THE PREDICTION RACKET:

Constructing, Characterizing and Governing Florida's Hurricane Risk

by

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Abstract

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The Prediction Racket:

Constructing, Characterizing, and Governing Florida's Hurricane Risk

Dissertation directed by Professor Roger Pielke, Jr.

The prediction racket describes a situation in Florida where insurance rate decision makers look to catastrophe models to reduce uncertainty about future loss and in the process characterize ever more risk. To alleviate the racket's affect on the public, the Florida legislature mandated its residual market, Citizens Property Insurance Corporation (Citizens), provide "affordable property insurance." However, Citizens struggles to satisfy its mandate because disagreement about the risk detracts from constructive debate needed to reconcile conflict between insurer economic sustainability and insurance affordability. This undermines legislative efforts and threatens Florida's democratic process.

This dissertation examines the interrelated social and decision process of constructing understanding of the hurricane risk, negotiating its characterization, and implementing insurance. Three independent research projects address each part of the process. First, I consider the conflicting claims that hurricane losses have increased due to geophysical changes or social changes. I assemble a global dataset of hurricane landfalls and find no long-period trends, supporting earlier research conclusions that societal changes explain increasing losses. Second, I present the ratemaking process as wholly political and examine the role of catastrophe models in the evolution of Florida's hurricane risk affordability and insurability. I find that, over the period of analysis, conflict over modeling science attributed to the decline of perceived insurability of

Florida's hurricane risk. I conclude that without a means to judge the scientific quality of the models, they serve in the ratemaking process simply as political tools to support interests' preferred rate decisions. Finally, a policy evaluation of Citizens identifies trends in its success and failure meeting the goal of affordable property insurance. I attribute responsibility for performance to four main factors: 1) the use of Citizens as means to deflect market judgments of risk, 2) the logical impossibility of an actuarially sound residual market, 3) the politicization of the hurricane risk, and 4) false assumptions in the state's economic model. The dissertation concludes with a list of policy options designed to expand the scope of debate beyond one of insurance ratemaking and towards considerations of policy that improve the availability of affordable property insurance.

To Grandpa Bones (W. Stanley Weinkle) and
Papa Chicky (Bernard S. Chaikin)

Preface

I began my research on Florida's governance of risk with a personal inquiry of deconstructing my own constructs of reality about Florida and its notorious urban quagmire, Miami. After many hours of a circular internal dialog of "What is the problem? Why do I think that?" that amounted to overly philosophical navel gazing, I found that I too had a vision for Florida's future. My vision was a relic of 1970's Miami, The Keys were still largely undeveloped, few had cell phones, and the waterways were abundant with Square Grouper. I had no personal experience of these days past and therefore, fancied the vision from music, photographs, and stories from older generations. My vision of the future as a relic of the past also depicts my idea of a good time: less population density, fewer electronics, and way fewer developed and surveillanced landscapes. That is, true to my hometown, I highly value fun and modern social developments have impinged on my fun times. Though money is a great value to maximize; it is ultimately, just a means to more fun. In my mind, Florida's problem was its inability to resist society's changing ideas about how best to make merry. This of course is silly.

It has now been many years since I lived in Miami. During a trip back to gather data for my dissertation research I was able to experience and see Miami from a whole new perspective. While lounging in a pool at midnight with views of the city and a warm ocean breeze, I found that this modern day version of fun really wasn't so bad. Instead, the way the powers-that-be have molded Miami over the last 30 years or so has created something quite spectacular. I found the ambient purple lighting quite nice. But what makes Miami special, its passionate pursuit for fun, is also its fatal flaw because the antithesis of fun is, seemingly, moral responsibility.

During my research, I came across several instances of people claiming that Miami has a dearth of morality. Indeed, some directly warned me about shady politics in the city and the state. Though I appreciated their sincerity, I know from experience that shady politics is a way of life for Miami residents. For example, when I was a child, my elementary school principal was ousted for forging students' grades and attendance records[1]. While undergoing trial for corruption during the aftermath of Hurricane Andrew, the mayor of Miami Beach, Alex Daoud, was also accused of jury tampering by offering disaster assistance. Recent news, demonstrates a continued pattern. In early September the *New York Times*[2] told of the consecutive indictment of three South Florida area mayors and mentioned several others charged of corruption in the past. Such brash accusations do not mean the end of a political career in the Sunshine State. The current governor, Rick Scott has clearly demonstrated this by running for office (and winning) after his own bout with heavy corruption charges[3]. Finally, let us not forget, South Florida's botched democratic process in the presidential elections of 2000 and 2012.

Like the sirens of Greek mythology, Miami beckons with its twinkling lights and promise of pleasure, yet underneath the glamour one finds it permeated with social strife and unscrupulous politics. While Miami pursues fun, and the money to make it possible, the city becomes ever more lustrous and its ability and willingness to respond to the humanitarian needs of its resident population seems to dwindle. The idea of Miami as a "world-class city" is often invoked in defense of its actions. The phrase connotes greatness in human accomplishment and a city that strives for dignity and social stability. But failures of the democratic system demonstrate very public ways in which public policy makers consistently fail to advance the public interest over those of a powerful elite. In planning for the future, balance needs to be

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[1] AP. 1990. Principal Ousted. *The Times-News*. Sept. 30.

[2] http://www.nytimes.com/2013/09/02/us/arrests-of-3-mayors-reinforce-floridas-notoriety-as-a-hothouse-for-corruption.html?src=me&ref=general&_r=0

[3] http://www.politifact.com/florida/statements/2010/may/21/bill-mccollum/rick-scott-former-healthcare-ceo-barely-escaped-pr/

found between the bullish quest for fun and the moral responsibility to residents that comes with being at the forefront of social change and a respected world-class city.

My grandfather and his brother having fun in Miami Beach; February 7, 1931.
State Archives of Florida, Florida Memory, http://floridamemory.com/items/show/136585

Acknowledgments

After I read the synopsis of a book or the abstract of a paper, I read the acknowledgements. I find that acknowledgments place the author into an intellectual and social context. In a way, acknowledgements serve as a type of confession where the author admits that their work does not come from a wellspring of brilliance or tenacity. Instead, the writer acts only as a conduit for expressing the shared knowledge, experience and charity of their community. Much of my motivation for study and writing comes from an odd affection for a good argument. Because of this, I appreciate clever commercials, interesting political campaigns, and lighthearted tiffs. I owe a great many people for this interest and to whatever talent in the practice of rhetoric one may consider as part of my repertoire.

Foremost, I owe a great gratitude to my parents, Jeff and Ondrea Weinkle, for their unwavering support of my amorphous intellectual pursuits. My father taught me the moral value of rhetoric as an essential tool of justice while my mother entertained most all of my arguments as I learned how not to make them.

My academic advisor, Roger Pielke, Jr. served as the "World's Best Advisor." Over the last several years, he encouragingly read and listened too my many musings of variable quality. But I am most appreciative of his committed moral support, insightful life lessons on tact, and teachings of argument as a form of art.

Rade Musulin significantly contributed to my depth of understanding about the interface of the insurance industry and public policy. His knowledge inspired a great appreciation for human factors, hopes and fears, behind the process of governing Florida's hurricane risk.

The other members on my academic committee, Max Boykoff, Bill Travis, Lisa Dilling, and for a time, Gary McClelland, each contributed to my professional development in different ways. I hold a special gratitude to each of them, but as a whole I am thankful for their distinctive practices and representations of the academic profession.

This dissertation benefited greatly from the experience and knowledge of several insurance experts in Florida. I sincerely appreciate their time and willingness to share their challenges on the politically sensitive topic of ratemaking for Florida hurricane risk. It was an enlightening experience for me.

Since the beginning of 2013, Chris Austin and the Modeling Team at ICAT Managers have patiently helped me understand the work of an insurance company. This dissertation owes much to the knowledge they have shared with me.

I warmly regard a group of professional scientists, teachers, and mentors that have helped me along the way over the years. Each contributed to my accomplishments and aspirations: Craig Pelton, Tina Taub-Montemayor, Kenny Broad, Sam Fitch, and John Basey.

The staff and students housed in a cozy bungalow designated as the Center for Science and Technology Policy Research acted as my work family over the last 5 years. Like a family they have supported my achievements and kindly forgotten my less-than-graceful moments. I owe a special gratitude to Bobbie Klein, Ami Nacu-Schmidt, and Rad Byerly. As well, I am grateful for the candid tales of experience and cheerful encouragement given by Shali Mohleji. Zach Johnson helped tremendously with newspaper searches and other research endeavors.

At the very beginning of my research, childhood friend, Scott Kimball, helped me wade through and make sense of a mess of financial jargon. His help kept me from many embarrassing moments later in the research process.

Gene Longenecker has helped me to better understand the inner workings of government and disaster management. I have enjoyed many hours of fruitful academic discussions that generally end with the dumbfounded realization that somehow life has duped us into situations that one may have the audacity to describe as a career.

A number of people have contributed to my personal well being while working on this dissertation. If I create a long list, I risk missing a few that have no less added dynamic to my days. But I would like to mention a few in particular. First, Tevis Blom, my most favorite sparring partner, was pivotal to any semblance of sanity and balance I maintained while working on this dissertation. He tirelessly smoothed my frizzle created by long hours staring at a computer screen, brought me up to the mountains and off the beaten trail, and made sure I ate something more substantial than Lemon Drops. Second, Lauren Firtel has edited all of my college entrance essays; and so, without her perhaps none of this would have been possible. Her interpersonal skills and patience surpasses that of any I could ever hope to achieve. Third, Gaby Stockmayer has kept me company and chatted away about life during many a hike around

Boulder. She has always been ready to ease a rough day with a good happy hour and her sincere interest in my research on insurance never ceases to bewilder me. Finally, Joe Naroditsky has shared with me a lifetime of philosophical banter, ideological pursuits, and ironic outcomes. His contributions as my ‘loyal opposition’ have always helped me consider things under a new light.

I also recognize the generous financial support of several organizations. I am particularly grateful to an award from the National PERISHIP Awards. Their funding provided support to spend several weeks in Florida collecting data and finding new understandings for the state’s social and economic dynamics. As well, ICAT Managers provided substantial support in the last year of my writing. Teaching and research assistant positions provided through the Cooperative Institute for Research in Environmental Science, Environmental Studies Program, Sociology Department, and Ecology and Evolutionary Biology Department provided many semesters worth of support. Finally, I thank the good graces of the tax-paying American public who have supported my scholarly pursuits by virtue of Federal student loan programs.

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CHAPTER 1: Introduction

The Prediction Racket

Since 2007, the affliction of 'too much money' has troubled the reinsurance industry[4] (AON Benfield 2011). When reinsurers have too much money it means that the supply of their product, capital, has outpaced demand or rather, losses. The story of how reinsurers came into too much money is the story of the prediction racket and the creation of a "'new normal' higher level of global catastrophes" without corresponding catastrophic losses (AON Benfield 2013, p. 3). I aim to tell this story by taking a close look at public policy efforts to manage the hurricane risk in Florida with insurance.

By the phrase, prediction racket, I mean two things. First, I mean a whole lot of unpleasant fuss and noise over hurricane insurance[5] rates in Florida. It's quite a bother and very unproductive in respect to public policy goals of maintaining "an orderly market for property insurance.[6]" Second, I mean a situation in which insurance rate decision makers look to catastrophe models to reduce uncertainty about future loss and in the process characterize ever more risk. This occurs because science cannot uniquely define Florida's hurricane risk. It can only provide estimates based on different sets of closed systems defined by theoretically relevant parameters, none of which scientists can demonstrate represent Florida's true risk. Therefore,

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[4] Reinsurance is often described as insurance for insurers. For example, when you buy homeowners insurance you do so through a primary insurer. The primary insurer considers you and all its other homeowners risks together and then purchases reinsurance to cover some of its collective risk. Reinsurance is largely unregulated and participates directly within the international capital markets where risk of all types from all places is packaged, traded, invested etc.

[5] Throughout this dissertation, I use the terms windstorm insurance and hurricane insurance interchangeably. In general for homeowners, windstorm insurance provides coverage for several wind related perils such as tornados. However, in Florida, the primary concern regarding windstorm coverage or windstorm insurance is the included coverage for hurricane losses.

[6] FL ST 627.351 (6)(a)

expert knowledge about risk has a tendency to mask an underlying political conflict over preferred outcomes for the Citizens' policy.

Who's preferred outcomes should Florida's policy makers work to achieve in making decisions about rates? On one hand they may seek to improve the affordability of hurricane insurance coverage. Lowering rates helps the public in the short run. But as rates decrease, the probability of insolvency increases and the risk management scheme looks less like conventional insurance. On the other hand, policy makers may seek to improve the economic sustainability of the insurers providing coverage. Increasing rates helps protect insurers from the probability of insolvency. But as rates increase, the public has an increasingly difficult time accessing insurance due to cost constraints. As a result, these conflicting perspectives duel it out in the political process of ratemaking. Still, making a decision about rates one way or another does nothing to resolve the conflict between insurance affordability and insurer economic sustainability. Where one perspective wins, the other loses. Consider the following story depicting a recent incident of the prediction racket.

Battle of FLOIR

During the balmy Florida summer of 2013, Florida's CFO, Jeff Atwater, and Citizens Property Insurance Corporation CEO, Barry Gilway galloped towards the gates of the Florida Office of Insurance Regulation (FLOIR) and demanded to speak with the authority over all Florida insurance rate decisions, Insurance Commissioner Kevin McCarty. Atwater and Gilway, are noble spokesmen of rival perspectives on appropriate decision making behavior. As a career state politician, Atwater has a long history as a leader of the democratic perspective[7] on ratemaking and argues for a role of all political interests in the ratemaking process. Gilway

[7] Jeff Atwater served as a co-sponsor of the Windstorm Bill that created Citizens (Citizens Property Insurance Corporation 2002)

comes to Florida by way of large financial corporations all over the world and carries premier private insurance expertise (Insurance Journal 2012). He leads the technocratic perspective of ratemaking and argues that market judgments of risk determined by technical expertise ought to act as the premier if not sole consideration in the ratemaking process.

Atwater and Gilway have come to Commissioner McCarty to plead their cases for a preferred rate decision. Atwater told McCarty of reinsurers' 'too much money' problem that has caused the cost of reinsurance to plummet by 15-20% (Atwater 2013). He raised the idol of the "Florida family" depicted as buckling under pressure from insurers' burdensome costs and in desperate need of "economic relief" (Atwater 2013). The time has come, Atwater pleaded, to lower the cost of windstorm insurance coverage!

Gilway disagreed. He raised the battle flag of actuarially sound and proclaims that in 2011, Citizens needed a rate increase of 56%, but in 2014 it needs an increase of only 18.3% (Hemenway 2013). Citizens has come too far on its journey towards actuarially sound to quit just yet. As a final word, Gilway warns that Citizens "remains only a bad storm season away from breaking the bank and being forced to assess all Florida policyholders" (Hemenway 2013). He urged that windstorm insurance rates must continue to increase!

