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# JOURNAL OF INSURANCE REGULATION

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Cassandra Cole and Kathleen McCullough  
Co-Editors

Vol. 37, No. 3

The Florida Insurance Market:  
An Analysis of Vulnerabilities to Future  
Hurricane Losses

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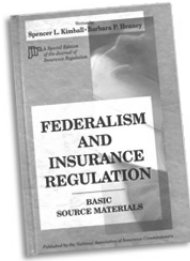
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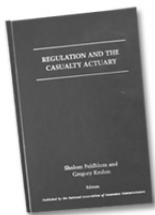
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# The Florida Insurance Market: An Analysis of Vulnerabilities to Future Hurricane Losses

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Jack E. Nicholson \*  
Karen Clark \*\*  
Glen Daraskevich \*\*\*

## Abstract

Florida is the peak zone for hurricane risk. The authors evaluate the current vulnerabilities and risks associated with the residential property insurance system in Florida and its financial capability to respond to future hurricane events. The state's residential property insurance system is composed of private insurers and Florida's three public risk financing entities: Citizens Property Insurance Corp. (Citizens), the Florida Hurricane Catastrophe Fund (FHCF) and the Florida Insurance Guaranty Association (FIGA). The Florida residential insurance market has been transformed since the last Category 5 hurricane—Andrew—made landfall, and the current system has not been tested with a major hurricane loss. The authors used the characteristic event (CE) methodology to analyze the impacts of 20-, 50- and 100-year hurricanes on the Florida market from both a micro and a macro perspective. Using a set of realistic assumptions, the analysis illustrates and quantifies Florida's vulnerabilities to hurricane losses by estimating the numbers of private insurer insolvencies and resulting impacts on Florida's public risk financing entities for each of the hurricane scenarios.

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## I. Introduction

Florida is the most vulnerable state to hurricane losses and is known as a “peak zone” (Aon Benfield, 2018).<sup>1</sup> Since 1900, 70 hurricanes have made landfall along the Florida coastline—one-third of the U.S. total. During this time period, two of the three U.S. landfalling Category 5 hurricanes struck Florida along with more than 40% of the Category 4 storms (NOAA, 2017).

On average, Florida is hit with a hurricane every other year. Florida has been lucky for the past two decades. The 10-year period from 2006 to 2015 with no landfalling hurricanes was unprecedented in the historical record. In the 1920s, Florida experienced 10 landfalling hurricanes, including two Category 4 storms that would each result in more than \$75 billion of insured losses if they occurred today.

Figure 1 illustrates the insured losses that would be experienced today from historical Florida hurricanes. The top loss would be a recurrence of the 1926 Great Miami Hurricane that would result in insured losses of more than \$128 billion—and this was a Category 4 storm.

**Figure 1:**  
**Estimated Insured Losses for the Five Largest Historical Hurricanes Affecting Florida Based on Current Exposures**

Date	Event Name	Category	2017 Insured Loss
Sept. 18, 1926	Great Miami Hurricane	4	\$128 billion
Sept. 17, 1928	Great Okeechobee Hurricane	4	\$78 billion
Sept. 17, 1947	1947 Fort Lauderdale Hurricane	4	\$62 billion
Aug. 24, 1992	Hurricane Andrew	5	\$56 billion
Sept. 10, 1960	Hurricane Donna	4	\$50 billion

Source: AIR Worldwide, 2017

\* Modeled loss to onshore property, contents and business interruption, and additional living expenses for residential, mobile home, commercial and auto exposures as of Dec. 31, 2016, using the indexed takeup rates provided in the 2017 CATRADER release. Losses include demand surge and account for storm surge.

1. Florida is referred to as a “peak zone” in that it is considered to have the most insured concentration of risk representing the largest insured loss potential in the world. As such, it is difficult for reinsurers to diversify or offset Florida hurricane risk with other risk.



Recent events—including hurricanes Harvey, Irma and Maria—highlight the magnitude of destruction that is possible from flooding and hurricane force winds. Hurricane Irma was almost the “Big One,” and Florida dodged a bullet with this storm. On Sept. 7, 2017, the meteorological forecasts were projecting Irma to make landfall near downtown Miami as a borderline Category 4/Category 5 hurricane. Had Irma taken this path at this intensity, the insured losses would have exceeded \$180 billion.<sup>2</sup> Such an event would have caused most domestic insurers to become insolvent, and undoubtedly exhausted the capabilities of the FIGA to pay the claims of policyholders. At some point, Florida’s luck will run out.

The purpose of this study is to evaluate the vulnerabilities and risks associated with the residential property insurance system in Florida and its financial capability to respond to hurricane events. The state’s three public risk financing entities—Citizens, the FHCF and the FIGA—will collectively be referred to as Florida’s public risk financing entities.

The authors illustrate a methodology that would enable Florida policymakers to more fully quantify the current vulnerabilities of the residential property insurance market in Florida in order to strengthen and enhance the resiliency of the system. The residential property insurance system in Florida is essentially subsidized by taxpayers, but the public is not generally aware of the potential magnitude of its financial involvement in assuming hurricane risk.

## II. Review of the Literature

Very little research has been done to examine the viability of the current probable maximum loss (PML) methodology for evaluating insurer solvency, and no previous studies have evaluated the capabilities of the Florida residential property insurance system as a whole. The current system has not been tested with a hurricane loss greater than \$12 billion, which is less than the insured loss Hurricane Andrew caused in 1992.

The Florida Commission on Hurricane Loss Projection Methodology (FCHLPM)<sup>3</sup> was created in 1995 to develop standards and to review hurricane computer models for ratemaking and PML purposes. There are currently five models that have been reviewed and found acceptable by the FCHPLM.<sup>4</sup> While these models are similar in structure with the same model components, the loss estimates vary widely between the models. For the most recent model submissions,

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2. Estimated by Karen Clark and Company.

3. The FCHLPM is designated in Section 627.0628, Florida Statutes, as an expert panel consisting of 12 members that are designated in the law. Additional information regarding the FCHLPM can be found at <https://www.sbafla.com/Methodology/>.

4. These models were developed by the following modeling organizations: AIR Worldwide Corp., Applied Research Associates Inc., CoreLogic Inc., Florida Public Hurricane Model, and Risk Management Solutions.

the difference between the highest and lowest model-generated PMLs based on the same set of exposure data is nearly a factor of two.<sup>5</sup>

Not only is there significant variation in the loss estimates among the models found acceptable by the FCHPLM, but also different model versions from the same model vendor can result in widely fluctuating numbers from year to year. This is because the models are based on numerous expert judgements and assumptions.

Clark (2012) has commented that much of the volatility in the model loss estimates is due to “noise” and changing assumptions versus new science. Clark points out that models are not strictly objective tools since many assumptions are based on experts’ opinions and biases rather than objective data. Weinkle and Pielke Jr., (2016) have noted model inconsistencies and consider them as “politically stylized views about an intractable scientific problem.”

Although there have been criticisms of models due to volatility and inconsistencies associated with PMLs, the viability of the current PML approach for evaluating insurer solvency has not been researched extensively or tested systematically using alternative methodologies and actual insurer data. Some authors have suggested alternative PML approaches for insurance purposes (Cummins and Freifelder, 1978; Wilkinson, 1982; and Woo, 2002), as well as proposed new PML engineering approaches (Unanwa, 1997). Other authors have analyzed computer model output in terms of sensitivity, uncertainty, and validation results (Iman, Johnson and Watson 2005a; Iman, Johnson and Watson 2005b; and Pinelli, Gurley, Subramanian, Hamid and Pita, 2008), but none have attempted to quantify the impacts on individual Florida insurers or the Florida market as a whole using a comprehensive set of hurricane scenarios and a consistent methodology.

Evaluating and stress testing an insurer’s exposure to various catastrophic hurricane losses is required by the Florida Office of Insurance Regulation (FLOIR) for selected companies each year.<sup>6</sup> This stress testing is limited and is based on the current PML methodology and a few historical hurricanes. Individual insurers’ PMLs and their risk transfer program are not made available to the public. Additionally, no consideration has been given to stress testing the Florida insurance system as a whole.

Stress testing Florida’s insurance system would involve comprehensive tests of Florida’s public risk financing entities since their role is one of supporting the system. The state of Florida depends on these public entities<sup>7</sup> to provide a residual market; to prevent insolvencies; to stabilize the market, including Florida’s

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5. On the FCHLPM’s website, see Form 8A for each accepted model in order to compare various return periods on both an aggregate and an occurrence basis.

6. See FLOIR’s website at <https://www.floir.com/Sections/PandC/prepared.aspx>. In 2015, 112 insurers writing residential property insurance were subject to FLOIR’s Annual Reinsurance Data Call. It was determined that “...all had sufficient reinsurance, capital, and surplus to pay for claims of their policyholders in a 1-in-100-year storm event or higher.” A catastrophe stress test was performed on 67 of these insurers based on three loss scenarios. The results for 2016 and 2017 were not posted at the time of this paper.

