localized insurance companies. Although this structure of insurers has allowed for greater availability, it has also increased the system fragility by focusing risk among financially limited insurers with minimal geographic diversification. With the development of more coastal properties, and the sharp rise of pricing, insurers exposure became concentrated in high-risk areas. With reinsurance pricing being volatile, alongside an increasing frequency of billion-dollar loss events, underwriting stability became even more stressful.

In most recent years, there has been an insurgence of insurance company insolvencies. This has been caused by recurring storms, increased litigation costs, and limited capacity in the global reinsurance market facing intensified pressure. With seven insurers being insolvent since 2021, alongside the rapid expansion of policies held by Citizens of 1.5 million active policies in 2024, Florida's insurance market is increasingly dependent on state intervention

2.3 Legal and Regulatory Context

In addition to the many challenges Florida insurance market faces, it has also been conflicted with a complex legal environment that has intensified claim costs which have contributed to insurer liability. Florida has a one-way attorney fee statute, which previously required insurers to pay the legal fees of policy holders who've won in litigation, regardless of the settlement amount. This then created financial incentives for excessive claims disputes. In addition to this, the Assignment of Benefits (AOB) framework allows third party contractors to gain control of insurance claims, which often results in inflated repair charges and legal issues. Between 2013 and 2019, there was an increase of proportionality between claims frequency and litigation costs. While claims frequency stayed constant, the costs of these legal actions rose by 400%. This placed major pressure on underwriting margins. There were actions that were taken

against these practices. Legislative reforms such as Senate Bill 76 (2001), and Senate Bill 2-A (2002), were brought to limit AOB misuse and curb attorney fee structures. These were brought to help, yet they have been slow to show their effect. Many insurers had already absorbed many different years of high losses prior to the reform. Alongside, hurricane related claims continue to accumulate across Florida. This combination of delayed regulatory response, volatile legal exposure, and concentrated risk all contributed to the mountain of financial stress within Florida's insurance system. This led to a weakening of market resilience and increasing reliance of state-backed systems such as Citizens Property Insurance.

2.4 Parallels to the 2008 Financial Crisis

In 2008, the United States faced many challenges that exhibit notable structural similarities to that of Florida's homeowner insurance market. Prior to 2008, banks underestimated the tail risks within mortgage-backed securities. They relied heavily on historical assumptions which failed to account for correlated loss events. With Florida, insurers have historically priced hurricane exposure based on long-term probability models that CAT modelers have made. They treated these catastrophic events as statistically rare, rather than increasing in severity. In both cases, one with the housing market, and the other with coastal developments, both created conditions that could single handily impact the whole market, triggering widespread financial stress. Although the underlying driver of this systematic turmoil differs, such as the credit degradation in 2008 versus climate-driven asset risk today, the mechanism of systematic fragility is comparable. It does not in itself imply they are identical causations, as the insurance crisis in Florida is fundamentally driven in the physical rather than the financial risk dynamics as 2008 was.

3. Literature Review

3.1 Climate-Driven Catastrophe Risk

It has been proven consistently that while the frequency of hurricanes and tropical storms are not increasing, their intensity and destructive potential have risen due to climate change (Center for Climate and Energy Solutions [C2ES], 2024). Empirical analyses have shown that the warmer the sea surface temperature is, the greater the intensity of a hurricane. Sea surface temperature acts as an engine for these storms. And with reports saying that 80% of Atlantic hurricanes between 2019 and 2023 underwent rapid intensification linked to elevated ocean temperatures (Climate Central, 2023), it is only increasing its wind speed. NOAA researchers also note that global warming contributes to increased rainfall rates a wind speeds, making landfalling hurricanes substantially more damaging than past climatological norms (Geophysical Fluid Dynamics Laboratory, 2023).

Climate science is emphasizing that hurricane severity is shifting toward a new normal, rather than random events. For example, storms are moving more slowly and maintaining their strength longer after landfall due to atmospheric pattern changes, which highlights the risk of inland damage (Environmental Defense Fund [EDF], 2023). These findings are aligned with C2ES (2024), which warns that economic vulnerability to hurricanes is rising because housing developments are continuing to go toward high-risk, coastal areas. Despite the increasingly severe climatic conditions, this rising trend is progressing.