Commissioner McCarty, weary of this timeless Florida battle, acknowledged the noblemen's' concerns, but encouraged the two to find compromise. He has received word of reinsurers too much money problem and looks hopefully towards "a tremendous amount of capital coming into the marketplace today" (SachsMedia 2013). To Atwater he explained that ratemaking has lots of ins and outs and many a what-have-you and well, its "very time-consuming" (McCarty 2013). McCarty explains to Atwater that policyholder rates may not come down any time soon because "many insurance companies have chosen to transition large rate increases over a period of years" and still others "may purchase more reinsurance rather than reducing rates" (McCarty 2013). He concludes his lesson by paying appropriate homage to the Florida families who needed economic relief and assured the CFO that the FLOIR "will remain vigilant in its review of rate filings…to ensure all possibilities for such relief" (McCarty 2013).

To Gilway, Commissioner McCarty merely shrugs and takes his rate request filings. In September Commissioner McCarty came forward with a decision. The FLOIR trumpeted over all the appropriate media channels, "The combined overall statewide average rate increase requested by Citizens… was 7.9%. The Office set the rate at 6.3%" (FLOIR 2013). Some cheered while others booed.

McCarty had found a compromise on the insurance rates. He raised them, but not all the way. However these men's' extensive and dramatic efforts have done nothing for resolving the conflict between insurance affordability and insurer economic sustainability. It simply altered this year's winners and losers.

Is this risk real?

In recent decades, Americans have heard the call for the rates of government run insurance programs to reflect the 'real,' 'true,' or 'actual' risk from insurance experts (Michel-Kerjan and Kunreuther 2011), members of government (Office of the Insurance Consumer Advocate 2012), and interest groups (R Stree Institute 2013). On its surface, the critique implies that government run insurers use fanciful ideas of risk developed by those in charge. Recent political debates that focus on the costs of government run flood, windstorm, and social insurance all seem to support this case. The National Flood Insurance Program a residual market for flood insurance, has roughly a $30 billion debt to the US Treasury as a result of flooding from several catastrophic loss events such as Hurricanes Katrina and Sandy (Postal 2013). In

2004 and 2005, Florida's Citizens experienced a deficit over $2 billion (House Majority Office 2009). In addition, the cost of government sponsored health care, social security and pension plans have occupied much of media headlines for the past several decades.

In accordance with the criteria of insurability (Berliner 1982), rectifying these problems require raising the cost of insurance, removing policies from the insurance programs or both. That governments do not readily do this, gives the impression of inadequate rates. Certainly, this conclusion would not be so far fetched if any of these programs were a conventional form of insurance. But, these government run insurance programs are not forms of conventional insurance they are residual markets.

Residual markets are unlike conventional forms of insurance because they have the ability to spread risk over time by incurring debt and paying it back gradually into the future (King 2009). Conventional insurance, better known as the private market, does not have this ability. As a private business, when insurers experience losses surpassing their ability to pay (i.e. they become insolvent) for all intent and purposes they have gone out of business. Because residual market debt does not cause the government 'to go out of business' the residual market can withstand the impact of periodic catastrophic losses that exceeded its capital and therefore, offer policyholders coverage for less.

This creates two perspectives on any residual market insured risk. On one hand, private market insurers view a risk with solvency and the need to respond to market judgments of risk in the back of their minds. On the other hand, government residual markets view the same risk with public affordability and judgments of political risk in the back of their minds. Hence, neither party considers the other to have rates that reflect the real risk because each groups prioritizes different aspects of the risk being insured. To put it in terms of social science, private insurers and residual markets have a different "social construction of reality" (Berger and Luckmann 1966) for a given risk.

In order for insurers to make insurance available they must have the ability to calculate the odds of loss. In this way, insurance is limited to the management of measurable uncertainty concerning loss (Knight 1921; Berliner 1982; Bernstein 1996). Insurance cannot manage what we cannot measure. In order to apply insurance to a particular risk insurers need to decide relevant aspects and the extent to which those aspects are measurable. However, just as perspectives on a risk vary so too do perspectives on knowledge.

In recent decades, insurers' use of catastrophe models to estimate risk has dramatically changed their view of many natural disaster risks and perspectives on necessary rates (Subcommitte on Consumer Credit and Insurance 1993; Grossi and Kunreuther 2005; see also Cabantous et al. 2010). However, due mainly to the time scales involved, the scientific quality of these models is undeterminable (Chapter 7; see also Oreskes et al. 1994). So, do catastrophe model estimates constitute measurable risk or scientific theory about the unknowable? One of the original catastrophe modelers, Karen Clark, argues that the models as they are made and used to today, fall into the latter category. She described much of catastrophe modeling as "scientific unknowledge" and warns that insurers,

> should not be lulled into a false sense of security by all the scientific jargon which sounds so impressive because in reality… the science underlying the models is highly uncertain and it consists of a lot of research and theories, but very few facts, the things that scientists don't know (Simpson 2011a).

Based on Clark's warning, we see that private market claims that residual markets do not represent the real risk masks their own imaginative process of ratemaking.

Still, the global insurance system relies heavily on the use of the catastrophe models. Despite their questionable ability to depict anything known, their widespread use in capital markets makes their estimates real for insurers' decision making. To the extent that residual markets need not rely on market judgments of risk catastrophe model estimates may carry little weight. Yet, final decisions about rates have real world impacts. They affect insurers' real and perceived risk of insolvency and therefore their willingness to remain in a certain market. As well, rate decisions affect costs to policyholders and their access to services intended to serve their well-being.

Why study insurance and residual markets?

In many ways, the insurance industry rivals government. Insurance has a governing effect on society by enforcing punishment in the form of monetary costs for behavior it judges as morally reprehensible (Ericson et al. 2003; Baker 2000). When insurers' sense of "moral risk" (Ericson et al. 2003) conflicts with government's the two compete for the public's trust to identify those risks worth fearing or accepting (see Slovic 1999; Davies and Croft 2011). Similar to government, insurance provides for the general welfare, creates employment, and contributes to national GDP (Ericson et al. 2003; NAIC 2013; III 2012). To the extent that income going to taxes is unavailable for insurance premiums, the insurance industry and government compete for revenue to provide these services. In 2012, insurance policyholders in the United States spend over $1.8 trillion in insurance premiums (NAIC 2013). By comparison, in 2011, the Federal government collected $2.3 trillion in taxes (Congressional Budget Office 2012). If considering revenue as a proxy for power, the insurance industry provides the Federal government a worthy opponent.

Though the insurance industry and the government may seem as adversaries, the two have grown and prospered from a symbiotic relationship. Beginning in the 1930's, property and casualty (P/C) insurance has played a pivotal role in the success of Federal economic policies for real estate by providing windstorm coverage, which included the hurricane peril, to meet mortgage lending requirements (Lecomte and Gahagan 1998). However, around the 1960's, insurers began struggling to manage the large catastrophic losses coming from the nation's growing urban areas while also providing coverage at an affordable rate (US Government 1968). As a result, governments created P/C residual markets to support the economic policies that depended on the availability of affordable property insurance.

In the *Federalist Papers No. 45*, written in advocacy of adopting the US Constitution, as a public policy guiding the implementation of democracy, James Madison, argued the abilities of states and federal governments served different needs of the nation. The two governing powers are equally important under different circumstances, "The operations of the federal government will be most extensive and important in times of war and danger; those of the State governments, in times of peace and security" (1787). States provide more intimate governing, spurring loyalty and interest in the community. By virtue of its ability to pool greater resources than the states, the federal government better withstands times of crisis and maintains power when interacting with foreign nations.

Residual markets are public policies. Studying residual markets provides an opportunity to assess the implementation of the democratic process and roles of state and federal government in serving public objectives in managing risk. Like any other public policy, the progress of residual markets in meeting stated public objectives is of interest to ensure a successful democratic governing regime. The political controversy surrounding residual markets in recent years gives reason for their evaluation in relation to the goals policymakers have intended them to achieve. Using a specific public policy as a case study of the democratic process reveals power relationships in society and points of contention thereby leading to a fruitful discussion for how policymakers can improve policy outcomes.

Florida's Citizens Property Insurance Corporation

Since Hurricane Andrew in 1992, Florida has struggled considerably with maintaining the availability of affordable property insurance coverage for the hurricane peril. Socioeconomic factors have contributed to Florida's difficulties. On one hand, the state has areas along its coasts of significant income inequality (Bee 2012), valuable real estate (Schwartz and Wilson 2007), and high population density (Hobbs and Stoops 2002). On the other hand, the state experiences frequent hurricane landfalls and insurers perceive Florida has having the largest hurricane risk in the world (Insurance Executive C 2012). Taken together, insurers and policy makers have found it increasingly difficult to provide affordable property insurance to residents.

Florida economy rests, nearly by half, on the real estate sector[8], making the availability of insurance coverage in the state vital. As a result, legislators have created a series of different residual markets programs to maintain the availability of affordable property insurance in the state when the private market has been "unable or unwilling" to do so[9]. The most recent residual market program, created in 2002, merged two preexisting residual market entities to create Citizens Property Insurance Corporation (Citizens)[10]. In 2007, Citizens legislators changed

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8 bea.gov

9 For example, FL ST 627.351

10 Citizens' counterpart is the Florida Hurricane Catastrophe Fund (FHCF). While Citizens is a state run primary insurer the FHCF is a state run reinsurer. The FHCF has a significant role in the governing of Florida's hurricane risk, however I choose not to discuss its role in depth for two reasons. First, an in depth discussion is beyond the scope of this dissertation which focuses on the Citizens' specific legislation. Second, a discussion of the FHCF is better placed in the context of governments' internalization of the entire insurance system. For example, a research project that discusses Citizens, the FHCF, and Demotech (a credit rating agency that works closely with US federal and state governments) offers a vantage point to investigate the role of a publicly governed insurance system and the potential benefits and consequences thereof.

Citizens guiding legislation giving it the mandate to provide “affordable property insurance” in the sate. Still, the public expresses continued concern over the cost of windstorm insurance and the sustainability of the insurance regime.

Criticisms of the program abound. North Florida residents and politicians are concerned and outspoken about their cost of insurance subsidizing South Florida’s comparatively greater hurricane risk[11] (Newman 2009). Private market insurers consider the program as unfairly competitive (Olorunnipa 2012a). Some see Citizens as a harbinger of socialism (Tobia 2012). While others argue that Citizens’ experience with deficit after the 2004/2005 hurricane seasons exemplifies the insurance industry under climate change if rates are not adjusted to consider anthropogenic climate change (Mills et al. 2005). But despite widespread interest in how the program operates, no one has attempted to evaluate the program in respect to its legislative mandate. All existing reports that carry a semblance of evaluation are, intentionally or not, works of advocacy (e.g. Klein 2009; Lehrer 2011; Medders et al. 2012). A policy evaluation considers past performance in relation to stated goals and seeks to expand the scope of alternatives for policymakers. On the contrary, advocacy considers the future, often not in relation to stated goals, and seeks to promote specific policy action (Lasswell 1971; Pielke 2007)

This dissertation uses Citizens as a case study to better understand the use of residual markets as a mechanism for governing catastrophic risk. I look at the use and misuse of science to influence perspectives on hurricane risk and closely evaluate the hurricane record for demonstrable change in frequency or severity. I make the ratemaking decision process a central component for demonstrating the value laden process of using catastrophe model science as a

[11] Policy makers also have concern that in the wake of a catastrophic loss, burdensome subsidies may cause North Florida businesses and residents to move across the state line to Georgia or elsewhere (Thanks to Rade Musulin for making this point).

tool to negotiate the allocation of risk in society. A policy evaluation of Citizens provides insight into how insurers compete with government for the power to define risk and how government uses residual markets to shield the public from market judgments of risk. I consider how the current state of affairs threatens the Florida's democratic process by preventing the opportunity for public participation and policymaking that responds to public problems. Finally, I offer a list of options designed to move the debate from one about the right measure of risk towards a broader public debate about options for the state's economic future.

Citizens offers several advantages as a focus of study. First, whatever the measurement used to represent Florida's hurricane risk, the risk of catastrophic loss in the state is very real. The historical record and even current human memory provides several instances of severe hurricane landfalls in the state. Simple socioeconomic adjustments to historical losses (Pielke et al. 2008) suggest that given a repeat of storms similar to the Great Miami Hurricane in 1926 or Hurricane Andrew in 1992, Florida could experience insured losses on the order $92 or $27 billion, respectively[12]. Second, the program is very high profile. The prominence of Citizens as a topic of discussion in the insurance industry literature, media, scientific literature, and public debates provides ample opportunity for data collection and breadth of perspectives. Third, Florida makes publicly available a great deal of information about Citizens and the catastrophe models used in the state. Private insurers generally keep this type of information proprietary. The data available through Florida provides a unique opportunity to consider interests perspective on the hurricane risk and residual markets in the context of modeling and financial data.

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[12] www.icatdamageestimator.com; Website provides economic losses. I use the common method of dividing economic losses by half to estimate insured losses.

Conclusion

This dissertation demonstrates Florida's prediction racket in concentrating efforts on finding a scientifically correct measure of risk while neglecting underlying value conflicts. I use the state's notorious residual market for windstorm insurance, Citizens Property Insurance Corporation (Citizens), as a case study of how society manages the shared risk that it faces. The dissertation is motivated by the desire to expand options for policymakers and improve the availability of affordable property insurance in Florida.

The research demonstrates that popular views of extreme geophysical events, such as hurricanes, don't necessarily reflect experience. I shed light on the process of ratemaking, a decision process that has received a great deal of public attention in recent years. I focus throughout on the difference of risk perspective represented by private insurers and residual markets. I argue that many of the criteria of insurability used to judge the performance of a private insurer does not apply to a residual market. Therefore the conflict over the actuarial soundness of Citizens depicts a conflict of power for control over the state's characterization of hurricane risk. The work here provides insight into the relationship between government and private insurance, the state of democracy in Florida, the continued desirability of traditional economic policies, and the role of predictive modeling in decision making.

CHAPTER 2: Overview

This dissertation has four parts and 10 chapters. The first part included Chapters 1, 2, and 3 and provides a backdrop for the rest of the dissertation. **Chapter 1** provided a general introduction of dissertation's focus. I presented the situation in Florida as a prediction racket and the insurance ratemaking process as political. I explained the reason Citizens serves as an ideal case for studying residual markets in the United States. **Chapter 2**, as the reader will currently observe, consists of a chapter-by-chapter overview of the dissertation. **Chapter 3** outlines the historical context that gave rise to Florida's Citizens Property Insurance Corporation. I pay specific attention to social, political, and economic factors in three policy arenas: federal government, Florida government and the insurance industry.

The second section provides background information necessary for the research projects presented in section three and includes Chapters 4 and 5. **Chapter 4** reviews the scholarly literature pertinent to the research and presents theories used as basis for the arguments I make as part of the dissertation. It concludes in a brief argument regarding the relationship between symbolic politics and insurance rates. **Chapter 5** presents the methodology for the design of the research projects and the dissertation in its entirety.

The third section consists of three independent research projects used to satisfy dissertation requirements and garner further insight into Florida's struggle to maintain the availability of affordable property insurance. The section includes Chapters 6, 7, and 8. **Chapter 6** presents a homogenous dataset of global tropical landfalls used to analyze the existence of trends. I found no long- term global trends in hurricane landfall frequency or severity. The work has been published in the scientific literature (Weinkle et al. 2012). **Chapter 7** demonstrates the political process of ratemaking in Florida and characterizes the role of catastrophe models in the evolution of Florida hurricane risk affordability and insurability. I attribute changes in model uncertainty to disagreement about the insurability of the Florida hurricane risk. I conclude that without a means to judge the scientific quality of the models they serve simply as political tools to influence ratemaking outcomes. **Chapter 8** is a policy evaluation of Florida's Citizens Property Insurance Corporation in respect to the legislatively mandated goal to provide "affordable property insurance." I demonstrate trends in the policy's performance and judge responsibility for trends. Finally, I consider implications for Florida's democratic process.