7. As the term “public entities” is used, it also incorporates quasi-public entities which can be argued are a more correct characterization of both Citizens and FIGA.

economy; and to pay losses to policyholders if insurers fail. Given that Florida's public risk financing entities use assessments on policyholders as a source of funding, it is in the public interest to manage Florida's catastrophic hurricane risk in a transparent and comprehensive way.

A number of authors have conducted studies that point out that stress testing is used widely to identify vulnerabilities for financial systems. These studies include: Jones, Hilbers and Slack (2004); Sorge (2004); Čihák (2007); and Henry and Kok (2013). Various studies in the insurance literature consider financial solvency from the individual insurer standpoint. Examples of such studies are those by BarNiv and McDonald (1992); Cummins, Harrington and Klein (1995); Lee and Urrutia (1996); and Grace, Harrington and Klein (1998). Medders and Nicholson (2018) raise concerns about the public financing of hurricane risk in Florida and note vulnerabilities within the insurance system and their impact on its future. However, their article deals with public policy and does not involve stress testing the system or provide an illustration or example of how such stress testing can be done. No studies were found that stress tested insurance systems similar to the stress testing of financial systems as noted above.

### **III. Background on the Florida market**

Hurricane Andrew made landfall near Homestead, FL, in August 1992. The storm caused \$15 billion in insured losses and resulted in 11 insurer insolvencies (Bailey, 1999). This was a major shock to Florida's insurance system partly because prior to Andrew, the largest U.S. hurricane loss was \$4 billion caused by Hurricane Hugo in 1989. The magnitude of Andrew's loss was not anticipated by insurers and reinsurers, most of whom were using simplistic premium-based methodologies to evaluate hurricane risk.

Hurricane Andrew was the impetus for major changes in the Florida insurance market, most notably:

- The expansion of the involuntary market.
- The largest U.S. property/casualty (P/C) insurers pulling back from the state.
- The creation of the FHCF to provide additional capacity for the marketplace.
- A moratorium on cancellations and nonrenewal.
- The rise of thinly capitalized domestic insurers heavily dependent on the global reinsurance market and the FHCF.

#### *Introduction of Catastrophe Models*

Hurricane Andrew also led to the widespread adoption of catastrophe models for estimating hurricane loss potential. Prior to Hurricane Andrew, most U.S.

insurers were using premiums to determine how much reinsurance to buy, and companies, for the most part, were not tracking their actual property exposures. The 1970s and 1980s were decades of relatively low hurricane activity, and the industry had become complacent even though coastal populations and property values were swelling—particularly in Florida.

The first catastrophe models were developed in the mid-1980s, well before Hurricane Andrew (Clark, 1985), but there was skepticism about this new modeling technique and no strong impetus for adoption. At the time, the insurance industry collectively assumed that the worst-case scenario hurricane would cause \$7 billion in insured losses (All-industry Research Advisory Council, 1986) even though the first hurricane model projected that a Category 5 hurricane making a direct hit on Miami would cost insurers \$60 billion. Few believed that number. Lewis (2007) provides a brief historical context describing the insurance industry's attitude regarding the early hurricane computer modeling results preceding and following Hurricane Andrew.

Hurricane Andrew confirmed the validity of the catastrophe models. After this event, it was easy to extrapolate that had Andrew hit 20 miles north, the loss would have been four times higher, i.e., \$60 billion. Catastrophe modeling technology brought two major advancements to the industry: 1) the use of actual property values to estimate losses; and 2) the use of simulation techniques to generate many possible future events to develop a full probability distribution of losses. The primary model output is the distribution of losses, called the Exceedance Probability (EP) curve as shown in Figure 2 on page 7.

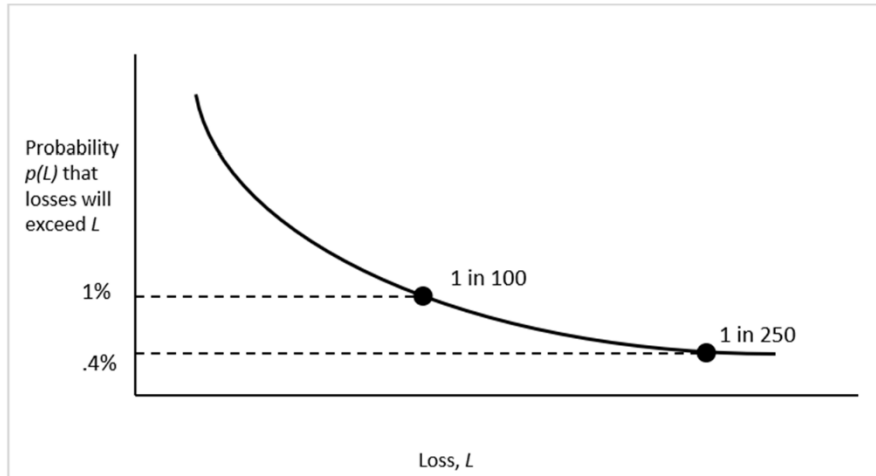
The EP curve shows the estimated probabilities (vertical axis) of exceeding losses of different sizes (horizontal axis). While a specific curve is generated by a specific model version, in reality there is significant uncertainty surrounding these numbers due to data limitations and imperfect scientific knowledge.

Uncertainty around the probabilities results from the paucity of historical data used to estimate the frequencies and severities of future events by landfall location. For example, there have been only two Category 5 hurricanes to make landfall in Florida since 1900, and both have affected South Florida. Does this mean the return period is 50 years or 100 years? What is the chance of a Category 5 hurricane making landfall near Tampa or a Category 4 hurricane near Jacksonville? These are the questions the catastrophe models attempt to answer with the development of the EP curves. Because there is so little data available, model developers must make many assumptions based on expert judgment rather than scientific facts. This is in large part why the EP curves can differ so significantly between modeling companies and between model versions from the same company.

Uncertainty around the loss stems from the fact that engineers and modelers face uncertainties about how different types of structures will respond to various wind speeds. There are other factors affecting the losses as well, such as demand

surge and assignment of benefits (AOB).<sup>8</sup> AOB has been an ongoing problem that has resulted in increased claim costs in Florida.

**Figure 2:  
Illustration of EP Curve**



Despite the uncertainty in the EP curves and the widely differing numbers that result, the industry has gravitated to one point on the curve—namely, the 1% loss exceedance, more commonly known as the 1 in 100-year PML. This number is used by the rating agency Demotech to assign financial strength ratings to Florida insurers and by the FLOIR for solvency tests. Essentially, insurers in Florida are expected to buy reinsurance up to their 1 in 100-year PML.

From a regulator’s perspective, the primary issue in relying on the PML is that it does not provide a consistent yardstick for comparing insurers. As explained previously, the PML can differ by a factor of two for the same insurer depending on which model is used. Also, there are various levers and secondary modifiers that have a significant impact on loss estimates that can be turned on or off by individual insurers. Additionally, because most of the models used to generate the PMLs are proprietary to the model vendors and “black boxes” to the model users, the PML does not provide a transparent yardstick. And because model versions can change significantly, the PML does not provide a stable currency. Therefore, the PML lacks the three things crucial to a regulator for a robust rating methodology: 1) consistency; 2) transparency; and 3) stability.

8. Demand surge refers to the surge in prices when materials and labor are in short supply following a catastrophic event. AOB refers to a legal situation where benefits are assigned to a third party, which, if abused, may unnecessarily inflate claims costs and the ultimate losses following an insured peril.

The PML can also mask exposure concentrations and give insurers a false sense of security. The PML shows the loss amount for which an insurer has a 1% chance of *exceeding in a year*. Over a 10-year period, an insurer has almost a 10% chance of exceeding this loss amount (exposures held constant). The PML gives no insight into where or by how much the PML will be exceeded. In fact, insurers trying to “optimize” their PMLs to a particular model version may end up building unknown exposure concentrations in areas where that model has a “miss” or bias. These exposure concentrations can easily lead to insolvencies resulting from losses that far exceed the PMLs. While PMLs generated from the catastrophe models are far better than the methods used prior to Hurricane Andrew, the PMLs do not provide enough information to ensure a stable and efficient residential property insurance market, particularly in Florida—the most hurricane-exposed state.

### *Changes in the Florida Residential Property Insurance Market Since Hurricane Andrew*

Since Hurricane Andrew, the Florida residential property insurance market has been transformed. Much of the business previously written by large national insurers has shifted to the less capitalized Florida domestic insurers, who are heavily dependent on both the FHCF and the private risk transfer market for their financial viability. At the time of Andrew, approximately 288 insurers (Florida Department of Insurance [DOI], 1993) wrote residential property insurance business in the state. However, Allstate and State Farm, two large insurer groups consisting of four companies—Allstate Indemnity Company, Allstate Insurance Company, State Farm Fire and Casualty Company, and State Farm General Insurance Company—wrote more than 50% of the Florida residential property insurance by the number of policyholders (2,347,139 out of 4,463,054 total policyholders).<sup>9</sup> The population in Florida was 13.93 million in 1993 and had grown to an estimated 21 million by 2017. In 1993, the Allstate and State Farm companies collectively had a policyholder surplus of \$8.87 billion (\$15.4 billion adjusted to 2017 dollars). Operating today as Florida-based subsidiaries of their parent companies, State Farm Florida Insurance Company, Castle Key Indemnity Company and Castle Key Insurance Company have a combined surplus of \$1.47 billion and a 7.5% market share by number of policyholders.<sup>10</sup>

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9. The authors adjusted the data because commercial property insurance was reported as one number and did not separately break out the number of policies for commercial residential property insurance policies. The authors make the assumption that the residential portion is 10% of the total reported commercial property insurance policyholders.