The insurance industry literature supports this climate driven shift in catastrophic risk. Swiss Re, one of the most prominent reinsurance firms, reports that actuarial models historically relied on backward-looking probability assessments, which then fail to capture non-linear shifts in hurricane damage potential under the current climate trajectories. Along with this, the National Associated of Insurance Commissioners (NAIC, 2023) makes a note that while this catastrophe

modeling has improved, the projections often underestimate the impact of clustered events and systemic exposure in high-density regions such as Florida.

Overall, the literature demonstrates a clear message, that the intensity, not frequency, is increasing in hurricanes. This then leads to an elevated loss of volatility. With this progression in climate driven damage, there are few studies that explore how the intersection of the intensity of hurricanes and coastal communities expose challenges to traditional insurance risk models. This will reveal a conceptual gap that this paper will address in later sections.

3.2 Underwriting Practices and Risk Modeling Limitations

The insurance market handles risk as independents. They operate on the assumption that they can be pooled across policyholders to minimize the financial impact of the individual losses. What makes this challenging with catastrophe risk is the principle due to spatial correlation and clustering of losses. This causes multiple policyholders to experience extreme damage simultaneously (Kunreuther & Michel-Kerjan, 2015). Traditional models assume that a normal distribution of risk is present, yet the factors of coastal concentration and the climate-driven amplification introduced fat-tailed loss distributions. This makes catastrophic events statistically rare but economically devastating (Froot, 2001). These conditions contribute to systemic exposure, which a single event like something catastrophic can threaten insurer solvency.

In addition, literature identifies moral hazard and adverse selection as contributors to this market contortion. Homeowners are ill advised and may underestimate the risk of where they live, or they fail to invest in mitigation when insurance is underpriced, while insurers may start in competitive premium reductions to maintain market share, despite all the increasing exposure to catastrophic volatility (Pauly, 2018). Studies further suggest that insurance markets in these high-

risk areas follow the trend to underprice coverage due to competitive pressure and regulatory constraints. This suppresses the risk-based pricing and then delays the economic correction until after high-impact loss events (Surminski & Bouwer, 2015). Catastrophe risk is often concentrated to geographic zones. Meaning, unlike the standard financial markets, where risk can spread easily, catastrophic events reduce risk-spreading effectiveness and increase dependence on capital providers, such as reinsurance firms.

The combination of underpriced risk, minimal geographic diversification, and dependence on external financing mechanisms, these all weaken the insurance markets resilience over time (Niehaus & Mann, 2018). Financial engineering tools such as reinsurance contracts and catastrophe bonds (CAT bonds) are designed to distribute this risk, some researchers argue that they may contribute to this temporal risk shifting rather than true risk reduction, especially when it is applied under the conditions of market vulnerability (Froot, 2021). These insights are critical for understanding Florida's market instability it is facing right now.

3.3 Financial Risk Transfer Mechanisms

With all the risk in Florida, risk transfer tools have become essential for the insurance market. Especially for the stability in regions that are subjected to high catastrophic risk. Traditional reinsurance contracts enable insurers to cede portions of their risk portfolios to third-party reinsurers, which lets the underwriting capacity expand and protects the insurer against insolvency during years of extreme loss, like a major category 5 hurricane (Swiss Re, 2015). However, heavy reliance on reinsurance also increases financial vulnerability when market conditions tighten. Following the year of a major storm, premium renewals can rise sharply. Analysts show that reinsurance pricing for Florida property exposure has increased by over 50%

since 2020. This directly affects insurer solvency margins and policyholder affordability (Guy Carpenter, 2024).

Catastrophe bonds (CAT bonds) are a form of insurance-linked securities (ILS) and provide an alternate capital market solution. It transfers disaster risks to paying investors, in exchange for above market yields (Froot, 2001). These bonds can reduce an insurers dependence on the traditional reinsurance route and could also provide instant liquidity during major storms that follow with a substantial loss. However, CAT bonds operate under predefined loss triggers and have been set previously by historical data and probability models. Some researchers argue that these bonds undermine the seriousness of climate-driven risk patterns (Swiss Re, 2015; Surminski & Bouwer, 2015). As a result of this, CAT bonds could potentially distribute risk temporally, rather than adjusting the markets' structure, and delaying rather than correcting the systemic exposure.