The fourth and final section includes Chapters 9 and 10. **Chapter 9** seeks to expand the scope of alternatives for the policy problem. I review some common alternatives often discussed and potential drawbacks. Then I offer other avenues for policy alternatives and in some cases, offer specific policy options. My recommendations are not prescriptive but instead I aim to broaden the public debate beyond discussions of ratemaking and towards value considerations of Florida's economic future. **Chapter 10** is a conclusion to the overall dissertation. I recap the information and research findings presented here. Finally, I consider broader implications of managing catastrophic risk in society using insurance and the democratic process.

CHAPTER 3: Context

Introduction: Florida Did Not Create Its Insurance Difficulties by Themselves nor Overnight

The current debate over Florida's hurricane risk did not evolve overnight. As urban areas grew, supported by federal, state and insurer policies, policy makers managed the hurricane risk by reallocating the risk in society. In the 1990's however, perception of the hurricane risk changed dramatically and the discussion of how best to manage the hurricane risk evolved into one about how best to measure the risk. This chapter outlines historic public policy decisions at the federal, state and insurance level that encouraged urban growth and dependence on the availability of affordable property insurance to support national economic goals.

This chapter proceeds in four sections. First, changes in federal economic policy beginning in the 1930's form the foundation for increasing vulnerability in Florida through real estate development. As prevailing economic theory and ideology changed in Washington, policy makers reallocated the risk associated with growing exposure amongst different subsets of the national population. The second section describes the history of Florida's economy and population growth and legislative attempts to manage the insurance regime to support both. Florida's unique sociopolitical characteristics fostered the economic dependence on the real estate sector. However, these characteristics also created social vulnerabilities to rapid swings in financial markets. The third section presents historical changes in the insurance industry's perception and measurement of the hurricane risk. Since the introduction of the homeowners policy in 1950, actuaries warned of pricing the policy too low in respect to the catastrophic hurricane coverage implicit with the inclusion of windstorm. The final section outlines local and international events that changed perceptions of the hurricane risk. Changing perceptions gave rise to a new political importance to the measure of hurricane risk represented in the price of windstorm insurance[13].

In the 1930's, economic policy motivated rapid development of real estate throughout the nation while prevailing economic theory enabled spreading the associated financial risk across the national population. A key link between public policy goals and the vitality of insurers developed at this time when banks made windstorm coverage a mortgage lending requirement (Lecomte and Gahagan 1998). As a result, the availability of affordable property insurance became a national priority because without access to insurance, the goal of creating economic wealth through real estate was not possible (US Government 1968). Many decades later in the 1970's and 1980's the prevailing economic theory changed and spreading risk over large and unaffected populations fell out of favor. The change encouraged a contraction in the total population burdened by the risk created by the proliferation of real estate exposure by federal policies.

Florida's unique history and proximity to the Caribbean significantly influenced patterns of population growth and cultural conflict in the state. Vacillations in real estate and land development boom and bust cycles amplify economic effects on Florida residents because the state's economy disproportionately relies on these sectors. Catastrophic hurricane events that coincide with declines in the real estate market exacerbate the severity of public felt economic hardship. In turn, Florida legislatures manage the windstorm insurance regime to maintain insurance availability and alleviate cost pressure on homeowners.

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[13] Because this dissertation deals with Florida insurance, I use the terms windstorm insurance and hurricane insurance interchangeably. Technically, hurricane insurance is a misnomer. Insurance providing windstorm coverage includes the several wind related perils. However, in Florida, the concern about windstorm coverage is due to the implicit catastrophe potential of the hurricane peril. Colloquially, hurricane insurance or hurricane coverage is often used.

Changes in Federal policy guiding the regulation of the insurance industry created opportunity for insurers to design insurance policies and prices to prosper from and support overarching public economic and social well-being goals. Much controversy surrounded the pricing of the windstorm peril since the creation of the Homeowners insurance policy in 1950 because the peril encompassed catastrophic loss potential from hurricanes. In addition, actuaries did not know how to incorporate quickly advancing knowledge and theory about hurricane activity coming from the science community. The fast growing real estate sector promoted competition in the insurance market and dissuaded insurers from incorporating considerations of increasing exposure and knowledge from loss experience into hurricane risk pricing.

Four events in 1992 changed perceptions Florida's hurricane risk. First, the landfall of Hurricane Andrew caused the largest catastrophic loss that the insurance industry had ever experienced making evident the increased exposure along Florida's coastline. Second, insurers ushered in the use of catastrophe models for ratemaking heightening their concerns for future loss potential. Third, the international public policy community brought climate change to the forefront of scientific and political debate. Fourth, the federal government passed new policy intended to revive the faltering real estate market by expanding mortgage lending to those that met affordable housing characteristics.

Collectively, these events created a political importance for the measure of hurricane risk reflected in rates. The larger estimates of risk produced by catastrophe models supported a need for price increases and answered to feelings of wariness felt by insurers and regulators fearful of future instabilities in the market. Likewise, the models provided support for proponents of climate change policy looking for evidence of increasing severity of weather events and support for the use of insurance as a means to adapt to climate change. Legislators heard claims that this 'new' perceived hurricane risk threatened the economy and conflicted with public policies to sell homes to those with lower incomes (Subcommitte on Consumer Credit and Insurance 1993).

Federal Policy Encourages Rapid Real Estate Development

Changes in the national economy invited different economic theory to guide federal economic policy. With these changes, policy makers fueled real estate development booms on several instances and reallocated the associated risk to different populations. John Maynard Keynes, an economist well known for his work on risk and uncertainty, reflected on the global experience with the Great Depression of the 1930's. He argued that the future presented unknowable fluctuations in economic activity and government responsibility for this uncertainty alleviates public hardship (Keynes 1937). His perspective, better known as "Keynesian Economics," influenced the formulation of Franklin D. Roosevelt's New Deal. The New Deal encompassed many policies that stimulated economic activity by spreading the associated risk amongst the national people. As part of the New Deal, FDR created the Federal National Mortgage Association (Fannie Mae) as a means to transfer the risk associated with mortgage lending from the banks to the government. The policy encouraged lending to a wider segment of the population and facilitated growth in the real estate sector of the economy especially, after the return of soldiers from World War II and the rapid population growth from the 1950's "Baby Boom" (Kennedy 2009).

Also during the 1930's, the insurance industry began creating policies that offered multiple peril coverage under a single rate. In October 1938, the insurance industry began offering the "Extended Coverage," a single rate policy that covered several perils including riot and all forms of windstorm, which in turn included hurricanes. Considering it a luxury, few purchased the Extended Coverage policy (Lecomte and Gahagan 1998). In September of the same year, the Great New England Hurricane caused extensive damage along the northeastern seaboard. With their new obligations to national lending policies banks made Extended Coverage a mortgage lending requirement. This married insurance coverage to Federal housing and economic policy goals.

During the 1960's, the Federal government first experienced difficulty in maintaining the availability of insurance as a means of maintaing economic stability in real estate. Several hurricane landfalls and urban riots (e.g. Liberty City Riot of 1968) during the late 1950's and 1960's led many insurers to withdraw from urban areas. Without an insurance presence, policy makers found it difficult to rehabilitate affected areas. A presidential committee charged with evaluating the situation concludedthat "Communities without insurance are communities without hope" (US Government 1968). By the end of the decade, policy makers concerned themselves with the rapid decline of many urban areas- a policy problem more commonly known throughout the 1970's and 1980's as Urban Decay or Urban Blight.

To address conflict over responsibility for the risk associated with growth, change, and decay in the nation's urban areas, the Federal government signed into law the "Compilation of the Housing and Urban Development Act of 1968[14]. The Act reallocated risk to different populations, moving some of the risk associated with real estate development to private industry, to the states, and to the federal government. For example, federal policy makers privatized Fannie Mae moving its risk, including debt, from the federal government to private industry. Policymakers created a federal reinsurance program for riot loss to encourage states to create residual markets that ensured continued public access to the necessary insurance required for a mortgage (i.e. windstorm). The legislation called these residual markets FAIR plans- Fair

[14] PL 90-448

Access to Insurance Requirements[15]. As well, the Federal government created the National Flood Insurance Program (Committee of Banking and Currency 1968). These two policies spread the risk of riot and flood associated with economic policies regarding real estate across the American population. However, state residual markets for windstorm ensured that state populations maintained the windstorm risk.

By 1970, nearly two thirds of Americans lived in owner occupied homes (Kennedy 2009). The federal government recommitted to a real estate centered economy and pushed to further expand mortgage lending with the creation of the Federal Home Loan Mortgage Corporation[16] (Freddie Mac). But over the decade, the economy demonstrated significant inflation, energy and commodity price fluctuation, market volatility and unemployment leading to a decline in real estate and associated industries. The erratic behavior of the economy, not experienced since WWII, caused the federal government's favorability of Keynesian economics to wane. In his presidential nomination speech, former President Ronald Reagan framed the nation's economic struggle as one of an "overgrown and overweight" federal government. He viewed the cost of spreading economic risk over the entire national population as unacceptable. With his election in 1980, federal policy used economic ideas developed by Milton Friedman and the "Chicago school of economics" as guiding principles for federal economic policy throughout the 1980's. Friedman had an ideological sentiment of a free society and maintained that a business had no social responsibilities. He went so far as saying that business men who believed otherwise "are unwitting puppets of the intellectual forces that have been undermining the basis of a free society these past decades (Friedman 1970)." Much of Friedman's scholarly work rested on utility theory and promoted consumers as rational decision makers- meaning that

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[15] Many states still have FAIR plans though the riot reinsurance program expired in 1983.

[16] PL 91-351

decision makers have the capability and foresight to weigh all costs against benefits associated with choices (e.g. Friedman and Savage 1948).

Consequently, federal policymakers initiated a program of extensive 'deregulation' and decreased intervention of government in managing risk associated with economic policies. Deregulation of the savings and loans industry enabled it to begin lending to commercial real estate developers. Policymakers revised the federal income tax code encouraging the use of real estate as a tax shelter. Combined, the two policies fueled an increase in real estate development and sales throughout the nation, which in turn fostered the growth and development of the mortgage bond market (Lewis 1989). However, the savings and loans industry lacked experience in commercial real estate and lent to "developers who built poorly conceived and in many cases poorly built projects" (Cumming 2006). The real estate and building boom quickly ended around 1986 due to, at least in part, another change in the tax code discouraging use of real estate as a tax shelter and a subsequent financial crash of the savings and loans industry (Cumming 2006).

Florida's Political and Economic Characteristics Support Development Along the Coastline

The northern and southern development of Florida took place at differently times and by different cultures with different politics. The early 19th century Florida economy relied heavily on plantation farming and slave labor. State policy makers created the initiative to drain the Everglades making the land more suitable for agriculture and real estate development (Florida Department of Environmental Protection 2009). In 1861, Florida joined the Confederate States of America and during the Civil War the Confederate Army used the state's extensive coastline for supplying goods to region. Following the conclusion of the Civil War, Florida gained re-admittance to the United States in 1868, but maintained social and political characteristics of the confederate south with much of the population concentrated near the Georgia border (US Census 1995).

Towards the end of the 19th century, Henry Flagler, a resident of Ohio and a primary investor in Standard Oil, expanded his Florida East Coast Railway south towards Miami. The railway fostered growth in population, tourism and the legendary 1920's Florida land boom in the southern part of the state. A Miami politician at the time observed that upon the arrival of the railroad in 1896, "it seemed that the flood gates were opened and people came from everywhere" (Williams and George 1995). Those from the northeast, primarily New Yorkers, came to settle in the southern part and shared the social and political characteristics traditionally associated with the Civil War era "Union." The rapid population growth in South Florida by those with contrasting values to the northern part of the state caused numerous difficulties in government, including voter suppression (e.g. US. presidential elections of 1876, 2000, and 2012) and misrepresentation of the electorate[17]. Even today, the significant differences in cultural characteristics between South Florida and the rest of the state foster a mutual resentment between the two.

During the 1920s and 1930's, hurricane landfalls facilitated change in real estate development in the state. A loss of trust in real estate and land developers caused the Florida land boom to dwindle by 1925. But the destructive Miami Hurricane of 1926 and the deadly the Okeechobee Hurricane of 1928 ended the land boom by revealing the region's propensity for environmental extremes (Blake and Gibney 2011; Cumming 2006). In the midst of the Great Depression, little real estate development took place in the state with the exception of Miami Beach where real estate developers built hundreds of Art Deco style apartment buildings

[17] Swann *v.* Adams 385 US. 440 (1967)

(Cumming 2006). In 1935, the Labor Day Hurricane destroyed much of Flagler's railroad leading to The Florida Keys. The company created to own and manage the railroad sold the portion of the railroad running through The Keys to the state. Eventually, the state turned the existing infrastructure into a scenic roadway known as the Overseas Highway. The new roadway enabled people to visit the area more easily in their own vehicle and this encouraged real estate development in the area.

As Florida population grew over the 20th century, hurricane losses created instability in the insurance market that threatened the state's economy. Florida remained sparsely populated in the early 1900's (Hobbs and Stoops 2002), but by mid-century, Florida population and housing grew dramatically due to the post World War II baby-boom and New Deal public policy enabling easier access to mortgages (Kennedy 2009). Real estate developers subdivided large swaths of land creating housing developments (Cumming 2006). In the midst of this building activity, several hurricane landfalls and subsequent losses caused insurance market instability in some areas of the state, mainly Monroe County. In response Florida legislators created the Florida Windstorm Underwriting Association (FWUA), a residual market for wind coverage in 1970. Legislators created the policy at the same time that federal policy makers encouraged the creation of state residual markets or FAIR plans by offering federal riot reinsurance. Florida never purchased the reinsurance and legislators did not create the FWUA as a FAIR plan (Fritzel 1982).

During the 1980's several international, federal and economic events interacted to change the local Miami economy and promoting greater population density and investment in luxury real estate. Drug smugglers used Florida's vast coastline to grow a cocaine trade and the Miami-Columbia route accounted for 80% the annual US cocaine business (Corben 2006). The illicit trade infused the South Florida economy with cash affecting the economics of the region. One expert explains,

> Drugs destroy a community when you're dealing with street level. When your talking about drug dealing on a level where major drug dealers are living here and vacationing here, they're buying homes, laundering their money and so forth, that kicks up the economy of a city or of a community (Corben 2006).

The drug trade created a demand for goods that supported a luxurious lifestyle with high incomes including, real estate, cars and clubs. In 1980, Cuba's president, Fidel Castro, permitted nearly 120,000 Cubans to immigrate to the United States from the port in Mariel, Cuba. Fifty percent of those immigrating during the "Mariel Boatlift" settled permanently in Miami increasing the labor force by 7% (Card 1990). These changes in Miami's socioeconomics coupled with federal deregulation policy, changes to the federal tax code, and encouragement to revitalize neighborhoods created an explosion in condominium development, known as "Condomania" (Cumming 2006).