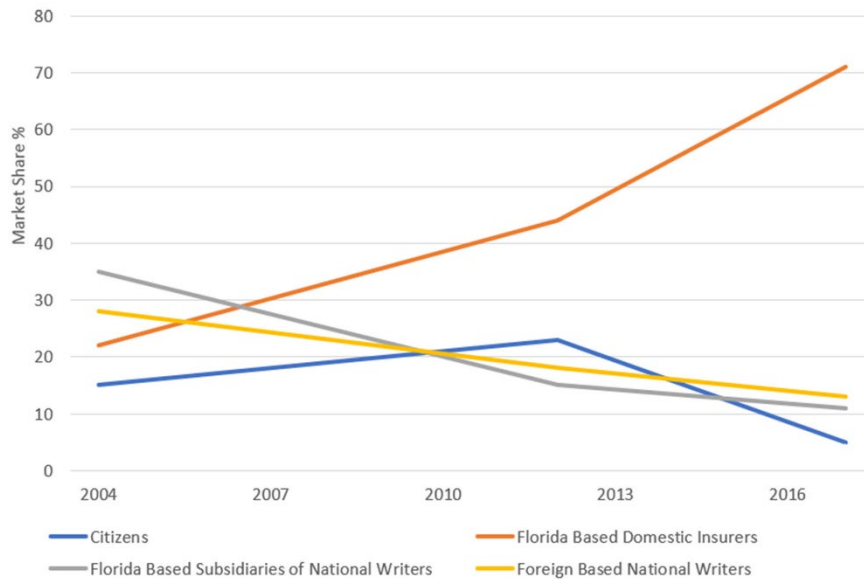
10. As reported in Florida Office of Insurance Regulation (2017), State Farm Florida Insurance Company’s surplus at Dec. 31, 2016, was \$1,083,656,557, and the surplus for the Allstate subsidiaries were \$13,683,768 for Castle Key Indemnity Company and \$370,460,752 for Castle Key Insurance Company.

According to Citizens (2017), insurers participating in the market can now be characterized as:

- Citizens with a 5% market share.
- Florida-based domestic insurers with a 71% market share.
- Florida-based subsidiaries of national writers with a 11% market share.
- Foreign-based national writers with a 13% market share.

Figure 3 illustrates the increase in market share of the Florida-based domestics since 2004.<sup>11</sup>

**Figure 3:  
Florida Residential Property Insurance Market Share Percentage  
Changes by Policyholder Count**



Source: Citizens Market Share Report, June 30, 2012, and Sept. 30, 2017

Over time, the Florida-based domestics have taken over a larger and larger share of the market, but their surplus and financial strength is only a fraction of that compared to the national writers. As of calendar year-end 2016, the total policyholder surplus of 62 Florida-based domestics comprising more than 70% of the residential market was reported as \$5.2 billion. Citizens reported a surplus of

11. The data in the figure represents three data points as of June 30, 2004; June 30, 2012; and Dec. 31, 2017.

\$7.4 billion, and the Florida-based subsidiaries of national writers reported a surplus of more than \$1.5 billion. The foreign-based national writers had a combined surplus of \$158.2 billion, but they will only be responsible for about 13% percent of hurricane losses (FLOIR, 2017).

### *Florida's Public Risk Financing Entities*

What is common to all of Florida's public risk financing entities is that they involve insurance premium assessment mechanisms that function to essentially tax the public to finance losses. These entities do not rely on private capital, and they do not earn profits as a result of taking insurance risk.

Citizens operates as the state's residual insurer for residential property insurance risk.<sup>12</sup> The FHCF operates as a type of mandatory state-administered reinsurer and is designated in Florida Statute as a state trust fund under the State Board of Administration (SBA).<sup>13</sup> FIGA is a nonprofit corporation with the purpose of paying claims of insolvent P/C insurance companies ordered to be liquidated by a court of competent jurisdiction.<sup>14</sup>

## **IV. Discussion of Vulnerabilities**

### *Potential Hurricane Losses*

Understanding the consequences of varying size hurricane losses on the state is crucial for Florida policymakers. According to the FHCF,<sup>15</sup> Florida has \$2.2 trillion of residential property insurance exposure, and based on the state's expected hurricane frequency, it is only a matter of time before a large destructive hurricane strikes. The current system has not been tested against a large loss or even a repeat of Hurricane Andrew, which would cause \$50 billion to \$60 billion today according to the catastrophe models. While significant gains have been made since Hurricane Andrew, the hurricane loss potential grows every year as property values increase and the Florida residential insurance market remains highly vulnerable to the hurricane threat.

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12. See Citizens' website at <https://www.citizensfla.com/> and refer to Section 62.351(6), Florida Statutes for additional detail regarding Citizens operations.

13. See the FHCF's website at <https://www.sbafla.com/fhcf/> and Section 215.555, Florida Statutes for additional information regarding the operations of the FHCF.

14. See FIGA's website at <http://www.figafacts.com/home> and Section 631.50, Florida Statutes for more information regarding FIGA.

15. See the FHCF's 2018 Ratemaking Formula Report at [https://www.sbafla.com/fhcf/Portals/FHCF/Content/AdvisoryCouncil/2018/20180613\\_Final2018FHCF\\_RatemakingFormulaReport\\_RI.pdf?ver=2018-06-14-134647-403](https://www.sbafla.com/fhcf/Portals/FHCF/Content/AdvisoryCouncil/2018/20180613_Final2018FHCF_RatemakingFormulaReport_RI.pdf?ver=2018-06-14-134647-403).



### *Reinsurance/Risk Transfer Market Volatility*

Hurricane Andrew resulted in a lack of reinsurance capacity following the cutback or withdrawal of many reinsurers from the Florida market. The FHCF was created in 1993 primarily to solve the problem of uncertain reinsurance capacity following large hurricane events. In 2006, a different problem arose due to the spike in reinsurance costs following 2004 and 2005 when eight hurricanes affected the state, illustrating that even if the insurance system in Florida can handle one or several multibillion-dollar hurricanes, risk transfer markets can be highly volatile following such events. In light of market disruptions associated with reinsurance underwriting cycles, the state has routinely enacted major legislative initiatives following large hurricane events.

### *Financial Markets Vulnerabilities*

Florida's public risk financing entities face vulnerabilities with regard to the volatility of the financial markets. Their claims-paying abilities depend on their ability to timely issue debt in anticipation of the exhaustion of existing resources. A large hurricane event could result in all three entities needing to issue debt. Since they have the same or overlapping assessment bases, it is possible that they may have to access the financial markets during the same time period. This could create a situation in which all three are competing for a limited amount of capital, thus resulting in a "clash financing problem," which could result in one or more of the entities failing to meet its overall mission and its obligations to policyholders.

Another vulnerability associated with limitations in the financial markets is the inability of the FHCF to finance capacity for a subsequent season after a large loss wipes out the FHCF's initial season's claims-paying resources. Under this scenario, if the FHCF cannot finance up to its statutory limit of coverage by its issuance of revenue bonds, insurers may need to replace a substantial portion of the FHCF's capacity with private reinsurance at a substantially higher cost. The FHCF's inability to maintain capacity in the insurance market could result in volatile pricing and in the lack of insurance availability for residential property insurance policyholders. A shortage of FHCF capacity for a subsequent season has been a concern for several years (Musulin, 1999). In the last 10 years, the FHCF has estimated that it would only be able to issue revenue bonds for \$7 billion to \$8 billion for an initial season and then have a more limited capability to finance coverage in a subsequent season if its liquid resources were wiped out. The FHCF's October 2017 Claims-Paying Capacity Estimates Report indicates that its subsequent season capacity would have been \$11.2 billion—a potential drop-off of \$5.8 billion (Raymond James, 2017).

The 2007–2008 financial crisis was a reminder that financial markets are cyclical and that a market crash is not uncommon (Mitchell, 2015). In the last 100 years, there were six major financial market crises: 1) the stock market crash of 1929; 2) the 1973 Organization of the Petroleum Exporting Countries (OPEC) oil

embargo; 3) the early-'80s recession from 1981–1982; 4) the Black Monday stock market crash in 1987; 5) the dot-com crash in 2001; and 6) the Great Recession in 2008. According to Mitchell, this has prompted some economic observers to speculate that a financial crisis now can be expected every seven years. While this may be an overestimate, historically, financial crises have been more frequent than a Category 5 U.S. land falling hurricane. The combination of a large hurricane occurring in the middle of a financial crisis could result in serious consequences for the state.