Alongside CAT bonds, weather derivatives provide another blanket of risk protection. Mostly used in industries such as energy and agriculture, these derivatives are used to hedge revenue volatility which are related to temperature fluctuations. While they can effectively manage financial uncertainty with heating and cooling days (HDD &CDD), their use in catastrophic events such as hurricanes is limited due to the relation between HDD, CDD, and losses that insurers face (Goorhuis & Kramer, 2019). Although financial risk transfer tools improve the short-term losses, their correction for the system for climate risked areas is not fulfilled.

3.4 Legal and Regulatory Market Influences

Alongside catastrophic events, legal dynamics have been shown to significantly influence Florida's insurance market stability. Research has found that litigation-intensive regulatory environments contribute to increased underwriting costs and volatility. This is especially the case when policy contracts are shown to broad interpretive rulings (Klein & Wang, 2009). The previous one-way attorney fee structure has been identified as a major component of claims inflation by both academic findings, and industry analyses (OIR, 2022). This created incentives for legal disputes because third-party contractors and attorney could use the Assignment of Benefits (AOB) to leverage and bypass insurers oversight. This often results in inflated repair estimates and disputed claim settlements (Michel-Kerjan & Kunreuther, 2011).

Industry reports that Florida accounts for about 9% of the total U.S. homeowner insurance claims, but nearly 79% of all litigation related claims nationwide. This represents a disproportionate legal burden compared to other states (Florida Office of Insurance Regulation [OIR], 2023). Legislative reforms such as Senate Bill 76 (2021) and Senate Bill 2-A (2022) have both aimed to reduce the AOB abuse and limit attorney fee exposure. However, academic studies suggest that the effects of such reforms materialize only gradually due to delayed and slow litigation, and existing contractual obligations (Klein & Wang, 2009). Additionally, insurance economic literature indicates that regulatory environments may delay market conditions, contributing further to risk underpricing (Pauly, 2018).

From a market perspective, these legal distortions produce a lot of financial stress within insurers, especially during periods of catastrophic losses when capital reserves are already strained (Surminski & Bouwer, 2015). Although reforms may reduce legal problems in the future, the compound effect of litigation costs, regulatory pricing constraints, and climate-driven claims activity has weakened Florida's ability to hold risk over time. These findings support the

argument that structural legal conditions have increased market instability rather than mitigate it. This raised concerns about long-term sustainability of insurance operations under current risk models.

3.5 Identified Research Gaps

While existing literature provides insights to the increasing volatility of hurricane damages and the risk (Climate Central, 2023; NOAA/GFDL, 2023), the economic dynamics of catastrophe exposure (Kunreuther & Michel-Kerjan, 2015; Froot, 2001), and the role of risk-transfer tools such as reinsurance and CAT bonds (Swiss Re, 2015; Guy Carpenter, 2024), most studies review these different factors as stand-alone terms. The research being constructed on climate-driven catastrophe risk focuses on the loss intensity trends. The economic studies emphasize risk management and financial engineering tools but rarely integrate climate projections into this as well. In addition, literature that addresses the distortions and litigation trends (Klein & Wang, 2009; Pauly, 2018) often views this from a legal and policy standpoint, without integrating the conditions of rising climate-driven impacts.

This paper addresses this gap through a multidisciplinary approach that is integrating climate science, insurance economics, financial risk-transfer tools, and a regulatory and policy analysis to evaluate whether these current risk mitigation strategies work. Whether they promote long-term systemic resilience, or short-term bandage under the intensifying climate-driven risk, while using the 2008 financial crisis as a comparative framework.

4. Analysis

4.1 Climate Risk and Market Sensitivity

Although the current insurance market in Florida faces challenges from climate-driven activity rather than credit deterioration, there are significant structural similarities to the years leading up the financial crisis in 2008. Prior to the market collapse, financial institutions relied on historical data for risk assumptions. These underestimated the likelihood of correlated mortgage defaults. The risk was dispersed through securitization. This masked temporally the fragility, and it increased the exposure the system had once it was exposed to extreme loss. A similar pattern is shown now in Florida's insurance market, where the catastrophe risk models depend on historical loss probabilities. These statistics they use do not account for the mountain of climate dynamics that research has shown storm increases severely. Instead of deterioration in credit quality, today's risk drivers are linked to the increasing hurricane intensity, the concentration of insurance in high-risk areas, and regulatory pressures.