Demographic analysts expect the pattern of Florida's population growth to pose challenges to the state. During the 20th century, Florida's population grew by 3,000% to become the third most populous state in the nation with over 10 million people (Hobbs and Stoops 2002). Between 1990 and 2000, the Miami metropolitan area grew by 23.5%, with Miami-Dade County becoming the most populous county in the state with about 2.5 million people (Florida Legislature Office of Economic and Demographic Research 2011a). Throughout the coming decades, the state's population analysts expect the population to continue to increase, albeit at a slower pace. Economic researchers express the slow pace of population growth as a challenge for the state because "[p]opulation growth is the state's primary engine of economic growth, fueling both employment and income growth" (Florida Legislature Office of Economic and Demographic Research 2011b). Yet at the same time, growth in employment opportunities does not keep pace with population growth creating concerns that as the state's working age population grows so too will unemployment (Florida Legislature Office of Economic and Demographic Research 2012a, p. 8).

Insurance Industry Priced the Hurricane Risk to Maintain Competitive in the Market

Insurers long considered market factors when pricing the hurricane risk. In the midst of World War II, the Supreme Court overturned a 19th century ruling[18] excluding insurance as an act of commerce and immune to federal antitrust regulation and instead declared that "Congress did not intend that the business of insurance should be exempt from the operation of the Sherman [Antitrust] Act[19]." The ruling enabled Congress to regulate insurance directly but it chose not to do so by enacting the McCarran-Ferguson Act[20] in 1945. The Act put into place a brief moratorium during which Congress directed the state governments to establish sufficient regulation overseeing the insurance industry operations in their state. State created legislation newly enabled insurance companies to write coverage for multiple lines of business. However, the availability of multiple line policies did not in and of itself create demand for them. As one insurance executive described it,

> It is argued that there is no public demand for these broad policies. It is equally true that insurance has never been sought; but has been sold by the insurance companies. As better policies were developed endeavor was made to interest the public in these broad forms of protection" (William D. Winter cited in Hunt 1962).

The ability to create multiple line policies allowed for the industry to eventually create the "homeowners" insurance policies that offered multiple line coverage at a quantity discount. The policies provided coverage for the hurricane risk because it included Extended Coverage. Insurers introduced the first Homeowners policy to the market in 1950- at the same time that

[18] Paul *v.* Virginia 75 U.S. 168
[19] United States *v.* South-Eastern Underwriters Association 322 U.S. 533
[20] 15 U.S.C

Parents of the Baby Boomers were taking advantage of New Deal era mortgage lending policies and the real estate development grew throughout the nation. Because banks made Extended Coverage a mortgage lending requirement new homeowners actively purchased the homeowners policy. But within the insurance industry, the homeowners policy remained "controversial" and the package discount unwise (Hunt 1962). Some objected to the discount because insufficient data history and conflicting opinions in the meteorology community suggested significant uncertainty about the potential frequency and severity of hurricane loss. A 1959 excerpt from the *Proceedings of the Casualty Actuarial Society* describes the concern,

> … in states exposed to hurricanes, the 10-year loss experience may have an abnormal or subnormal number of such storms, and even longer term weather studies make it difficult to establish the normal frequency of hurricanes. The problem is further complicated by the conflicting views of weather men on the relative bearing on trends of sunspot cycles and longer term climatic changes (Longley-Cook 1959).

But, insurers did not have any practical means by which to include these early meteorological theories nor was there much demand to do so because the popularity and profitability of the homeowners policy diminished concerns about properly measuring the hurricane risk (Hunt 1962).

Even as information on hurricane losses collected over the decades, insurers actively priced the hurricane risk with consideration for market competition. For locations subject to catastrophic hurricane loss, the actuarial literature advised in the actuarial literature that ratemakers should price the windstorm portion of the homeowners policy using a long-term historical average of at least 20 years separate from the standard 5-years used to price the rest of the homeowners policy (Walters 1974). In a review of the actuarial literature, (Chernick 1998) writes that since Walters' 1974 paper, the matter of pricing the windstorm risk did not appear again until Karen Clark introduced catastrophe models as a means to estimate the hurricane risk and discuss the consequences and management of "what-if" and 'worse case' catastrophe scenarios (Clark 1986). Outside of the scholarly literature, research demonstrated the possibility of hurricanes losses over $10 billion (All-Industry Research Advisory Council 1986). But, the insurance industry met catastrophe model advocacy with little interest (Bailey 1999; Lewis 2007) because a lull in hurricane landfalls during the 1970's and 1980's and rapid real estate development encouraged insurers to continue driving down the overall cost of the homeowners policy and its included catastrophic coverage.

Measurements of Florida's Hurricane Risk Gained 'New' Political Significance

In 1992, several events culminated to create political importance in the measurement of Florida's hurricane risk accepted for pricing insurance. During the 1980's, scientific endeavor made atmospheric research a prominent concern and interest developed in the role of global ocean-atmosphere circulation in influencing atmospheric phenomena such as North Atlantic hurricane activity (e.g. Gray 1984). Scientists used findings in ocean-atmosphere interactions to develop seasonal hurricane predictions (Camargo et al. 2007). Alongside this work, political concern grew about the risks presented by increases in global average temperatures caused by increased concentrations of greenhouse gases in the atmosphere. Computer modeling facilitated the creation and testing of scientific hypotheses about changes in current environmental hazards and the creation of new ones. In Congress, legislators organized hearings to address the,

> growing scientific concern that by the next century, the temperature of the earth's atmosphere may increase to a level unmatched in thousands of years… This global warming may lead to rising sea levels, changing rainfall patterns, and greater extremes in weather (Sen. J. Bennett Johnston, Senate 1987).

Global warming or climate change risk garnered great political importance and began appearing in Presidential candidacy debates in 1988[21] (Revkin 2012). When international policy makers established the United Nations Framework Convention on Climate Change[22] (UNFCCC) in June 1992 climate change became a prioritized international political and scientific matter.

Two months later in August 1992, Hurricane Andrew made landfall just south of Miami, FL causing ~$16 billion (1992 $) in insured losses. Shoddy construction led by the savings and loans industry throughout the 1980's caused losses 25- 40% greater than generally expected (Bailey 1999; The Miami Herald 1992). Of the 371 insurers reporting losses from Andrew (cited in Pielke and Pielke 1997, p. 176), nine companies became insolvent as a direct result of the storm. Assessments caused a tenth company's insolvency (cited in Lecomte and Gahagan 1998). Losses exceeded the resources of the Florida Insurance Guarantee Association (FIGA) prompting the sale of a $500 million municipal bond- a response considered a "win-win all around" (Sen. John Grant quoted in Bailey 1999). Even still, the sudden instability in the insurance market led to an inability to obtain Extended Coverage, which in turn caused rapid deterioration of Florida's economy. As one insurance representative explained to me, "Well essentially what happened, Hurricane Andrew hits and the economy of this state [Florida] collapses. And when I say collapses I mean it completely shut down" (Insurance Industry Representative A 2012).

The insurance industry regarded the loss as an indication for a need to increase rates in a market that had previously driven rates down due to market competition or poor ratemaking practices (Bailey 1999). For some time prior to the event, in order to remain competitive insurers writing homeowners in Florida accepted an unprofitable insurance side of the business

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[21] The topic has been discussed in every presidential election since 1988.
[22] The UNFCCC eventually produced the contentious Kyoto Protocol.

because they were doing well on the investment side of the company (Bailey 1999). During Congressional testimony, one insurer explained that prior to Hurricane Andrew, market conditions led insurers to become "fat, dumb, happy" (Subcommittee on Consumer Credit and Insurance 1993). J.W. Greenberg, an executive of the insurance company AIG, advised the insurance industry that Hurricane Andrew presented "an opportunity to get price increases now" (Garcia and Satterfield 1992).

But state regulators required a justifiable estimate of the risk to enabled insurers to raise rates. Just prior to the Andrew's landfall, Karen Clark, a pioneer in catastrophe modeling, issued a modeled $13 billion loss estimate from the storm. At first, the estimate affronted insurers but after the storm they viewed the prediction as a success because it was closer to Andrew's realized loss than the industry's existing estimates (Lewis 2007; Grossi et al. 2005). This single prediction, considered a success, garnered great industry support for the use of catastrophe modeling to provide justifiable estimates of the hurricane risk.

The Florida' legislature, insurance commissioner[23], Tom Gallagher, and public met the request for substantial rate increases based on modeled estimates with a great deal of resistance. Gallagher argued that the industry's long-standing poor assumptions about Florida's hurricane risk and disregard for growing exposure should not be the immediate problem of policyholders. He reportedly told the private insurance industry that,

> I'm not going to let you raise insurance rates. In fact, I'm going to hold your feet to the fire and make you crawl back up the hill to profitability over a period of several years. The consumer in this state is not going to be saddled all at one with the economic impact of your mistakes as long as I am the Commissioner (Tom Gallagher quoted in Bailey 1999, p. 39).

[23] At the time of Hurricane Andrew, the insurance commissioner was an elected position.

The Florida public and policy decision makers viewed insurers new measures of hurricane risk as politically unacceptable and a threat to the economic well being of the state.

Meanwhile, reeling from a collapse in real estate and the savings and loans crisis, the Federal government passed the Federal Housing Enterprises Financial Safety and Soundness Act of 1992[24]. The act directed the government-sponsored enterprises, Fannie Mae and Freddie Mac, to expand mortgage lending to individuals and families with lower incomes that met affordable housing criteria (Committee on Oversight and Government Reform 2009). Federal mortgage lending goals clashed with insurers' heightened perception of hurricane risk caused by catastrophe model estimates. As a result, insurers' demands for rate increases or market withdrawals "triggered an insurance crisis of unprecedented size and scope," (Rep. Joseph Kennedy II Subcommitte on Consumer Credit and Insurance 1993) because unavailability of affordable property insurance covering windstorm threatened the success of new federal mortgage lending policies. Before the US Congress, a representative from the real estate industry claimed the new conception of hurricane risk and increasing cost of windstorm insurance was impeding economic prosperity,

> **Rep. Jim Bacchus** (D-FL)**:** So I hear you saying that this [cost of insurance] is costing a lot of young people a chance to purchase that first home or a lot of others a chance to move up in the home market. In doing so it's affecting our ability to create economic growth, this is costing us jobs?
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> **Tim McWilliams** (real estate broker): Yes, it costs us jobs throughout the market, all the way from construction, all the way through real estate, banking (Subcommittee on Consumer Credit and Insurance 1993).

The controversy alerted Congress to a "homeowners insurance crisis" and legislators cited the "availability and affordability" homeowners insurance as a national problem (Subcommitte on

[24] PL 102-550

Consumer Credit and Insurance 1993; GAO 1994) that threatened the ability to obtain and maintain a mortgage.

In response to the economic threat of insurance industry instability due to catastrophe model risk estimates, the Florida legislature expanded the state's residual market for wind by allowing accessibility of the FWUA to grow and creating the Florida Residential and Commercial Joint Underwriting Association (JUA) and the Florida Hurricane Catastrophe Fund (FHCF). Legislators also created the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM), a regulating body to control the science modelers used to estimate Florida's hurricane risk. The JUA provided multi-peril homeowners in all areas of the state and wind in areas not eligible for the FWUA (Deffenbaugh 2002). The FHCF helped to control the cost of insurance by providing reinsurance[25] to Florida's windstorm insurance market including the FWUA and JUA. Catastrophe model estimates also affected hurricane risk perceptions in the international reinsurance industry and the administrators of the FHCF could offer reinsurance at a price that reflected a different measure of risk than that available on the reinsurance market. According to Bailey (1999, 142), at the time of the creation of the FHCF, the Department of Insurance, the Legislature, and the insurance industry "were hopeful" that before the state experienced another hurricane that tested Florida's new insurance system, the Federal government would instate a reinsurance program backing the FHCF[26].

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[25] Many people describe reinsurance as insurance for insurers. The international reinsurance industry operates largely unregulated by any government.

[26] By the end of 1994, the FWUA had increased in size by 198% due to changes in areas eligible for coverage and decision makers vocalized concern about the JUA's fiscal conditions and aggregate exposure (Lecomte and Gahagan 1998). At the same time, the distaste for Keynesian economics that appeared in the 1970's and during deregulation of the 1980's created an acute concern about Federal involvement in managing risk. Economic interests encountered the cost of social programs, including disaster relief (Bipartisan Task Force on Funding Disaster Relief 1995), with a contemptuous fervor over the issue of "moral hazard" (Baker 1996).

As legislators attempted to slow the pace that insurance rates reflected insurers' rapidly intensifying perception of the hurricane risk, atmospheric scientists measured increases in the Atlantic basin hurricane activity. Political interests conflated the increase with climate change. In 1995, the Atlantic Basin exhibited above average hurricane activity (Goldenberg et al. 2001). Scientific review of the hurricane activity data revealed the year as one of the most active in the 50 years prior and followed on the heals of the "remarkable inactive" years of 1991-1994 (Landsea et al. 1996). The sudden increase in activity, scientific hypotheses about the effect of climate change on hurricanes, and the record losses of Hurricane Hugo[27], Hurricane Andrew, and other weather related events (Changnon et al. 1997) led to the widespread belief that "hurricanes… have become increasingly frequent and severe over the last four decades as climatic conditions have changed in the tropics" (Bipartisan Task Force on Funding Disaster Relief 1995). In response to the political connections made between climate change and hurricane losses, the global reinsurance industry "joined forces" (UNEP 2011) with public policy makers in the international climate change policy process, particularly through the UN Environment Programme Financial Initiative (UNEP FI). The relationship seeks "to firmly anchor insurance expertise and components into any global adaptation mechanism under the international climate-change regime[28]" (Climate Wise et al. 2010). Despite political efforts to

[27] In 1989, Hurricane Hugo made landfall in South Carolina causing $7 billion in damage (1989$; Blake and Gibney 2011)

[28]Pielke (2010) details the UNEP's Intergovernmental Panel on Climate Change (IPCC) systematic mischaracterization of cause and effect relationships between natural disaster economic losses and natural disaster events. The mischaracterization has important implications because the IPCC and the UNEP FI both work through the UNEP to establish global policies with one (i.e. IPCC) identifying, characterizing and quantifying risk and the other (i.e. UNEP FI) pricing risk. In turn, the IPCC has encouraged global financial markets to make the impact of climate change on disaster losses to become 'real'[28] in so much that people believe that insurance pricing reflects a real or true measure of risk. So, even though increases in disaster losses cannot yet be attributed to scientifically observed changes in the climate, international insurers and

make a connection between hurricane disaster losses and climate change, socioeconomic research demonstrated that increasing inflation, wealth, and population since the 1950's primarily drove the observed increase in the size of hurricane losses (Pielke and Landsea 1998; Pielke et al. 2008).