Insurers that are required to participate in the FHCF also face a vulnerability regarding their statutory ability to rely on the FHCF's claims-paying estimates. The SBA is required by law to estimate and publish the FHCF's claims-paying capacity twice a year—once in May and again in October of each contract year.<sup>16</sup> These estimates are important from an insurer's standpoint in that they help determine FHCF coverage and are necessary in structuring financial resources for paying catastrophic hurricane claims.

If the FHCF cannot fund its statutory limit of \$17 billion, it is only obligated to its actual claims-paying capacity regardless of the amount of capacity that it estimates. The task of accurately estimating the FHCF's claims-paying capacity is challenging at times, and the results may not be reliable. The larger the liquid assets available for paying claims, the less post-event bonds would be immediately needed, and less financial market risk would be involved in the timely reimbursement of claims. The FHCF's cash balance, reinsurance, pre-event bonds or other financial products can be used to enhance liquidity. A liquidity position of \$17 billion would, for all practical purposes, eliminate the risk since no immediate debt would need to be issued to fund the FHCF's claims-paying capacity.

### *Other Vulnerabilities*

As Florida-based domestic insurers have grown their market share in recent years by taking policies out of Citizens, FIGA has been forced to re-evaluate its risk and determine its potential liabilities. One issue that FIGA faces is managing its risk associated with insolvent insurers that have large books of condominium units. Having data on the insured values of condominium units would be beneficial for evaluating FIGA's potential liabilities associated with a large catastrophic hurricane event. FIGA has not been tested with a Category 5 hurricane hitting a major population area or areas of the state since Hurricane Andrew. Thus, FIGA's greatest vulnerability is the lack of data for evaluating its potential obligations as a result of a catastrophic hurricane. Today, the state is relying heavily on debt issuance and the risk transfer market in lieu of policyholder surplus protection. Such high leverage has resulted in increasing vulnerabilities to Florida's residential property insurance system.

Florida's public risk financing entities each have common and unique vulnerabilities. As a market of last resort, Citizens' size and manner of operations

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16. See Section 215.555(4)(c)2., Florida statutes.

have made it an attractive target for litigation. Since Citizens is considered a public financing entity ultimately backed by bonding and emergency assessments on a broad base of P/C policyholders, public policy dictates that greater safeguards be put in place to protect the public from abuses.

## **V. Impact of Catastrophic Hurricanes: Examples and Analysis**

To quantify the current vulnerabilities of the Florida market, a two-part study was conducted. The first part focused on 62 Florida-based domestic companies and estimated for each insurer the financial impacts from a set of realistic hurricane events.<sup>17</sup> The second part of the study examined how Citizens, the FHCF and FIGA would respond to the same set of events.<sup>18</sup>

### *Study Methodology*

The set of hurricane events was selected to provide meaningful comparisons between insurers. Landfall points were positioned at 10-mile increments along the entire Florida coastline. At each landfall point, the characteristics of three types of hurricane were defined: the 20-, 50-, and 100- year hazard probability events. Note that for this study, the authors did not select extreme scenarios, such as 250- or 500-year events. The intent of this study is to investigate vulnerabilities of the Florida residential property insurance market with respect to hurricanes having a reasonable likelihood of occurring.

Because hurricane risk changes along the Florida coast, the event characteristics must vary by landfall point in order to keep the hazard probability the same. For example, the 100-year hurricane in Southeast Florida is a Category 5 hurricane, but in parts of Northeast and Northwest Florida, it is a Category 4 storm. Likewise, the 20- and 50-year hurricane characteristics vary by region within Florida.

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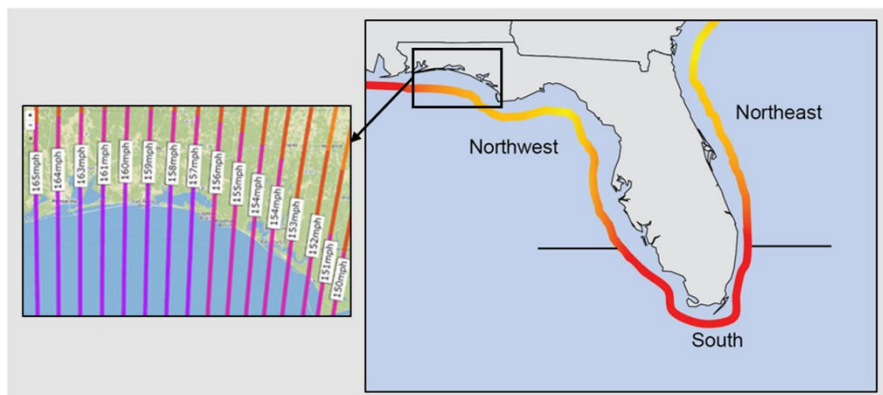
17. Though hurricanes can result in flooding, this analysis focuses on wind losses given that very little flood coverage is written by private insurers in Florida. For example, in 2017, the National Association of Insurance Commissioners (NAIC) shows only \$84.5 million of net written premiums for flood coverage compared to \$9.52 billion in net written premiums for residential property. This represents less than 1% of total net premiums written.

18. Florida-based domestic insurers that did not report policyholder data by county to FLOIR or ones that had incomplete data were not used in the analysis. State Farm Florida Insurance Company was the only significant insurer (having a 6% market share by total number of policies in force) that was not included in the analysis since it does not report Quarterly Supplemental Reporting (QUASR) data by policyholder count by county to FLOIR. Thus, 62 Florida-based domestic insurers out of a total of 64 were used for the first part of the study. All other insurers (excluding State Farm Florida Insurance Company) that participated in the FHCF were used for the second part of the study.

With respect to hurricane hazard, Florida can be divided into three distinct regions as shown in Figure 4: 1) Northwest; 2) South; and 3) Northeast. Within the Northwest and Northeast regions, the hazard probabilities change along the coast as indicated by the color of the coastline—red indicating a stronger (higher wind speed) event.

There are 111 10-mile spaced landfall points, and the characteristics of each event have been derived through extensive analyses of the historical data and the use of expert meteorological judgment. Following the CE methodology described more fully in Karen Clark and Company (2014), there is a smooth transition in storm track and wind speed between the landfall points. This ensures that all sections of the coastline are handled consistently.

**Figure 4:**  
**Florida Divided into Three Regions**



As long as the events are credible from a meteorological perspective, the exact parameters selected for each storm are not critical for the analyses. What is important is that the *same* comprehensive set of storms is applied to each insurer. This is the only reliable way insurers can be compared with respect to hurricane vulnerability and financial solvency. A follow-up study could test the sensitivity of the results to a different set of events.

It should be noted that none of the events has a peak wind speed that has not been observed historically. The maximum peak wind for the 100-year event in South Florida is 165 mph—equivalent to Hurricane Andrew’s peak winds at landfall. Therefore, all the events represent hurricanes that could easily occur in the future.

The loss estimates for this study were generated using the Karen Clark and Company (KCC) high-resolution hurricane model. The structure of this model is identical to the traditional catastrophe models, and all model components are developed using the same scientific data sources. The KCC hurricane model produces all the same output as the traditional models, including PMLs and annual average losses (AALs). In addition to the traditional EP curve metrics, the KCC model produces loss estimates for different return period events—the CEs.

**Obtaining and preparing the exposure data**

The data used for this study was the personal and commercial residential policy data obtained from the FLOIR. This data included for each insurer total policies and insured values by county as of December 2016.<sup>19</sup> In order to analyze the data, the KCC industry-wide property exposure database (KPD) was used to distribute the county-level data to five-digit ZIP code resolution that could be run through the hurricane model. Along with distributing the insured values, assumptions were made with respect to the coverage amounts, construction types and deductibles. Appendix A includes a detailed description of the assumptions used for this analysis.

In order to test the robustness of the methodology, the loss estimates obtained based on the ZIP code data were compared to the loss estimates obtained based on geo-coded street address data for several companies for which the higher resolution data were available. Appendix B shows the results of those comparisons that serve to validate the acceptability of the process for this study.

**Overview of individual insurer analyses and assumptions**

For each Florida insurer, the losses for the 333 hurricanes in the 20-, 50-, and 100-year CE event sets were estimated. A fully probabilistic loss analysis was also conducted for each insurer to estimate the EP curve and the 100-year PML.

To estimate the impact of each event on insurer solvency, it was assumed that each insurer buys risk transfer protection up to 75% of the KCC model-generated 100-year PML. As was discussed earlier in this paper, different insurers use different models for estimating the PMLs, and there are significant differences between the models. The KCC hurricane model PMLs tend to be above the midpoint of the range. Therefore, 75% of the KCC PMLs will be close to the average PML for the five models found acceptable by the FCHLPM. While this assumption will not be correct for every insurer, it should not bias the results. For the insurers for which their reinsurance programs are known, two purchased more reinsurance than this assumption, and three purchased less.