A key indicator of this market instability is the series of insurer rating downgrades which were issued by Demotech in 2022. These were cited for insufficient capital reserves and rising loss ratios for several smaller Florida-based insurers. The downgrades of these insurers' ratings triggered liquidity challenges, as mortgage lenders such as Fannie Mae and Freddie Mac, require homeowners to have insurance for an A-rated carrier. When these insurers are downgrades, thousands of policies are transferred to Citizens Property Insurance, which tightens market concentration, making the government increase exposure. This is similar of how the collapse of mortgages prompted the government intervention in 2008. Like the credit rating downgrades that revealed the risk in the system prior to the global recession. Demotech's assessments highlight capital fragility, and the dependency on external tools within Florida's insurance market.

Furthermore, the way the economic system is structured in Florida parallels the economic system of pre-2008, relying on financial risk-transfer tools such as reinsurance and CAT bonds.

These were designed to mitigate immediate losses; however, it may distribute the risk rather than reduce it. During the lead up of 2008, securitization provided short-term risk dispersion, but it ultimately obscured the structural deficiencies until a correction occurred. Similarly to this, Florida has risk-transfer tools that also will delay than resolve the insurers exposure to catastrophic loss. This could also potentially worsen the long-term system, making it vulnerable to climate patterns, especially in this rapidly increasing climate change world.

With these parallels, the underlying causes differ dramatically. The 2008 crisis was rooted in the deterioration of credit and asset models. The current insurance crisis, however, is driven by the physical climate risk, which exceeds the actuarial predictability. In both cases, the mispricing of extreme events and the delay of corrective measures created conditions in the system where the financial stability relied on outside tools that are not designed for aligning the structure of the system.

4.2 Evaluation of Financial Risk-Transfer Mechanisms

Even though the roles of financial tools are to expand the underwriting capacity, these tools function more so for short-term liquidity protection rather than long-term structural. Reinsurance is expanding the underwriting capacity in the short term; it is increasing the cost of when following the major storm seasons. This suggests that the risk is being transferred temporarily, rather than it being fully reduced. This increase is signaling that global capital suppliers are adjusting to the growing volatility of the region. This reinforces the possibility that financial relief today may turn into future market withdrawal or prohibitively expensive coverage. Kousky (2024) similarly finds that under realistic climate change projections, financial risk-transfer mechanisms may not maintain coverage availability in markets like Florida, demonstrating that such tools provide temporary liquidity rather than long-term risk stability.

CAT bonds operate similarly. They introduce new investor capital; however, their effectiveness relies on historical thresholds that are not reflecting the climate-based severity being seen today. A study by Benet (2024) notes that catastrophe bonds often fail to align with real loss outcomes when model-based triggers do not match current risk patterns, demonstrating that risk is displaced rather than diminished under worsening climate dynamics.

5. Conclusion

This paper examined whether current risk mitigation strategies, specifically reinsurance, CAT bonds, and weather derivatives, function as a stabilizer within Florida's homeowner insurance market. It was gone through whether it helped or was merely a deferment from collapse. Through analysis of climate intensification geographic exposure, and financial engineering practice, the findings tell that while these instruments provided short term solvency support, they do not substantially reduce the vulnerability of the system. Instead, the reliance of historical probability tools and the use of external capital create a conditional stability that will deteriorate under catastrophic events. This mirrors the deferred correction seen prior to the financial crisis in 2008.

Going forward, the stability of Florida's insurance market will depend less on increasing financial complexity, but more on reducing the underlying drivers of loss exposure. Long-term resilience will require the integration of climate-adjusting pricing, restrictions on high-risk property developments, such as coastal. It will also need stronger capital preparedness rather than the continued reliance on post-event financial absorption. As the intensification of severe weather becomes more economically relevant, policies being introduced and the different market behaviors will have to shift from juggling risk, to actively managing and reducing it. Without a transition toward a mitigation driven insurance strategy, the current way the system structures

risk evolves into a systemic failure point once financial protection layers become insufficient. This shift, from reactive to preventive, is essential if Florida wants to avoid a crisis like the 2008 financial crisis.

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