In so much that people believe insurance pricing reflects some true measure of hurricane risk, larger or smaller estimates support some public policies over others. Two main conflicts arise between political policy efforts and modeled estimates of hurricane risk. First, catastrophe models that produce large estimates of hurricane risk support observation that increasing population and wealth along the coasts leads to rising disaster losses. But the pricing that reflects the risk of building along the coast conflicts with federal public policy to grow the national economy with real estate development. Second, select financial and environmental interests view large estimates of hurricane risk produced by catastrophe models as consistent with beliefs that climate change exacerbates hurricane losses. Pricing the risk accordingly makes the threat of climate change 'real' to society because the cost of social behavior becomes more expensive. But, pricing that reflects climate change risk conflicts with socioeconomic research demonstrating that a climate change signal cannot as of yet be detected in the loss data beyond that caused by changes in society. Overall, how insurers choose to measure Florida's hurricane risk has implications for the public policies that follow.

At the turn of the century, real estate policy again came into conflict with measurements of the hurricane risk and Florida legislators restructured the state's residual market for windstorm insurance. In 1999, based on the average of several catastrophe models Florida regulators

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policymakers push insurance as a means to adapt to climate change risk both perceived as current and predicted in the future. Recent work argues regardless of the existence of a connection between observed climate change and experienced losses, insurance as a policy for climate change adaptation is illogical (McAneney et al. 2013) approved a 96% rate increase for the FWUA (Deffenbaugh 2002). By 2001, Fannie Mae encouraged mortgage lending to those with minimal to no income by offering zero down payment loans and this fostered more real estate development (Committee on Oversight and Government Reform 2009). In 2002, on the background of a housing boom based on mortgaged lending to low income families and rising insurance rates due to a perceived increase in the Florida hurricane risk, the Florida legislature passed the Windstorm Bill (SB 1418) into law. The law merged the FWUA with the JUA and renamed the JUA as the "Citizens Property Insurance Corporation" (Citizens).

Conclusion

A long human history of changing public policies and knowledge caused acceptable practices for managing risk to evolve. Persistent support for a nation al economy centered on real estate development encouraged concentration of population and wealth in Florida. But Florida too has social and political uniqueness that supports this trend and in particular, supports development along the coast. Throughout most of the US development history, insurers played an active role by offering policies that support economic policies. In addition, competition for market share led insurers to overlook catastrophic hurricane loss potential in their pricing of the homeowners insurance policy- a policy intimately connected to the success of US real estate policy.

The 1992 catastrophic loss from Hurricane Andrew coincided with a grand federal initiative to amp-up real estate development and international efforts to address climate change concerns. Catastrophe models became a centerpiece for estimating risk and establishing insurance rates, but their estimates imply the need for rethinking public policy. On the one hand, larger estimates conflict with traditional means of wealth creation with real estate development.

On the other hand, larger estimates support climate change public policy but conflict with socioeconomic research findings. The newfound political importance in measuring the Florida hurricane risk has changed the public debate of how best to manage the risk into one about how best to measure the risk. Consequently, current political discussion avoids discussion of options to reconcile conflict between economic policies that grow risk and the demand for affordable insurance.

CHAPTER 4: Literature Review

Introduction: Without a Single, Shared Understanding of Risk Politics Plays an Integral Role in Defining Risk

This chapter presents the background scientific literature supporting the direction of inquiry and the arguments made in the following chapters. It follows, I believe, a linear progression of building blocks where each new section builds on ideas presented in the previous. The chapter has five sections that bring the readers attention to specific areas of research used to orient my dissertation work. A sixth section pieces together the literature to suggest an orientation for understanding insurance in the context of public policy. I do not develop the discussion completely and note the need for further research and justification. However, I find it useful here as it represents the way that I have come to understand public debates about the use of insurance as public policy. The final section concludes the importance of understanding insurance in the context of the literature on public policy making and the potential to help improve understanding for 'how insurance works.' I use several terms throughout the dissertation that mean different things to different people. For clarity, I use italics to designate these terms and define them in this chapter. For reference, the reader can find the defined terms in italics also in Table 1.

In the first section, I discuss some key aspects of the literature on risk and implications for scientific knowledge. As a type of uncertainty, people perceive risk subjectively based on their cultural beliefs, feelings, analytical processes, etc.; and so, people disagree as to what the risk 'is' (Douglas and Wildavsky 1982). The section develops a differentiation between aleatory uncertainty and epistemic uncertainty (Stewart 2000)- what I call ignorance. Though risk often takes the form of feelings (Loewenstein et al. 2001; Slovic et al. 2004), for the purposes of this dissertation which focuses on matters of insurance, I use the term 'risk' to refer to a measurable uncertainty concerning loss (Knight 1921; Keynes 1937; Mehr et al. 1985; Bernstein 1996). Changing, competing and conflicting knowledge complicates efforts to reach a shared meaning of risk (Oreskes 2000; Latour 1987; Sarewitz 2004). Because scientists actively debate the state of knowledge, measurements of risk are subject to debate.

Second, I present the scientific literature discussing trends in hurricane losses and hurricane behavior. The subset of research focused on understanding hurricane frequency and intensity matters most for understanding disaster losses because the most intense hurricane (Saffir-Simpson Categories 3-5[29]) causes about 85% of US hurricane losses (Pielke et al. 2008). Since the substantial increase in hurricane caused insured losses beginning in the late 1980's, scientists have actively researched and debated the evidence of and cause for observed trends (or lack thereof) in the hurricane data. Underlying these debates, researchers focused on a key issue: can trends in hurricane behavior or losses be attributed to anthropogenic caused climate change? The conflict that arose from this question serves as an example of the argument made in the previous section, namely that disagreement about knowledge leads to disagreements about risk. The review of the literature on hurricane behavior and losses provides premise for the research I conducted as part of Chapter 6. It also provides some context for issues, discussed in Chapter 7 that arose around catastrophe modeling in 2006.

The third section considers the use and acquisition of facts for decision making, the process of which can, if taken too far, impede the democratic process (Pielke 2007). First I provide several necessary definitions for achieving communication with the reader on matters of

[29] The Saffir-Simpson Hurricane Winds Scale rates hurricanes based on a 1-minute sustained wind speed. The categories are as follows: Category 1, 74- 95mph (64-82 kt); Category 2, 96-110 mph (83-95 kt); Category 3, 111-129 mph (96-112kt); Category 4, 130-156 mph (113-136 kt); and Category 5, 157 or greater (137 kt or greater)

politics and policy making before moving onto a discussion on inquiry and decision making. Following in the philosophical tradition of pragmatism my dissertation works under the premise that individuals assimilate facts relevant for making a choice of a preferred course of action that achieves a preferred outcome (Dewey 1910). However, different perspectives in society may not and often do not, share a view of preferred outcomes of courses of action and therefore, develop different interpretations of the problem at hand. Democracy thrives on the ability of these different 'problem definitions' to come into public debate. The section ends with two examples of ways that the democratic process breaks down, the politicization of science and the scientization of policy (Weingart 1999; Pielke 2007). As well, I identify a the distinction of a democracy and technocracy as two competing decision making processes (Jasanoff 1990) to describe conflicting perspectives used for discussion in Chapters 7 and 8.

The fourth section considers the potential for interests to use computer simulation models as political tools. I first describe some of the literature on political symbols and their use by interests to motivate collective action (Rocherfort and Cobb 1994). In the literature on science and technology studies (also referred to as, science, technology and society and more broadly, the sociology of knowledge), scholars use the term boundary objects as something akin to political symbols used to communicate between conflicting areas of knowledge (Star and Griesemer 1989). Computer simulation models serve as useful tools for communication as one need not understand how they work in order to make use of the output (e.g. Carlile 2004). Still, the models represent select scientific ideas often hiding the conflict amongst scientists to the warrant of those ideas as knowledge and in this way can act as an indicator of power. To assimilate the literature on political symbols, boundary objects, and knowledge conflict, I use the term political tool to refer to the use of models in certain situations where participants seek to influence decision making by their use.

The fifth section discusses the role of catastrophe models, a type of computer simulation model, in affecting perceptions of risk insurability. Though insurance can only manage risk as measurable uncertainty, opinions differ as to where some information falls between the realm of knowledge or ignorance. This poses challenges for different perspectives to come to a shared conclusion on a particular risk's insurability (e.g. Charpentier 2008; Kleindorfer 2010). Catastrophe models, as the main conduit for scientific information about risk (Grossi et al. 2005) play a significant role in insurers perception of a risk and therefore its insurability. Judging changes in perception in relation to insurability criteria provide a means to understand where and why public policy makers may find success or struggles in implementing an insurance regime. The section ends with an overview of nine criteria of insurability (Berliner 1982).

The sixth section assimilates the literature into the beginnings of a framework for studying insurance problems in the context of public policy making. Understanding insurance in this context lends to greater understanding of much of the public debates over insurance and insurance rates. I provide this outline within this chapter because it represents the theoretical perspective that I use for the dissertation work.

The conclusion suggests that the importance of understanding insurance for public policy as a process of decision making and negotiating about a shared understanding of risk lay in assuring a healthy democratic process. Insurers' self-proclaimed problem that 'most people do not understand how insurance works' (e.g. Wells 2009; Johansen 2003; Lind 2013) implies a public need for understanding outside of the technical expertise and jargon. While the implementation of insurance public policy will remain highly technical, decisions about where insurance is appropriate for use offers opportunities for public participation.

Risk and What We Believe We Know

When one or more expected future outcome represents a threat then the future contains risk (Fischhoff et al. 1984a, p. 4). In this way, risk foreshadows the future; it is predictive. Risk exists in perception and feeling regardless of calculable abilities (Loewenstein et al. 2001; Slovic et al. 2004). The definition of *risk* used here is "uncertainty concerning loss" (Mehr et al. 1985, p. 19). This definition comes from the academic insurance literature and I believe it amenable to the discussion throughout and encompassing of definitions of risk in various disciplines. The definition also provides for a further discussion on uncertainty and the movement of ideas between different realms of uncertainty, namely risk and ignorance, and what this means for scientific knowledge. I use a definition of uncertainty that facilitates discussion about decision making. Throughout this dissertation, "*uncertainty* means that in a particular situation more than one outcome is consistent with expectations" (Pielke 2007). Though the role of uncertainty in decision making is discussed later. In this section, I discuss how uncertainty is constructed and in some cases, characterized as risk.

Economist Frank Knight (1921) argued that scientific inquiry offered a path towards measuring uncertainty so as "to predict the future for the purpose of making our conduct intelligent" (p. 16). In turn Knight pulled apart risk from the more encompassing idea of uncertainty on the basis of knowledge, "It will appear that a measurable uncertainty, or 'risk' proper, as we shall use the term, is so far different from an *unmeasurable* one that it is not in effect an uncertainty at all" (p. 20; emphasis in original). However, Knight had a very specific "dogma" regarding the abilities of science to produce knowledge that followed a linear process, "that the world is made up of *things*, which, *under the same circumstances*, always *behave in the same way*" (p. 204; emphasis in original). Thus, Knight seemed to believe that science offered an objective truth which in turn could be considered something different form uncertainty. For Knight, risk represented something known differentiated from the unknown.

John Maynard Keynes (1937) challenged the idea that, scientific inquiry or not, knowledge could be fundamentally separated from uncertainty. He viewed knowledge as a framework of variable ideas about how the world works and will continue to work, stating that "knowledge of the future is fluctuating, vague and uncertain" (p. 213). He thereby challenged the idea that in situations involving the open, complex systems, "there is no scientific basis on which to form any calculable probability whatever. We simply do not know" (p. 214). In turn, he relegated idea of risk as a measurable uncertainty to closed systems such as a game of roulette and left much of human decision making to fall outside of the realm of risk into uncertainty. Nonetheless, Keynes explained, that despite incomplete knowledge about risk, we make decisions by 1) assuming that the past is a good indicator of the future, 2) assuming our assessment of potential outcomes of the future are complete, and 3) "we endeavor to conform with the behavior of the majority or the average…what we may strictly term a *conventional* judgment" (p. 214; emphasis in original). In making this observation, Keynes points out that decisions about risk have a strong social component whereby likeminded people determine good decisions about risk.

But we don't all fear the same things nor to the same degree. The literature on perception of risk tells that humans use feelings (e.g. dread) and calculated analysis (e.g. probabilities) to evaluate risk with both working in tandem rather than separately (Slovic et al. 2004; Loewenstein et al. 2001). Thus, personal values play an integral role in determining risk acceptability (De Groot et al. 2013). In their seminal essay, *Risk and Culture*, Mary Douglas and Aaron Wildavsky (1982, p. 8), argued that "choice of risks and the choice of how to live are taken together" and therefore "common values lead to common fears (and, by implication, to a common agreement not to fear other things)." Naturally, then, risk assessment by experts and laymen alike, requires a blending of science and judgment, facts and values (Slovic 1999). Though between the two social groupings relevant information for assessing risk differs (Slovic 1987). However, experts and laymen are considerable vast groupings. While I believe it safe to simply say that laymen, or more broadly, the public encompasses a great many cultures this is also the case in regard to "experts" (e.g. Lee 2007; Carlile 2002).

Scientists constitute a particular type of expert, those involved in the "systematic pursuit of knowledge" (Pielke 2007, p. 79). Sociologists, Peter Berger and Thomas Luckmann (1966), argued that all knowledge of reality is "socially constructed" and learned from interaction with society or subsets of society. Through these social interactions, the institution of science gains the legitimacy and authority to define knowledge. Berger and Luckmann's argument at once gives the institution of science power over the domain of knowledge and challenges the ability of scientists to objectively know something without their own social interactions to legitimate their findings as knowledge of reality. Physicist and philosopher Thomas (Kuhn 1996) described scientific endeavor and knowledge as falling into established "paradigms" whereby those

> whose research is based on shared paradigms are committed to the same rules and standards for scientific practice. That commitment and the apparent consensus it produced are prerequisites for normal science, i.e., for the genesis and continuation of a particular research tradition (p. 11).

As a consequence, scientific knowledge is a product of closely-knit communities with likeminded views of relevant studies and findings (Kuhn 1996). All of scientific literature can be understood as rhetoric with each writing having the intent to persuade the reader to accept the argument as knowledge of reality (Harris 1997). Amongst different communities of science, scientists may actively contest the ideas which ought to constitute as knowledge, especially when the ideas fall into the realm of unproveable predictions (Oreskes 2000; Hughs 2012). Kuhn explained that the introduction of new paradigms provided choice of realities, “Like the choice between competing political institutions, that between competing paradigms proves to be a choice between incompatible modes of community life” (p. 94). Which brings us back to Keynes assertion that knowledge is not constant and it is prone to uncertainty. For even amongst those with the legitimate authority to define knowledge competing perspectives exist on how to do so.

As such, the boundary between the known and the unknown has much to do with the values of the one drawing the distinction. However, for ease of communication throughout this dissertation I develop a distinction between types of uncertainty. In science and technology (including insurance) *aleatory uncertainty* is considered a measurable product of chance and random processes (Stewart 2000). This type of uncertainty refers to a defined distribution of possible outcomes for an event with a lack of certainty about the final outcome prior to the conclusion of the event. Probability, variance, confidence intervals and error, to name a few, represent measures of aleatory uncertainty in the scientific disciplines where the confines of an experiment define the system. Because this dissertation focuses on insurance, I use risk to refer to a type of aleatory uncertainty concerning loss. *Epistemic uncertainty* arises from incomplete knowledge of a complex world (Stewart 2000). Keynes described this type of uncertainty when questioning the ability to characterize risk in open systems (e.g. “the price of copper and the rate of interest twenty years hence”). Throughout this dissertation, I call this type of uncertainty *ignorance*. Because science often endeavors to reduce uncertainty about future outcomes in a complex world (Lasswell 1971), scientific predictions though representing aleatory uncertainty also contain epistemic uncertainty. Consequently, risk is subject to debate in situations where perspectives on knowledge conflict.