Private reinsurance retentions were set at the minimum of 10% of surplus or the FHCF retention amount. Rating agency guidance indicates Florida insurers should have a retention equal to 15% of surplus or less. Companies for which their retentions were publicly available had an average retention of 10% of surplus. For several insurers, their private reinsurance programs were publicly available, and a subset of these results will be illustrated on an anonymous basis. The surplus figures were taken from the 2016 year-end numbers as reported in FLOIR's 2017 annual report.

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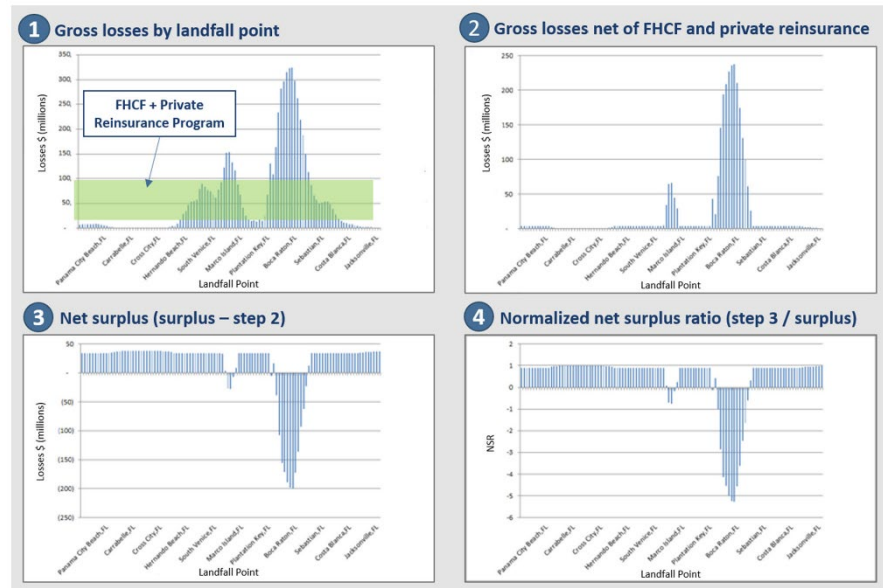
19. This analysis uses individual insurer data. We acknowledge that some Florida insurers are members of groups and that the possibility exists that insurers could receive cash infusions from group members to cover losses. It is also possible that the use of single-state insurers to conduct business in particular areas is a strategic business decision made for the purpose of protecting the group from a particular exposure or catastrophic loss. Since there is no requirement to bail out a group member and Citizens and Florida-based domestic insurers account for 76% of the market share, we do not include this option in the analysis.

For each insurer, the following was calculated:

- Gross losses for each CE.
- 100-year PML.
- Recoveries from the FHCF.
- Recoveries from private risk transfer programs.
- Surplus minus net losses.
- Normalized solvency ratio (NSR).

The NSR was calculated as described in Figure 5.

**Figure 5:**  
**Calculation of Normalized Solvency Ratio (NSR)**



The NSR is the rate adjusted normalized net surplus ratio for all the 100-year events.<sup>20</sup>

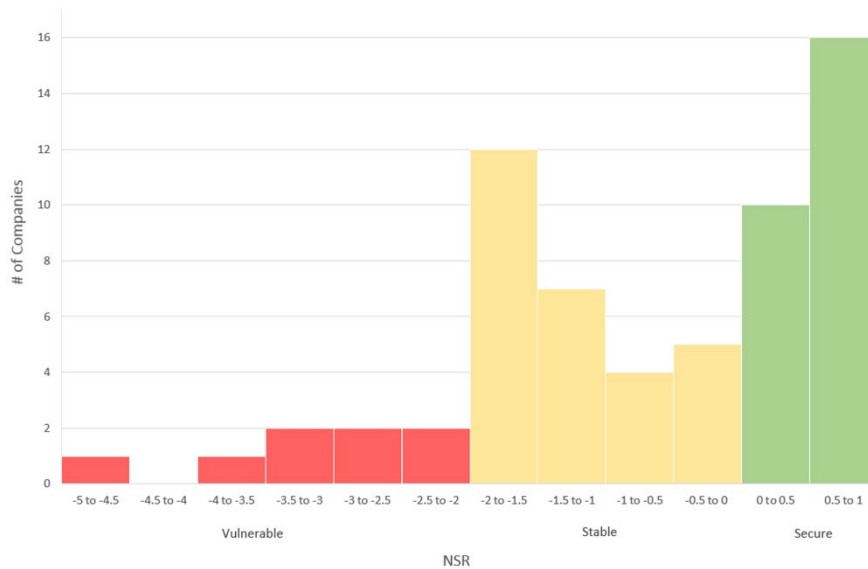
20. The authors did not include an adjustment amount to account for regulatory minimum surplus requirements given the varying amounts by company and the fact that overall such amounts would be insignificant relative to the magnitude of the catastrophic hurricane losses being modeled. Such treatment overall will not result in a bias toward greater insolvencies. See Section 624.408(1)(f)-(i), Florida statutes regarding the surplus requirements of Florida-based domestic insurers writing residential property insurance. The minimum required surplus is \$15 million but is phasing in for insurers that have held a certificate of authority before July 1, 2011. The phase-in ends after July 1, 2021.

$$NSR = \sum_{i=1}^n \left( Normalized\ Net\ Surplus_{FL\ 100\ Event_i} * \left( \frac{Event\ Rate_{FL\ 100\ Event_i}}{\sum Event\ Rate_{FL\ 100\ Event_i}} \right) \right)$$

Results for Insurers

Figure 6 shows the distribution of NSRs for the Florida domestic insurers. An insurer with an NSR > 0 has an expected positive surplus from the 100-year events. As the NSR becomes more negative, the insurer has a higher probability of insolvency from a 100-year hurricane.

**Figure 6:**  
**Number of Florida Insurers by NSR Band**



The NSR illustrates the wide disparity between Florida insurers. Twenty-six (42%) have positive NSRs and can be considered the most financially secure domestic insurers. On the other extreme, eight insurers (13%) have NSRs of -2 or less, indicating a relatively high likelihood of experiencing insolvency from a hurricane. All these insurers are rated “A” or better by Demotech. This information indicates that the Demotech rating methodology, which relies heavily on the PMLs, does not sufficiently differentiate insurers with respect to financial stability.

The study results can be presented in another way to further illustrate these points. Figure 7 on page 19 shows the losses from the 20-, 50- and 100-year

hurricanes (vertical axis) by landfall point (horizontal axis), commonly referred to as the CE profile. The highest bars indicate where the insurer has exposure concentrations and is most vulnerable to hurricane landfalls. The amount of reinsurance (private plus FHCF) and surplus available for the three Florida insurers is shown by the dotted line. Note that for these insurers, the private risk transfer program is known.<sup>21</sup> The numbers have been disguised but scaled consistently to show the relationship between risk transfer program plus surplus to the loss potential for each insurer.

A positive NSR means that an insurer's risk transfer program plus surplus will likely protect the company from all the 20- and 50-year events and most of the 100-year hurricanes. By contrast, an NSR below -2 indicates an insurer can just barely cover the losses from the 20-year hurricanes. To reiterate, the risk transfer programs and surplus for these companies are known, and all three are rated "A" by Demotech despite the very different risk profiles.

The study results also imply that the current FLOIR stress tests based on three historical hurricanes are not comprehensive enough to identify insurers that are vulnerable to hurricane losses. This analysis indicates that there is clearly a subset of highly vulnerable Florida insurers. Thus, consumers should have more reliable information on financial stability before selecting an insurer in Florida.

More comprehensive stress tests along with an improved insurer rating agency methodology would strengthen the Florida residential property insurance market. Accurately identifying the most vulnerable insurers gives those insurers the incentive to improve their underwriting and risk management practices. This would significantly enhance the resiliency of the Florida market and lessen the probability of financial stress on FIGA and ultimately the Florida taxpayers from future hurricanes.

### *Results for Florida's Public Risk Financing Entities*

The second part of the study examined the impacts of the 20-, 50- and 100-year hurricanes on Citizens, the FHCF and FIGA.