My distinction between risk and ignorance is different from others, most notably those made by (Wynne 1992). Wynn described four types of uncertainty with risk, uncertainty, and ignorance as three different categorical types (the fourth being indeterminacy). I create the distinction between risk and ignorance for three reasons. First, the discussion about how interests disagree about risk (a continuing narrative throughout this dissertation) is made simpler by two categories. Second, I find no practical difference between Wynne's distinction that uncertainty means, "we don't know the odds" and ignorance means, "we don't know what we don't know." If we don't know the odds we also don't know what we don't know or we are in some way unable to know. If we knew everything to be known, then we would know the odds, and ultimately we could define risk. Finally, in the context of decision making about risk, when one rejects a measured uncertainty concerning loss as constituting risk, one ultimately rejects the underlying assumptions as accepted scientific knowledge and regards those assumptions as still in the realm of the unknown or rather, ignorance.

Attributing the Cause of Hurricane Losses: An example of competing knowledges

In light of the above discussion, the controversy that arose in the scientific community concerning the cause for observed trends in hurricane behavior serves as a good example of the process of competing scientific paradigms and debating knowledge that constitutes risk or remains in the realm of ignorance. I do not develop a discussion on values here and how that attributes to scientists perception of risk. However, Chapter 7 does develop an extensive discussion on the role of values in debating acceptable measures of risk.

Term	Definition
Rate	The insurance rate is the cost of unit of insurance. Without considerations of numerous other cost factors, the insurance rate equals the pure premium.
Risk	Risk can mean a lot of things to a lot of different people. Here I use the definition, “uncertainty concerning loss” (Mehr et al. 1985) and because insurance can only manage measurable uncertainty, risk in the context of insurance means measurable uncertainty concerning loss.
Uncertainty	Decision making often, if not always, confronts situations of uncertainty. In different fields uncertainty has different connotations but for the purposes of decision making it means that “in a particular situation, more than one outcome is consistent with expectations” (Pielke 2007)
Aleatory Uncertainty & Ignorance	I differentiate between two types of uncertainty, aleatory and epistemic (Stewart 2000). Aleatory uncertainty is the measurable product of chance and random process and unique to closed systems though scientists often produce estimates of aleatory uncertainty for open systems. Epistemic uncertainty is a product of incomplete knowledge of a complex world and is unmeasurable. I call this type of uncertainty ignorance.
Policy	A policy is a commitment to a course of action (Lasswell 1971, Pielke 2007). Public policies therefore, are commitments to courses of action for or by the public.
Policymaking	In the context of public policy deciding upon a commitment to a course of action requires group effort. Policymaking therefore, is a process of organized, authoritative decision making (Pielke 2007).
Perspective	Often, those involved in policymaking have conflicting opinions as to the desired policy choice because they have different perspectives leading to different value preferences. A perspective is “a group or individual’s identity, expectations, and demands” (Lasswell and Kaplan 1950). Sometimes, perspectives organize into interests.
Politics	When perspectives involved in the policymaking process conflict, then they engage in politics or a “process of bargaining, negotiating, and compromise” to maximize shared values (Lasswell 1971, Pielke 2007).
Symbol	Symbols provide a means of communication and have a shared meaning for those that share a perspective but often have different meanings for those with differing perspectives. A symbol is an object to index meanings that are not inherent in, nor discernible from, the object itself (Elder and Cobb 1983). In this dissertation I assert that an insurance rate acts as a political symbol for risk.
Political tool	I develop the use of the term political tool to integrate the literature on political symbols, boundary objects, and conflicting knowledge. A political tool is an object that perspectives use as a means to bargain, negotiate and compromise for policymaking in situations where knowledge is contested and controversial. For this dissertation, I argue that catastrophe models act as political tools.

Table 1: Key terms

Over the past several decades, insured losses from natural disasters have increased dramatically worldwide (Munich Re 2012). Between 1980 and 2012, 65% of the world's natural catastrophe[30] insured losses occurred in the United States (Munich Re 2013). Of these losses, hurricanes and tropical storms accounted for 44% between 1991- 2010 (III 2012). Some recent extreme US hurricane losses demonstrate the trend of increasing loss. Making landfall in South Carolina in 1989, Hurricane Hugo was the first natural disaster to cause over a billion dollars in insured losses (Kunreuther and Roth 1998, p. 4). In 1992, Hurricane Andrew resulted in roughly $16 billion in insured losses (1992 $; McChristian 2012). The four hurricanes striking Florida in 2004 collectively caused $33 billion in insured losses; and in 2005, Hurricane Katrina rattled the nation and the insurance industry with $46 billion in insured losses (year of value unstated; Kunreuther and Michel-Kerjan 2009, p. 5).

Florida is susceptible to hurricane landfalls from the Atlantic Ocean. It also boasts a large population and some of the costliest real estate in the nation (Hobbs and Stoops 2002;

[30] I find "catastrophe" as somewhat of a loaded term and different people use the term differently. For example, some in the social sciences suggest that catastrophes may be something "more than just big disasters" (Natural Hazards Center 2009). Florida Congressional Representative Tim Mahoney used the term in the phrase "national catastrophe insurance crisis" either intentionally or unintentionally to describe a particular type of insurance coverage (Subcommittee on Oversight and Investigations 2008). Some suggest that beyond catastrophe there lay something even more tragic, the mega-catastrophe (e.g. King 2005). However, when the insurance industry uses the term it usually, if not always, refers to an event causing losses of $25 million or more. Use of the term in this way began in 1949 and it meant an event with losses of $1 million or more. To account for inflation, the meaning of catastrophe changed in 1983 to mean an event with losses of $5 million (Changnon et al. 1996, p. 22). At some point insurers redefined catastrophe to its present meaning of event with losses of $25 million or more (III 2013a). In my notes, I estimated that this occurred around or by 1999, though, I do not know how I arrived at this year. However, using the logic of adjusting the definition along with inflation, adjusting the $1 million value for inflation using the US consumer price index to the year 2012 suggests that the current measure of catastrophe, using the 1949 definition, should be around $10 million. Using the start date of 1999, inflation adjusting the value of $25 million to the year 2012 suggests a definition of about $35 million (calculations using www.measuringworth.com).

Schwartz and Wilson 2007). As such, Florida contributes substantially to US catastrophe losses. Between 1980 and 2010, Florida accounted for 16.5% of all US insured catastrophe losses (III 2012). As a considerable contributor to US catastrophe losses, Florida also plays a significant role in contributing to global insured catastrophe losses. Based on the data reported here, I estimate that between 1980 to about 2010, Florida, alone, contributed to over 10% of the world's insured catastrophe losses[31].

The time frame for observations of increases in insured hurricane losses coincided with the observation that Atlantic basin hurricane activity had increased since 1995 (Goldenberg et al. 2001) and increased scientific concern of climate change (e.g. the establishment of the Intergovernmental Panel on Climate Change in 1988). Following four of the "quietest" years of tropical cyclone activity on record, Atlantic basin hurricane activity in 1995 was the "busiest" of the previous 50 years (Landsea et al. 1996). Over the subsequent years, atmospheric scientists argued that the Atlantic basin had moved into a period of higher hurricane activity due to variability in the atmosphere-ocean system that made hurricane formation favorable (Saunders and Harris 1997; Landsea et al. 1998) and that they expected the heightened level of activity to persist on the order of decades (Goldenberg et al. 2001). At the same time, others investigated potential effects of anthropogenic climate change on hurricane activity but a review of that literature by Henderson- Sellers et al. (1998) revealed inconclusive results.

The active hurricane seasons of 2004 and 2005 coupled with the considerable social and economic impacts of several major hurricane landfalls, particularly Hurricane Katrina, precipitated a rancorous scientific debate on the implications of anthropogenic climate change on hurricane behavior. In August of 2005, the prestigious scientific journals *Nature* and *Science*

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[31] (0.165 FL Losses)*(0.65 US Losses) = 0.107

published articles that focused attention on the theorized affect of climate change on hurricane increased "destructiveness" (Emanuel 2005) and insurance affordability and availability (Mills 2005). Very shortly thereafter, Hurricane Katrina made landfall near the Mississippi/Louisiana border leading to widespread flooding in the New Orleans area. Some in media (e.g. Kluger 2005) and scientific community linked Hurricane Katrina to the recent scientific literature on climate change and used the event as an example of "how global warming[32] will make hurricanes even worse in the future" (Rahmstorf et al. 2005). In September, several scientists concluded in *Science* that the increase in Atlantic basin hurricane activity since the 1970s was "not inconsistent" with theories about the impact of climate change on hurricanes (Webster et al. 2005).

The National Oceanic and Atmospheric Administration concluded that the hurricane season of 2005 was the most active on record (NOAA 2006). Some scientists, for example (Mann and Emanuel 2006; Holland and Webster 2007), argued that anthropogenic induced climate change directly caused the heightened period of hurricane activity (see also, Trenberth 2005). Still, scientists analyzing the data quality of the historical record continued to challenge these findings by arguing that the data was not of sufficient quality to detect trends in frequency or severity (Kossin et al. 2007; Kossin and Velden 2004; Levinson et al. 2006). The time scales involved for evaluating and predicting hurricane activity (decades and centuries), provided an obstacle for deciphering which camp in the scientific community constituted knowledge, but the implications for future hurricane activity, Vecchi et al. (2008, p. 688) argued, were drastically different and therefore "it is both necessary and desirable to appeal to nonempirical evidence to evaluate which future is more likely." The implication following this Vecchi et al statement is

[32] Global warming and climate change generally refer to the same concept.

that in order for the scientific community to decide the truth about hurricane behavior the members of the community had first to decide which theory they found most desirable in respect to their personal values.

From the perspective of managing hurricane impacts on society, namely economic and insured losses, the issue remained not why hurricane activity had changed but why losses had increased. (Pielke and Landsea 1998) demonstrated that once the losses were adjusted to account for changes in population, wealth, and inflation, the trend was no longer presents. This means that changes in society caused the observed increases in losses from hurricane events, not trends in hurricane behavior. Since then several studies have replicated these findings (Nordhaus 2006; Pielke et al. 2008; Schmidt et al. 2008). Furthermore, investigation into the quality of the historical hurricane data suggested that advancements in the technology of hurricane monitoring caused at least a substantial portion of the observed increasing trend in hurricane frequency, though the multidecadal rise and fall was still evident (Landsea 2007). Changes in hurricane monitoring also brought into question the reliability of detecting trends in hurricane severity in the historical data (Landsea et al. 2006). In 2010, several scientists representing different general perspectives on the matter published a consensus article stating "we cannot at this time conclusively identify anthropogenic signals in past tropical cyclone data. A substantial human influence on future tropical cyclone activity cannot be ruled out, however, and could arise from several mechanisms" (Knutson et al. 2010). Overall, the research considering how society has changed both in its composition and in its technology indicated that if anthropogenic climate change was affecting hurricane behavior it could not yet be detected (Bouwer 2011). Nonetheless, some in the public, media, and the insurance industry continue to point to human-caused climate change as a factor responsible for at least part of the observed increase in hurricane-related economic losses in recent decades (Gillis 2010; Munich Re 2010). Still others attempt to extend the argument even further by linking difficulties with Florida's public insurance regime to climate change induced large hurricane losses (CERES 2012).

Public Policy, Politics and Democracy When Confronted with Uncertainty

The reader needs to know several definitions in order to proceed with a discussion on public policymaking under uncertainty. A *policy* is a commitment to a course of action to achieve goals. In the context of public policy, *policy making* is a process of organized, authoritative decision making and looks towards the future with the intent of reducing uncertainty (Lasswell and Kaplan 1950; Pielke 2007). *Politics* is the process of bargaining, negotiating, and compromise to reach shared goals and becomes a necessary part of policymaking when those involved represent different perspectives about the best course of action or even the problem at hand (Pielke 2007). A *perspective* is a "pattern of identifications, demands, and expectations;" and often similar perspectives organize into interests (Lasswell and Kaplan 1950). In democracies, multiple perspectives seek and exercise power through the process of politics to influence authoritative decision making about policy (Lasswell 1956; Dahl 1998; Young 2002a).

Public policy most often considers complex interactions between multiple open systems so policymakers must make decision under situations of irreducible uncertainty (Hammond 1996). Given that each possible course of action has more than one outcome consistent with expectations, how does a public policy maker make a decision? John Dewey (1910), an American philosopher of pragmatism, argued that in situations that present more than one possible course of action, the decision maker "thinks" and collects information in a process whereby "present facts suggest other facts (or truths) in such a way as to induce belief in the latter upon the grounds or warrant of the former" (p.8; original in italics). Ultimately, the need or want to solve a certain problem establishes an end so that the decision maker's inquiry "is aimed at the discovery of facts that will serve this purpose" and "[e]very suggested conclusion is tested by its reference to this regulating end" (p. 11). This means that the desired policy outcome acts as criteria for the decision maker to judge the relevance of facts available and the desirability of policy options.

A policy problem is a "perceived discrepancy between goals and an actual or anticipated state of affairs" (Lasswell 1971, p. 56). Defining a policy problem is not straightforward. They are outcomes of social processes whereby interested groups form "strategic representation of situations" (Stone 1988, p. 106). Political scientists, David Rocherfort and Roger Cobb (1994, p. 4) describe the means by which public problems come to light,

> The defining process occurs in a variety of ways, but always it has major import for an issue's political standing and for the design of public solutions. Cultural values, interest group advocacy, scientific information, and professional advice all help to shape the content of problem definition. Once crystallized, some definitions will remain long-term fixtures of the policymaking landscape; other definitions may undergo constant revision or be replaced altogether by competing formulation.

Because policy problems often create conflict in ends by multiple perspectives, each perspective's direction of inquiry and assimilation of relevant facts differ. Dewey (1927) built upon this early work on thought to examine public policy problems. He explained that public policy makers cannot assess or resolve a public conflict outside of understanding the historical context and the values and goals that distinguish the different perspectives. Given that public conflict are products of conflicting perspectives with unique systems of facts, the scientific disciplines are unable to provide public policy makers with *the* way forward, but only information about the past and potential for the future. Information alone does not drive decision making as one cannot arrive at a conclusion on the right course of action without preference for outcomes.

Nobel laureate and economist, Herbert Simon, echoed this perspective by arguing that one cannot determine a best means of action without reflection on values- "no *oughts* from *is's* alone[33]." Simon related the ability of multiple perspectives to generate different systems of facts supporting conflicting conclusions to the presence of ignorance in human understanding. Policy makers, he explained, were always faced with a "bounded" conception of reality, "Human beings don't see the whole world; they see the little part of it they live in, and they are capable of making up all sorts of rationalizations about that part of the world" (Simon 1983, p. 96). When values conflict so do rationalizations for appropriate action.

Therefore, from individuals' and groups' value preferences arise policy problems. But each perspective defines the problem differently. Problem definitions function "at once to explain, to describe, to recommend, and, above all, to persuade" (Rocherfort and Cobb 1994, p. 15). Thus, problem definitions always imply a preferred solution. This also means that "[p]olicy choices are always statements of values even if some value positions are so dominant that their influence goes unexamined or so unrepresented that their neglect goes unnoticed" (Rocherfort and Cobb 1994). Value laden choices arise at three points of conflict in the process of defining a problem: whether a problem exists, the best solution to that problem, and the best means of implementing solutions (Baumgartner 1989 referenced in Rocherfort and Cobb 1994).

The expansion of different problem definitions indicates an active democratic political process that incorporates multiple value preferences challenging existing power relationships (Schattschneider 1960). The final policy decision ultimately reveals which interests have

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[33] The "is-ought problem" originated with philosopher David Hume in his *Treatise of Human Nature* (1739)

political power as the policy maker demonstrates choice of those perspectives values over all other (Lasswell 1971; Schattschneider 1960). Political scientist, Robert Dahl (1998), argues that a healthy democratic process is characterized by five specific criteria for the rights of members of the democracy. The first, "Effective Participation" requires that members have the opportunity to make their preferences known to the policy decision makers. The second criterion, "Voting Equality" requires that the votes of members carry equal weight. The third, "Enlightened Understanding" requires that members have opportunities for learning about the policies of consideration, their options, and potential consequences. The fourth criterion, "Control of the Agenda," requires that members have the exclusive opportunity to decide the matters needed addressing which ensures that the democratic process is continuous, the opportunity to change existing policies, and the ability to bring forth policies of concern. The final criterion, "Inclusion of Adults" extends the preceding four criteria to all those members of the democracy, generally the citizens (p. 37- 38). Thus, the democratic process is threatened the state of affairs impedes the successful attainment of one or more of these five criteria.

Throughout this dissertation, I present several instances where the state of affairs threatens the democratic process. For example, the claimed public non-understanding of insurance threatens the democratic process along the criteria of enlightened understanding. I discuss this further below. However, two specific processes threatening the democratic process along the criteria of effective participation and controlee of the agenda need further explanation here because they have a central role in later discussion, particularly in Chapter 8. The first, 'politicization' describes a situation where "those engaged in conflict over alternative courses of action evaluate those alternatives solely according to the gains or losses they provide to a group's ability to bargain, negotiate, or compromise relative to its opponents" (Pielke 2007, 33–34). In this way, means (i.e. the political process) comes to substitute ends (i.e. policy making) and prevents policy making to address the social problem. This prevents sufficient control over the agenda by thwarting policy makers' ability to make decisions about policy or make decisions about policy that directly addresses the public problem. The second, 'scientization' occurs when political power replaces the political debate, a debate about value preferences, with a debate about conflicting science (Weingart 1999; Pielke 2007). Scientization threatens the democratic process by preventing participation of different interests present in the society from participating in a discussion about values (i.e. politics; Pielke 2007) because the debate becomes placed into the context of scientific knowledge.

The scientization of policy making can lead to a system of decision making that resembles less of a democracy and more of a technocracy whereby decision-makers forgo value politics and rely on scientists to assume the role of decision maker (Pielke 2007). Without democratic politics the values of those scientists involved in scientific inquiry become the dominant values represented in decision making. Democracy and technocracy are two idealized, competing systems that in practice have blurred boundaries (Jasanoff 1990). Throughout this dissertation, I use the two systems of decision making, democracy and technocracy, to explain competing perspectives in governing risk.

The politicization of science and the scientization of politics are mutually reinforcing and can ultimately stymie decision making (Pielke 2007). Teasing apart the known from the unknown embattles the underlying policy problem from needed decision-making, leaving decision makers with an "excess of objectivity" that can support multiple legitimate views of reality (Sarewitz 2004). The situation threatens the legitimacy of science because "In many instances there is a consensus over the 'state of knowledge', but the competition between political adversaries for legitimating knowledge pushes the demand for expertise in the direction of yet uncertified knowledge, that is, controversy" (Weingart 1999). Such situations are often symptomatic of deeper social issues or rather "wicked" policy problems that are moral in nature and policy makers have difficulty addressing these types of problems because large scale social change may be required in order to do so (Rittel and Webber 1973).

Political Symbols, Boundary Objects, and Implications for Computer Simulation Models

Political symbols align individuals and differentiate interests thereby acting as devices of power so that collective action is possible (Lasswell and Kaplan 1950; Elder and Cobb 1983). A *symbol* is "any object used by human beings to index meanings that are not inherent in, nor discernible from, the object itself…An object becomes a symbol when people endow it with meaning, value, or significance" (Elder and Cobb 1983, 28– 29). Policy studies differentiate between two general categories of symbols. Referential symbols relate solely to the thing in which the symbol denotes. There are often names, labels or signs. Condensational symbols summarize experience, feelings, and beliefs; it is "the needs, the hopes, and the anxieties of men that determine the meanings" (Sapir 1934; Edelman 1985, p. 2). In a classic work, political scientists, Murray Edelman (1985), described the entire political system as one of condensational symbols that endowed with virtue and authority by social beliefs. The realization of political institutions and programs reflect multiple interpretations of shared goals, such as equality or liberty. Though symbols reduce issue complexity by removing context to facilitate communication, at times, they can harm the democratic process by hiding value conflicts making people vulnerable to manipulation while simultaneously hiding and solidifying power relationships in society (Lasswell and Kaplan 1950; Edelman 1988).

Scholars in sociological studies of science and technology, describe symbols used to communicate between different areas of knowledge as "boundary objects," defined as

> objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation (Star and Griesemer 1989).

Boundary objects make collective action possible without a need for agreement or consensus on specific areas of knowledge. They "need not be accurate to be useful" because they act as a basis for conversation and pointing to things (Star 2010). Boundary objects, such as a machine, serve to transfer knowledge from one area of expertise to another by placing different knowledges within the same context to develop a shared meaning (Bechky 2003). Further, different settings (i.e. different knowledge interfaces) sometimes demand the use of different boundary objects in order to invoke pertinent knowledges for the problem at hand (Carlile 2002; Bechky 2003). However, when multiple knowledges convene to define and solve a perceived problem, value conflict can impede the use of a boundary object to transfer or transform knowledge into decisions because "creating common meaning is not possible; what is required is a process in which actors negotiate and are willing to change the knowledge and interests from their own domain" (Carlile 2004). In other words, participants need to engage in politics. In turn, the dominant usage of a boundary object reflects power relationships amongst those involved in conflict by serving to highlight and limit the representation of certain knowledges over others to influence decision making (Carlile 2004).

Computer simulation models often act as a type of boundary object (e.g. Sunberg 2009; Carlile 2004). Models derive power by acting as tools that provide information useful for "intervening in the world," the inner workings of which the user need not understand in order to make use of the model (Morrison and Morgan 1999a). For example, the public makes regular use of weather forecasts but few have a full understanding of the modeling process used in developing the forecasts. However, in accepting the forecast for use in decision making, one also accepts the underlying information used to build the models that scientists used to produce the forecasts as knowledge. Sociologist Bruno Latour has described technological artifacts, such as models, as "black boxes" whose "many elements are made to act as one" and in this way masks an entire ongoing history of decision making, uncertainty, and controversy of the box's inner workings of many interwoven ideas (Latour 1987, p. 131). Like black boxes, models need not accurately represent reality; they only represent a subset of hypothesis and hide controversy over these assumptions. Philosopher and economist, Marcel Boumans (1999) argues that scientists' use of choice in model construction provides a "built-in" justification so that the ability of the model to depict the phenomena it was built to produce determines success (Boumans 1999). Boumans (1999, p. 67) describes this built-in justification as akin to

> baking a cake without a recipe. The ingredients are theoretical ideas, policy views, mathematisations of the cycle, metaphors and empirical facts… However, a recipe is not unique in the sense that it is the one and only way to integrate a certain set of ingredients. Thus a new recipe is a manual for *a* successful integration of a new set of ingredients [emphasis in original].

The recipe creation process ends when the baker (modeler) creates a cake (output) to his liking.

Thus, different models applicable to a given problem represent different perspectives on knowledge and imply different courses of action. In order to incorporate the literature on political symbols, boundary objects, and opposing systems of ideas competing for acceptance as knowledge, throughout this dissertation I regard models as *political tools* used to negotiate understanding in public policy making where knowledge is contested and controversial (see also

Winner 1986). The acceptance of one model over another ordains the model creators, their built in justifications and claimed knowledge with power to influence decision-making.

Catastrophe Models Affect the Perception of the Insurability of Risks

Policymakers often use insurance to manage uncertainty about the future economic loss, but insurance has limits to its application. Using knowledge of probability and statistics, insurance acts to pool financial resources and redistribute those resources at times of loss by a member of the risk pool. This 'shifts' the impact of a loss incurred by an individual onto a larger group or 'risk pool' (Mehr et al. 1985). The availability of insurance depends upon the ability to calculate odds of loss (Bernstein 1996) so, insurance exclusively manages aleatory or measurable uncertainty (see also Knight 1921). Insurance cannot manage ignorance. Therefore, risk insurability has technical and social limits. By many accounts the availability of insurance begets an insurable risk (e.g. Insurance Executive A 2012). This perspective holds that the "knowledge and persuasiveness of the broker and the knowledge, imagination and courage of the insurer" (Mehr et al. 1985, p. 35) determines insurability. But this seems to describe a process of risk evaluation more akin to gambling then to the methodological application of scientific knowledge and expert judgment characteristic of the global insurance system.

Scholarly opinions abound regarding which risks are insurable, to what extent, and why (Faure 1995; Kunreuther and Michel-Kerjan 2004; Babbel 2006; Cummins 2006). Such discussions (e.g. Charpentier 2008; Babbel 2006) commonly use the essay, *Limits of Insurability of Risks,* by Baruch Berliner (Berliner 1982), as a foundation for further examination or reason for constructing one's own set of criteria. For example, Schmit (1986) argued that Berliner's criteria are too theoretical and established her own criteria based on which risks were already insured and common practice in textbooks. But I believe that criteria established in this way serves to perpetuate convention rather than address limitations of the insurance technology. Akin to this would be an analyst that first observes the regular human consumption of chips and soda and then establishing criteria for the ideal food. A better course of action has the analyst first reflecting on the limitations and needs of the human body and then establishing ideal food criteria.

The work here uses Berliner's criteria because the interest lies with how information or knowledge about risk has impacted the successful implementation of insurance. Berliner (1982) outlined nine criteria of insurability and argued that each criterion except the last (i.e. Cover Limits) could be numerically defined on a three dimensional, 8-axis Euclidean space. The origin represents absolute insurability; and as the "area of insurability" moves away from the origin the plotted risk becomes less insurable. Decision makers may disagree about where a risk lies in relation to the origin because they have different perspectives on the risk (Berliner 1985). However, I propose here and argue more thoroughly in Chapters 7 and 8, that decision makers may also disagree about the insurability of a risk because they disagree about what constitutes as knowledge about the risk versus that which still remains in the realm of ignorance (cf. Berliner 1985).

Insurers believe that catastrophe models are necessary to provide information used to assess risk insurability (e.g. terrorism Swiss Re 2005; Kunreuther and Michel-Kerjan 2004) and earthquakes (Baur and Breutel- O'Donoghue 2004, p. 12). The complexity of technology used in determining risks has stirred an "interdependency" between science and insurance where the underlying science behind measuring risk directly impact insurers' decision making (Kleindorfer 2010). Given that catastrophe models serve as the primary conduit of scientific information about risk to those that must decide the price of insurance coverage (Grossi and Kunreuther 2005), catastrophe models also serve as boundary objects and political tools.

Catastrophe models have demonstrably caused changes in insurers' perception of the insurability of particular risks. For example, in the case of flood, models have moved uninsurable risks into the realm of insurable (e.g. Menzinger and Brauner 2002). Likewise, the inability to model certain aspects of a once insurable risk or changes to modeling inputs have moved some risks from the realm of insurability to that of uninsurability (e.g. auto coverage in Davies and Croft 2011; mitigation discounts in FCHLPM 2010; and climate change in Charpentier 2008). If catastrophe models influence perceptions of risk insurability then in order to facilitate a discussion in later chapters on struggles in the successful implementation of insurance then we must first understand the criteria of insurability. The nine criteria of insurability define an ideal risk (Table 2), but few such risks exist (Berliner 1982). Still insurability criteria enable the identification of successful implementation of the use of insurance and specific areas of difficulty. Without them no one has any ability to judge a situation to qualify as insurance.

Berliner's Nine Criteria of Insurability

Criteria	An ideal risk is one which:
Randomness (of the loss occurrence)	Losses occur with a high degree of randomness.
Maximum possible loss	The maximum possible loss is very limited.
Average loss amount upon occurrence	The average loss amount upon loss occurrences is small.
Average period of time between two loss occurrences	The average time interval between two loss occurrences is small (i.e., losses occur frequently).
Insurance premium	The insurance premium is very high.
Moral Hazard	There is hardly any possibility of moral hazard.
Public policy	Coverage of the risk is consistent with public policy.
Legal restrictions	The law permits the cover.
Cover limits	Cover limits bound insurer responsibility.

Table 2: Criteria of Insurability for an Ideal Risk (adapted from Berliner 1982, p.16)

Randomness

The criterion of randomness refers to the nature of the loss event. Ideal risks occur with a high degree of randomness meaning that they have minimal predictability and dependence on other events. In the case of hurricanes, scientists and actuaries measure distributions of events and make decisions about weighing some distributions heavier than others (e.g. La Niña years are associated with higher landfall probabilities). Ultimately however, when and where a hurricane will make landfall and cause loss remains random and unpredictable. Catastrophic hurricane risk by definition includes aggregate loss, so the concern here is not for the dependence of one loss with another but with the randomness of hurricane events.

Maximum Possible Loss

Maximum possible loss has historically appeared in many variations of the phrase such as, possible maximum loss and estimated maximum loss. Here, it is used as probable maximum loss (PML). In short, the criterion of PML requires the ability of insurers to indemnify the maximum loss that they could occur over some time period, say 100 years. The measurement of PML has consequence for the amount of capital that an insurer must maintain.

Despite being a widely used and important concept, traditionally, PML lacked a consistent definition or means of calculation (McGuinness 1969; Wilkinson 1982). Further, any calculation was based in "sketchily informed judgment" due to data limitations (McGuinness 1969). In general, the PML denoted a "feeling" about the worse loss likely to happen (Black 1969). Today's method of defining risk with catastrophe models integrates information from a range of scientific, economic, and social disciplines to develop a distribution of several thousand hypothetical loss events that are believed to portray statistical relationships observed in real events. The models provide PMLs based on accumulated probabilities of an event occurring, which is then extrapolated to indicate time frames. For instance, consider a catalog of 1,000 hypothetical storms each with some probability of occurrence. To determine the 200-year PML, or put another way the loss with a 0.05% chance of occurrence in any year, the storms are ranked by loss amount in descending order and the probability of each storm is cumulatively summed until the sum is 0.005. The loss of the last storm included is the 200-year PML.

Average Loss Amount Upon Occurrence & Average Period of Time Between Two Loss Occurrences

The criteria average loss amount upon occurrence and average period of time between two loss occurrences are considered together because they are closely related. The idea of insurance hinges on the statistical law of large numbers (LLN) which claims that the average outcome obtained from a large number of trials approximates the true average and as more trials are performed the closer the approximation will come to the true average. By combining a large number of exposures, insurance facilitates the predictability of loss.