#### **Citizens**

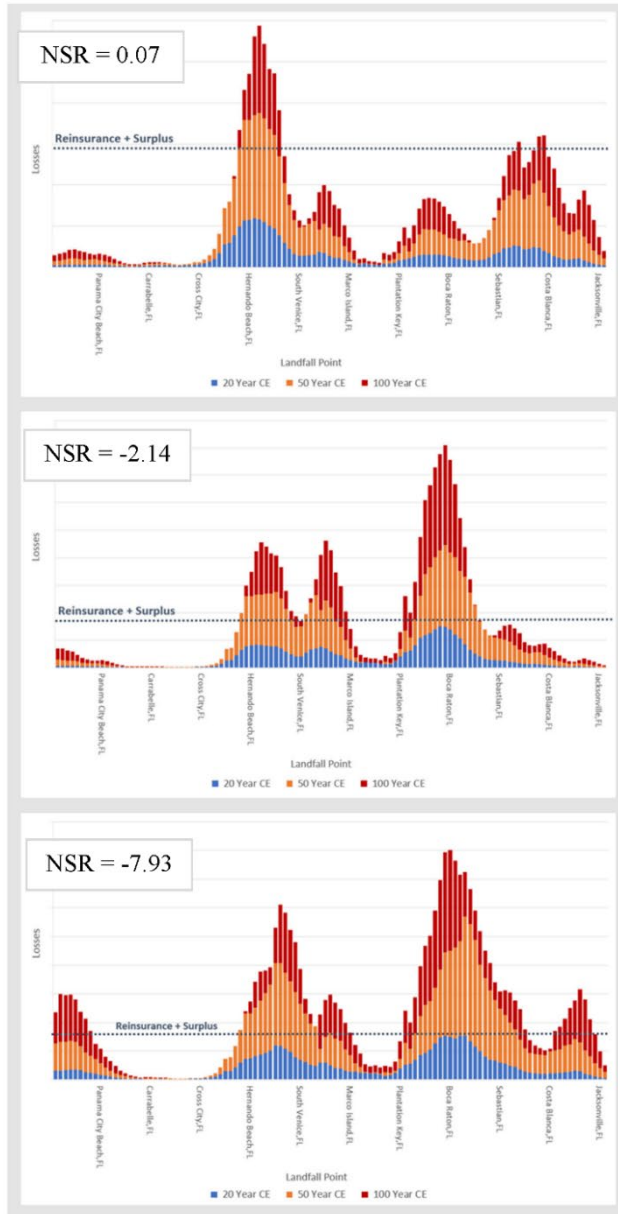
Notably, Citizens is financially secure due in large part to the amount of its surplus. Citizens Coastal Account has an NSR of 0.71, and Citizens Personal Lines Account (PLA)/Commercial Lines Account (CLA) has an NSR of 0.73, among the highest of all Florida insurers. Figure 8 on page 20 shows the 20-, 50- and 100-year CE profiles for Citizens PLA/CLA and Citizens Coastal Account (CA).

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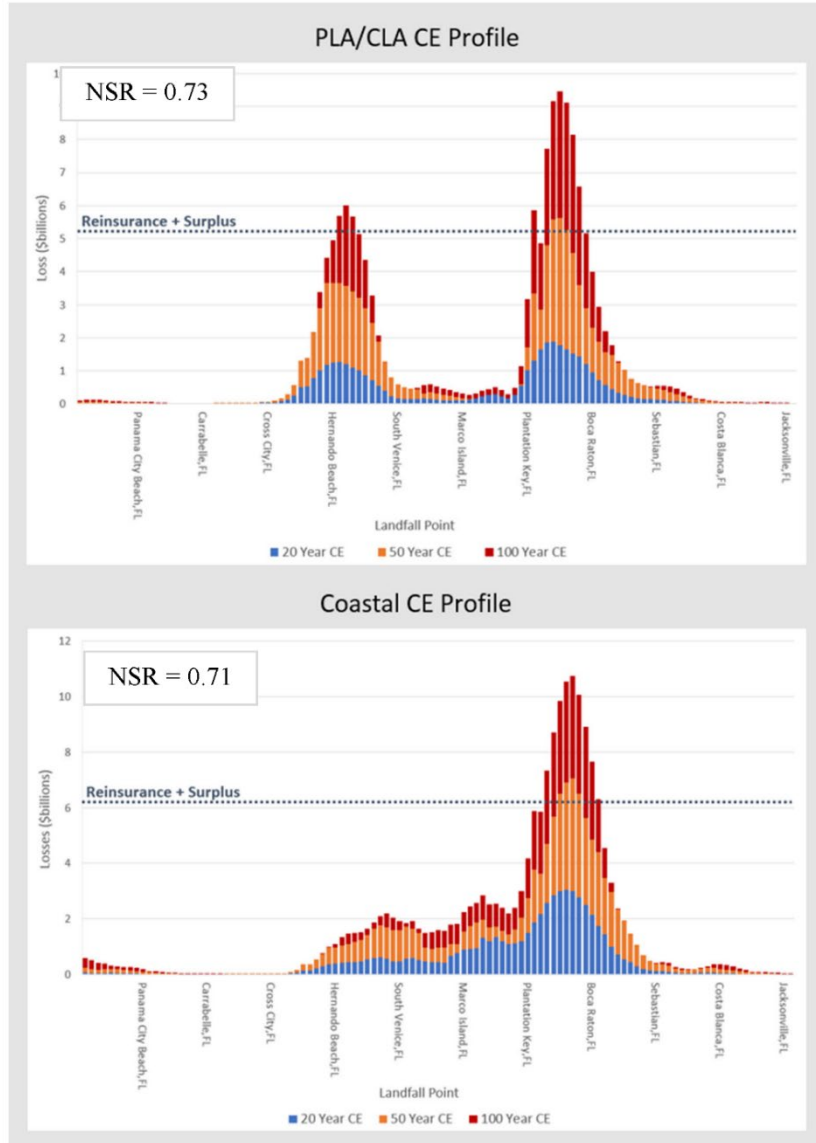
21. Note that the NSR of -7.93 is the result of the computation using an actual insurer's reinsurance program. Figure 6, which is based on the authors' estimates of reinsurance programs, does not indicate any NSRs below -5.



**Figure 7:  
CE Profiles for Three Florida Insurers**



**Figure 8:  
Citizens CLA/PLA Profile**



**Figure 9:  
Coverage and Retention Multiple**

Coverage Level (%)	Retention Multiple
90	5.1028
75	6.1234
45	10.2056

**FHCF**

To estimate the FHCF payout for each CE, the FHCF coverage level, coverage amount and retention were first calculated for each participating insurer. More specifically, the coverage level and FHCF reimbursement premium reported by each company under the 2017–2018 FHCF annual reimbursement contract was obtained. Pursuant to the contract, each participating insurer’s retention is calculated as the FHCF reimbursement premium multiplied by the retention multiple outlined in Figure 9.

Each insurer’s coverage amount is calculated as 14.9294 (the payout multiple) multiplied by the insurer’s reported FHCF reimbursement premium. The FHCF recovery for each participating insurer was estimated for each event, and the cumulative FHCF payout by event was estimated as the sum of FHCF recoveries for each participating insurer. Figure 10 on page 22 shows the FHCF payout by event, by landfall point.

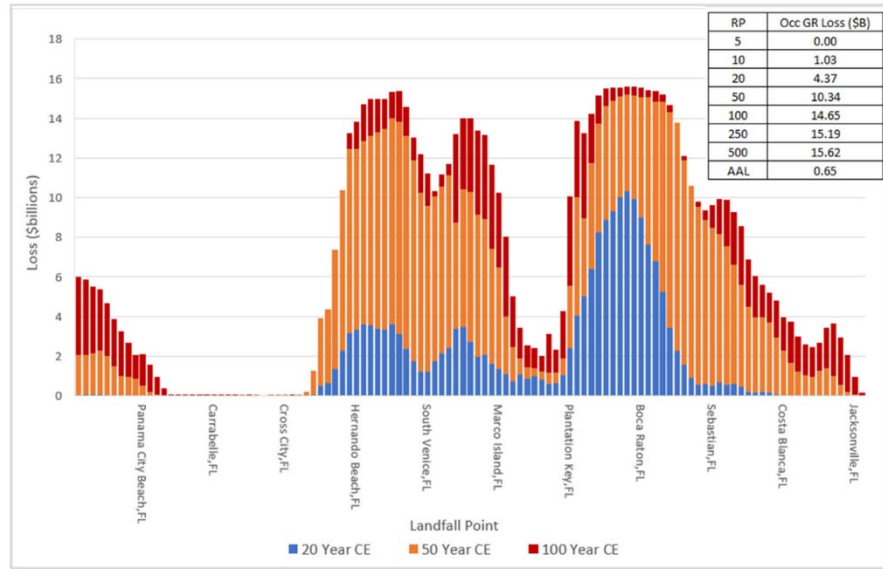
The FHCF’s statutory maximum limit for the 2017–2018 reimbursement contract year is \$17 billion. From the FHCF’s CE profile, it can be noted that a one in 500-year loss is not expected to exhaust the FHCF’s maximum limit, but would exhaust only \$15.62 billion of the \$17 billion limit.<sup>22</sup> For the FHCF’s statutory limit

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22. State Farm Florida Insurance Company was not included in this analysis, but represents a 6% market share by number of policyholders. Therefore, the authors made an exaggerated assumption to test if the results would be similar if the company had been included. The authors assumed that State Farm’s losses resulted in the company’s entire limit of FHCF coverage or \$384 million being paid out for each and every Florida landfall event. This was overly conservative to determine how the AAL and the various return times might be affected. The results showed that the AAL would increase from 0.65 billion to 0.95 billion, and the one in 500-year PML would increase to \$16.03 billion from \$15.62 billion. This helps confirm that the probabilities for the higher layers of FHCF coverage being exhausted are extremely low.

to be exhausted, all participating insurers would need to exhaust their FHCF coverage limit; this would appear to be a highly unlikely occurrence. Additionally, this result implies that the cost of risk transfer products should reflect the FHCF's lower probabilities at the upper layers of coverage. The methodology used here illustrates an improvement over the crude methodology that has been used historically to price FHCF risk transfer coverage.

**Figure 10:  
FHCF CE Profile**



**FIGA**

The study results can be used to quantify the numbers of insurers likely to become insolvent under different industry loss scenarios. Since most of the Florida insurers are highly dependent on reinsurance, the authors define insolvency as having a loss exceeding the insurer's risk transfer program. Figure 11 on page 23 shows the expected number of insolvencies by industry loss.

These numbers were calculated by first determining how many insurers would likely become insolvent from various size industry losses at each landfall point. Then, the average number of insolvencies for each industry loss range was calculated. The average was used because the number of insolvencies varies by landfall point.

The results indicate that at an industry loss size between \$50 billion and \$75 billion, 20 Florida insurers could become insolvent. This number is notable because most models agree that Hurricane Andrew would cause \$50 billion to \$60 billion if it occurred today. This means that more companies would become insolvent today than in 1992 from an Andrew-size loss. It is important to note that

not all \$60 billion events would cause 20 insolvencies. The number of insolvencies depends heavily on where the hurricane makes landfall.

**Figure 11:  
Companies Exceeding Risk Transfer Program**

Industry Loss Range (\$B)	# of Companies Exceeding Their Reinsurance Programs
< 25	0
25 to 50	11
50 to 75	20
75 to 100	37
> 100	48

Once a company is insolvent, most<sup>23</sup> of the unpaid losses are passed to FIGA and can be calculated for each event as:

$$\sum_{i=1}^n (Event\ Loss_i - FHCF\ Recovery - Private\ Reinsurance\ Limit - Surplus)$$

Where:

n = number of insurers insolvent for that event

Not surprisingly, FIGA is most exposed to hurricane landfalls near Miami, as noted from Figure 12 on page 24, where event losses can exceed risk transfer programs by several multiples. In extreme cases, the FIGA’s debt obligations can exceed \$40 billion. However, FIGA is limited in its statutory authority to fund insolvencies.<sup>24</sup> A hurricane event on the order of Hurricane Andrew could exhaust its financing capabilities (Florida Guaranty Insurance Association, 2018).<sup>25</sup> Results

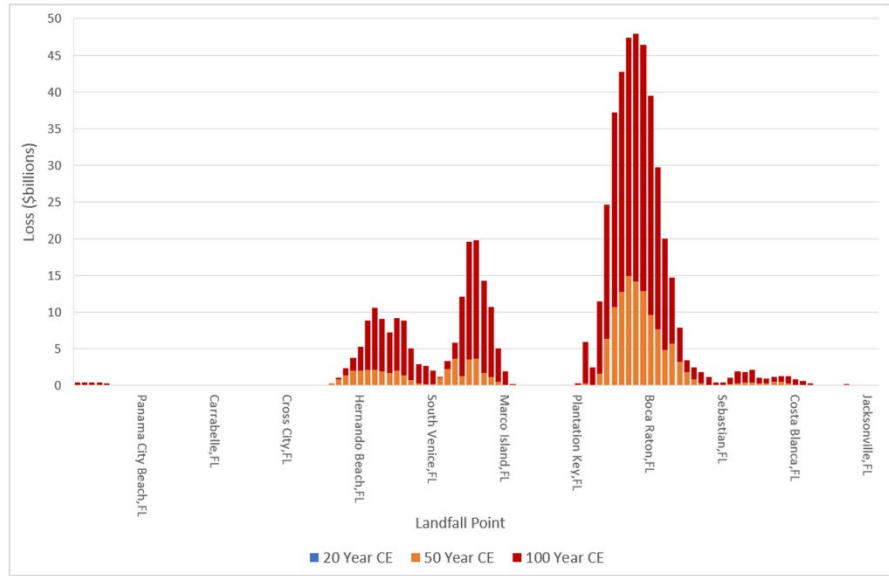
23. For example, residential homeowner policyholder recoveries are limited to \$500,000 for structure and contents claims, and a \$100,000 limit is applied to condominium units.

24. See Section 631(3)(a)-(f), Florida statutes.

25. FIGA has levied regular assessments 10 times and emergency assessments six times in the last 22 years for a total amount of \$1.7 billion. Since 2004, 31 insurers have become insolvent, with more than 73,000 claims costing an estimated \$1.8 billion, but no bonding has been required. The assessment base is \$18.4 billion (made up of 17 different P/C lines of insurance), and FIGA’s current emergency assessment authority would support \$2 billion in bonding. The civil case for bond validation purposes (Florida Insurance Assistance Interlocal Agency v. The State of Florida,

of the analysis indicate that it does not take a one in 100-year event to stress FIGA’s capabilities to the limit. FIGA is vulnerable to the potential volatility of the financial markets following an event and by its limited assessment authority.

**Figure 12:  
FIGA Debt Profile**



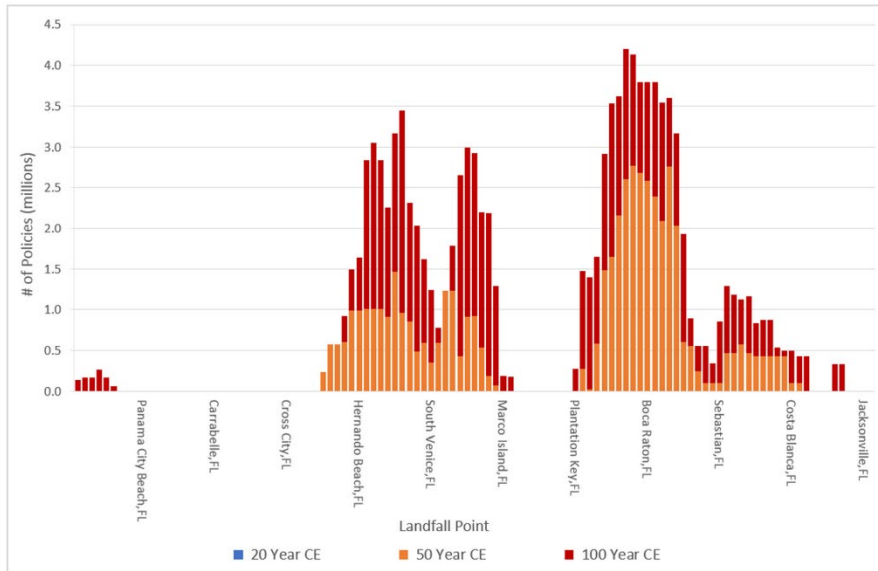
The authors of this study also assume that the policies from the insolvent insurers will be renewed by Citizens post-event.

At its maximum historical policyholder count, Citizens had almost 1.5 million policies in its combined PLA/CLA and CA. At the end of 2017, the combined policy count was 440,406. Figure 13 on page 25 illustrates that there are a large number of one in 50-year hurricanes that could result in the repopulation of Citizens to its historical maximum policy count. Additionally, a number of the one in 50-year hurricane events could result in a surge of policies by inundating Citizens with an extra 1 million policies or more, far surpassing the historical record. For certain landfall locations, a one in 100-year hurricane event could result in the Citizens policy count exceeding 4 million policyholders, which represent about two-thirds of all policyholders in the state. Citizens, FIGA and the entire Florida residential property insurance market are highly vulnerable to insurer insolvencies, which could arise from moderate to large hurricane events that are not extreme, but that could easily occur in the future.

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et al, 2008) served to validate the issuance of up to \$750 million of revenue bonds by FIGA. FIGA can use its regular assessments of 2% or \$386 million annually to pay its claims as well.

**Figure 13:  
Policies to Citizens from Insurer Insolvencies**



## VI. Summary and Conclusions

This paper has shown the state of Florida is highly vulnerable to hurricanes, not just extreme hurricanes, but from hurricanes that have characteristics of those that have occurred in the past and are likely to occur in the future. The authors conducted a two-part study—one from a micro perspective and the other from a macro perspective. The micro perspective included the analysis of 62 Florida-based domestic insurers. The macro perspective examined Florida’s public risk financing entities (Citizens, the FHCF and FIGA) to assess the impact of hurricanes on the residential property insurance system as a whole. The analyses were conducted using publicly available information on private insurers in Florida, data from the FHCF and Citizens, and a high-resolution hurricane model and industry database of property values. A transparent and consistent set of hurricane scenarios was applied to each insurer using the CE methodology. For the analyses, the 20-, 50- and 100-year hurricane events were used in order to represent scenarios with a reasonable likelihood of occurring.

Each private insurer in Florida has a unique geographical distribution of property values and will be affected by the scenarios differently according to the hurricane landfall location. In order to compare insurers across all events, an NSR was calculated based on the average difference between the scenario loss and the insurer’s surplus plus risk transfer protection. A positive NSR indicates the surplus

and risk transfer is enough to cover all 20- and 50-year events and most of the 100-year event losses. An NSR below -2 indicates the insurer will barely cover the 20-year event losses and is much more likely to be financially impaired from a hurricane. The analysis revealed a wide range in the NSRs, indicating disparities in financial solvency that are not being captured by the rating methodology of Demotech or the FLOIR stress tests. Among the Florida insurers rated "A" by Demotech, 26 (42%) have positive NSRs, indicating that they are among the most secure, while eight (13%) have NSRs below -2. The 62 Florida-based domestics had a combined surplus of only \$5.2 billion at year-end 2016 and were writing 71% of the policyholders in the state. In contrast, Citizens writes only 5% of the market with more than \$7 billion in surplus. Citizens is among the most financially secure insurers when compared to the Florida-based domestic insurers. Citizens' NSR ratio for its PLA/CLA is 0.73, and for its Coastal Account, it is 0.71.

The findings from the analysis can be used to calculate the number of insurers likely to become insolvent under various loss scenarios and the potential impact on FIGA. Interestingly, a repeat of a Hurricane Andrew-sized loss today (\$50 billion to \$60 billion) would result in more insurer insolvencies than occurred in 1992. For an industry loss from \$25 billion to \$50 billion, the expected number of insolvencies is 11. For a loss between \$50 billion and \$75 billion, the expected number of insolvencies is 20. FIGA is limited in its ability to finance the losses for these insolvencies. The authors found that FIGA's debt profile based on hurricane losses and resulting insolvencies could result in the need to issue more than \$40 billion in debt. To put this number in perspective, FIGA's net assessments since inception in the late 1960s have totaled \$2.3 billion. All guarantee fund net assessments in the U.S. since inception have totaled \$17 billion (FIGA, 2018).

If the insurance industry in Florida is affected by various sized hurricanes similar to those that have occurred in the past, the resulting insolvencies could lead to Citizens having to take on numerous policies in its role of a residual insurer. Citizens had a record number of policyholders (both accounts) in 2011 of 1,472,391. The number of policies that could repopulate Citizens given various size hurricane events will vary by landfall. However, the authors illustrate how a few 50-year hurricanes could inundate Citizens with an extra 1 million policyholders. Additionally, there are certain 100-year hurricanes that could result in Citizens inheriting an additional 3 million to 4 million policyholders or as much as two-thirds of all policies in the state.

This paper has identified various vulnerabilities in the current Florida residential insurance market and suggested new analytical approaches that could be used to strengthen the market. It is clear that while Florida's public risk financing entities provide some protection to Florida policyholders, the viability of the market depends heavily on financially stable private insurers. To date, most tests of Florida insurer solvency have focused on the one-number PML approach, which has numerous issues from a regulatory perspective. Stress tests should include a robust set of scenarios covering the complete Florida coastline so pockets of exposure that could lead to solvency-impairing losses are not overlooked and be extended to



Florida's public risk financing entities and their capability for responding and stabilizing the residential property insurance system over the long run.

Further research can be done examining the sensitivity of the results to the various assumptions used for this study. Publicly available information on each insurer's complete risk transfer program would enable more precise quantification of the solvency impacts of each hurricane scenario and perhaps is important information for Florida residential insurance policyholders. Stress testing under a range of financial market and reinsurance market conditions could also be insightful from a long-term risk management perspective.

## Appendix A

### *Assumptions Used for Analyses*

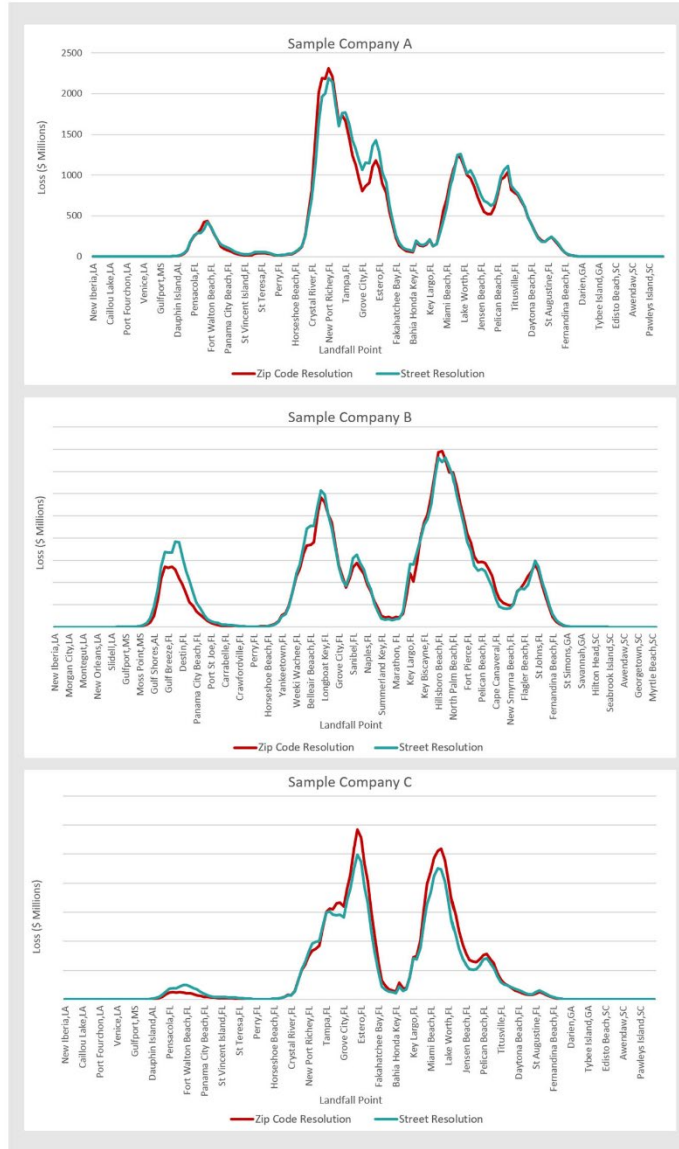
In support of this analysis, fourth-quarter 2016 QUASR exposure data was obtained from the FLOIR. Of particular note, the following information is provided for each company at county resolution: 1) policy type; 2) number of policies that include wind coverage; and 3) the total exposure value for policies in force that include wind coverage. Catastrophe model analyses have minimum data requirements and also provide higher quality loss estimates when data is provided at finer geographic resolution. Consequently, the following assumptions were made and applied to the QUASR data prior to importing into the catastrophe model to make the information more suitable for estimating insured losses for each company:

- 1) The KCC industry-wide KPD was used to distribute the QUASR county-level data to five-digit ZIP code resolution within the state of Florida. It was assumed that individual company exposure data was distributed to ZIP codes within each county in the same proportion as the industry.
- 2) Policy code descriptions contained in the QUASR data were used to assign appropriate occupancy codes recognized by the catastrophe model, including single-family home, multi-family home, agriculture, multi-family dwelling homeowners' association, and multi-family dwelling condominium owner occupancy codes.
- 3) In order to assign construction-type information to the QUASR data, an analysis of individual property data for Citizens and several Florida insurance companies was performed. The analysis indicated that residential and commercial residential properties north of the Gainesville area are predominantly wood frame, and properties to the south are predominantly masonry. Consequently, exposures in ZIP codes north of the Gainesville area are assumed to be wood frame, and properties in the remainder of the state are assumed to be masonry. Mobile home policies were assigned a mobile home construction code in all regions of Florida.
- 4) All properties in the analysis were assigned a year built of 1995, which is representative of the average residential and commercial residential building stock in Florida.
- 5) An analysis of individual property data for Citizens and several Florida insurance companies was performed to determine representative policy deductibles and coverage splits (the proportion of Building, Contents and Loss of Use coverage amounts) within the state of Florida. Average deductibles were estimated for each policy type at a ZIP code resolution,

and for single-family dwellings (the majority of the QUASR data), a 2% deductible was assigned to the majority of ZIP codes in Florida, with a range spanning a 1% deductible applied to more inland ZIP codes up to a maximum of a 4% deductible applied in a few coastal ZIP codes. Statewide coverage splits were estimated for each QUASR policy code. For the Personal Residential – Homeowners – Owner Occupied policy code (nearly 75% of the QUASR exposure), the total insurable value was assumed to split 70% building coverage, 20% contents coverage and 10% loss of use coverage.

## Appendix B

### 100-Year CE Zip Code and Geo-Code Loss Comparison for Three Companies



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# Journal of Insurance Regulation

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Cummins, J. David and Richard A. Derrig, eds., 1989. *Financial Models of Insurance Solvency*, Norwell, Mass.: Kluwer Academic Publishers.

Manders, John M., Therese M. Vaughan and Robert H. Myers, Jr., 1994. “Insurance Regulation in the Public Interest: Where Do We Go from Here?” *Journal of Insurance Regulation*, 12: 285.

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