In the case of catastrophic hurricane events, which are occur infrequently with large losses, the LLN has long been an obstacle to the insurability of the risk. In the 1970's, (Walters 1974) advised that actuaries use a long-term historical average of at least 20 years of hurricane losses to price the hurricane risk separate from the standard 5-years used to price the rest of the homeowners policy. The matter was reportedly dropped from the literature until the late 1980's (Chernick 1998) when catastrophe models were introduced as a means to address difficulties with satisfying the LLN and discusses the consequences and management of "what-if" catastrophe scenarios (Clark 1986).

Insurance premium

The insurance *premium* is the price of the insurance policy. Premiums include a great number of factors such as business expenses. An insurance *rate* is the cost of insurance per unit of exposure based on expected loss and associated costs (McClenahan 1987). In practice, the rate also has additional expenses included such as the costs of risk transfer and fluctuation loading. These cost considerations aside the *pure premium,* is equal to the product of frequency per unit of exposure and severity. The insurance rate and the pure premium are closely related. For an individual policy the rate and the pure premium are equal.

Traditionally, summing the total loss over a period of time and dividing by units of time calculated the pure premium. Today, insurers usually refer to the average annual loss (AAL) as a synonym to pure premium, though they are calculated very differently. The AAL is the average loss of a modeled loss distribution. However, the modeled catalog may itself be independent of time (e.g. a catalog of 1,000 *years* vs. a catalog of 1,000 *events*).

Moral Hazard

A hazard can be defined as "a condition that may create or increase the chance of loss arising from a given peril" (Mehr et al. 1985, p. 23). The idea of moral hazard argues that an insured's behavior or internal moral compass may increase the chance of loss. In order for a risk to be insurable, the insurance contract must seek to address the issue of moral hazard often with the use of deductibles.

Moral hazard has exhibited mixed meanings, but "[t]oday, moral hazard signifies the perverse consequences of well-intentioned efforts to share the burdens of life" (Baker 1996). Moral hazard describes risk arising from changing notions of what human society believes to be good, fair, and just. As such, economists, insurers, and academics may all describe the concept differently and claim that it does or does not appears in different instances. Generally, moral hazard encompasses two aspects: character and temptation (Baker 1996). Bad character or a change in character can increase the likelihood of loss because the individual will seek or cause an insured loss so as to benefit from the insurance pay out. Temptation is seen in the willingness to accept risk because insurance reduces the severity of the associated loss. This aspect is often termed 'morale' hazard and is understood more as a social phenomena than as an individual one.

Public Policy

The criterion of public policy requires that the risk being insured is consistent with the goals of the public interest (see Berliner 1982, 78). Ultimately, publics use insurance as a tool to accomplish common goals thereby entering into a mutually beneficial relationship with insurers who create jobs and collect profit. Contention will likely arise when the risks defined by insurers are inconsistent with publicly stated goals and public conceptions of those risks and of course, *vice versa*.

Legal Restrictions

According to the criterion Legal Restrictions, an insurable risk must be legal to insure. In this sense, legislation determines insurability. As legislation evolves in text or interpretation, a particular risk moves in and out of the area of insurability. A common basis for the great body of legislation that outlines the legal boundaries of insurable risk is "the duty of the state to look after the well-being of its citizens and its endeavors to live up to this obligation" (Berliner 1982, p. 99)

Cover Limits

The criterion Cover Limits requires insurers to establish limits on the insured risk in the interest of the economic sustainability of the insurer. In general, cover limits work to protect the insurer from inappropriate loss burden and defines risks that are worthwhile to both the insurer and the insured. In many ways, cover limits are similar to legal restrictions but established in the interest of the insurer.

Orienting an Understanding of Insurance as Public Policy

The discussion above provides a basis for orienting an understanding of insurance as public policy. Here I outline how I have come to understand and think about policy problems regarding insurance. Perhaps, in the future, I may build this out more fully, which will surely require further research and justification. But such an endeavor, for now, is beyond the scope of this dissertation.

In the context of insurance, policy makers have already implemented policy to address at least a part of the risk problem by deciding to use insurance to manage the risk. However, the implementation of insurance represents several further decision points. In order to apply insurance for managing risk those involved must come to an agreement about the risk insured. Berliner explained that even within the same discipline (i.e. insurance) different perceptions lead to disagreement about the size of a risk,

> Common terms indicating the size of risks such as, for example 'large risk,' small risk,' 'bagatelle risk' are, of course, clearly connected with the abstract general concept 'size of a risk' and therefore, also share its fate as a conceptual Tower of Babel. They contribute to the familiar state of talking at cross purposes. Only rarely will two discussion partners understand exactly the same thing by the term, 'large risk' (Berliner 1985).

Just as defining a policy problem depends upon perspective and values preferences, defining risk is a "political act, expressing the definers' values regarding the relative importance of different possible adverse consequences for a particular decision" (Fischhoff et al. 1984b). The act of defining risk has implications for power dynamics in society because "whoever controls the definition of risk controls the rational solution to the problem" (Slovic 1999). Therefore, implementing insurance, as public policy, requires an active political process to reach an agreement about the risk so that the insurance works to meet shared ends (e.g. economic sustainability and social stability).

Because perspectives on risk work to influence decision making about the risk insured and how to allocate the risk in society, political symbols develop to facilitate perspectives' identities and communication. I find a commonly used symbol in situations regarding political disputes over insurance to be the insurance rate. Insurance "rate" facilitates communication about risk by acting as a tangible symbol for the intangible idea of risk. In insurance contracts or in negotiations between insurers the rate is numerically represented and at times may act simply as a referential symbol. However, the rate becomes a condensational symbol when feelings, beliefs, or opinions arise regarding the appropriateness, adequacy or burden of the risk represented by the stated rate. Much public political discourse about insurance rates is often in regards to whether rates are "too high," "too low" or "actuarially sound" in each case reflecting different perceived problems in the chosen definition of risk.

The process of ratemaking arises as a specific type of policymaking whereby interests with different value preferences engage in politics to influence authoritative decisions about the risk insured (see also Meier 1991). In the political process of ratemaking about hurricane risk (Chapter 7), catastrophe models act as political tools in three ways. First, they provide information that affects perceptions of risk and thereby influence understanding of the political symbol 'rate.' Second, catastrophe models function to communicate between knowledge disciplines such as tropical meteorologists, insurers and regulators. One need not reach a consensus on the underlying science nor understand how the model works in order to use it. Third, each model represents a different representation on knowledge (that is often contested) providing supporting evidence for value preferences.

Rate decisions as public policy define winners and losers in society by two resulting outcomes. First, a rate decision allocates risk amongst society members by determining the favorability of error (Type I or Type II; Hammond 1996). Choice of a model that estimates a "large risk" means that insurance rates will produce more false positives proving costly to policyholders but not to insurers. On the contrary, a model that estimates a "small risk" means that insurance rates will produce more false negatives acting favorably for policyholders but unfavorably for insurers. Second, because insurance can only manage measurable uncertainty, insurance rate decisions determine acceptable knowledge because by establishing a rate, policymakers inadvertently define the uncertainty about the future relegated to ignorance (Figure 1).

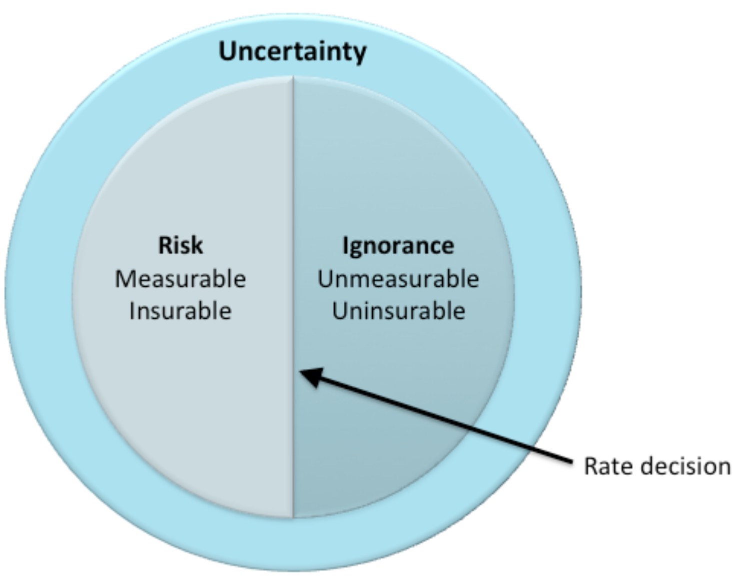

Figure 1: Rate decisions define the delineation between risk and ignorance

Conclusion

The public invests heavily into insurance in many areas of life and therefore has a strong interest in its successful implementation as public policy. The lore amongst insurance experts that ‘most people do not understand how insurance works’ indicates a problem for the ability of the public to participate in decision making about the use of insurance as a public policy. By placing insurance into the context of public policy making, encourages discussions about insurance to move away from the technical and towards the benefits and costs of its use as a public policy. Certainly, neither the general public nor even legislators need to acquire the technical know-how to run an insurance company in order to decide to use insurance as a risk management technology. But in order to affirm a strong democratic process the public is entitled to an enlightened understanding (Dahl 1998) of their policy options. This means that that the public needs to understand options to insurance, potential consequences of insurance, and the context for political disputes over insurance.

The literature demonstrates that the political process runs throughout decision making for insurance- in determining knowledge about risk, defining the risk problem, and communicating information between interests. Breaking through the mystique of insurance facilitates a constructive discussion about public values and the ability or inability of insurance to assist in certain problems. True, insurance is highly technical and complex. Implementing insurance will always require technical knowhow and the experience of experts. Still, improving the ability of the public to understand and participate in governing risk with insurance contributes to a successful democratic process.

CHAPTER 5: Methods

Introduction

This chapter presents the methodology used for the independent research projects in Chapters 6, 7, and 8 and so it has three sections. Both Chapters 7 and 8 share a narrative of conflicting perspectives, technocracy vs. democracy (Jasanoff 1990), on governing Florida's hurricane risk. Introduction of these perspectives occurs in Chapter 7, though I spend much more time developing them in Chapter 8. As well, both chapters greatly benefited from numerous interviews with Florida insurance professionals intimately knowledgeable of Citizens, its ratemaking process and the controversy that surrounds it. They requested that their quoted comments remain anonymous due to the political nature of the issue.

The first section provides the methodology for constructing a homogeneous dataset of global hurricane landfalls. This methodology and all of Chapter 6 reflects the published work in (Weinkle et al. 2012). I conducted the research under the premise that barring a long term trend in frequency and severity of landfalling hurricanes one has no reason to expect finding a climate signal in the economic hurricane loss data.

The second section provides the methodology for characterizing the role of catastrophe models in the evolution of the affordability and insurability of Florida's hurricane risk found in Chapter 7. I use newspaper reporting as an indication of hurricane risk affordability. This metric removes the use of exterior standards to judge a subjective value. I conducted the research under the premise that information from catastrophe models affect insurer perceptions of the hurricane risk and consequently, judgments about risk insurability. As well, the range between models' low and high estimates of loss serve as an indication of knowledge conflict or ignorance about the hurricane risk (see also Raymond James 2012). Given that insurance can only manage measureable uncertainty, conflict in the designation of risk and ignorance can have negative impacts perceived insurability. I investigate the political implications of changes in model uncertainty about the hurricane risk.

Finally, the third section presents the methodology of policy evaluation applied in Chapter 8 to Florida's Citizens Property Insurance Corporation. I use the policy sciences framework, developed by political scientist, Harold Lasswell, to orient the evaluation. The framework is rooted in the philosophy of pragmatism and judges policy success and failure in respect to stated objectives. I outline the two central pillars of the policy sciences, the social and the decision process.

Historical Global Hurricane Landfalls

The Data Used to Count the Frequency and Severity of Hurricanes Making Landfall and Identifying Time Periods for Reliable Data

A main obstacle in constructing a homogeneous global hurricane[34] landfall dataset concerns the varying quality of the hurricane best-track historical records. Indeed, uncertainty in hurricane location and intensity data is a function of the evolving observation network throughout the past century ranging from ship traffic, aerial reconnaissance, to satellite remote sensing. For instance, recent research has attempted to quantify potential missing North Atlantic tropical storms in the late 19th and early 20th centuries (Landsea et al. 2010; Vecchi and Knutson 2011) related to the ongoing Atlantic Hurricane Database Re-analysis Project (HURDAT; Landsea et al. 2003). Also, issues related to the viewing angle of eye temperatures among

[34] "Hurricane" is a region specific term used to describe a tropical cyclone in which the maximum sustained surface wind (using the U.S. 1-minute average) is 64 kt (74 mph or 119 km/hr) or more. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian. The term typhoon is used for Pacific tropical cyclones north of the Equator west of the International Dateline (NHC 2010). For purposes here, I simply use the term hurricane.

different satellite platforms have spurred research into reevaluating hurricane intensity during the past several decades in the Northern Indian Ocean basin (Hoarau et al. 2011). While objective satellite methodologies have been applied to global hurricane satellite data (Kossin et al. 2007), a meticulous human-based reanalysis of all global hurricanes during the last several decades remains an unrealized endeavor. Thus, it is important to acknowledge possible bias or errors in hurricane intensity and track information for each independent ocean basin prior to conducting long-period historical research.

I examine landfalls in five global hurricane-active development regions including the North Atlantic (NATL), North Eastern Pacific (EPAC), Western North Pacific (WPAC), Northern Indian Ocean (NIO), and the Southern Hemisphere (SH) using the most recent version of the International Best Track Archive for Climate Stewardship (IBTrACS v03r03; (Knapp et al. 2010). This impressive resource compiles hurricane intensity and location data. It is important to note that this dataset is not a reanalysis and considerable uncertainties likely remain unresolved in the respective estimates of hurricane location and intensity.

I utilize the United States Department of Defense Joint Typhoon Warning Center (JTWC; (Chu et al. 2002) best-tracks gleaned from the IBTrACS for hurricane lifecycle location and intensity estimates for the WPAC (1950-2010), NIO (1970-2010), and SH (1970-2010) for the time periods chosen in parentheses. While the WPAC basin was observed through aircraft reconnaissance until 1987, routine satellite monitoring (Dvorak 1984) was also critical for intensity estimates especially for the NIO and SH, and the time periods chosen roughly correspond to the beginning of the satellite era. As the JTWC data is not complete and less reliable prior to the mid-1980s in the SH and NIO, additional lifecycle points are filled in from the Neumann (1999) and NCAR ds824.1 (Neumann et al. 1993) portions of the IBTrACS full dataset. Especially in the NIO prior to 1980, some hurricanes are simply categorized as a tropical storm or hurricane with maximum sustained winds listed generically at 35 or 65 knots and are therefore likely biased low[35] (Hoarau et al. 2011).

The United States National Hurricane Center (NHC) best-track dataset (Jarvinen et al. 1984) is used for the NATL (1944-2010) and EPAC (1970-2010) basins. While considerable reliable data is available in the NATL back to at least 1900 (Neumann et al. 1993), as our focus is on assembling a homogeneous global dataset, I begin with 1944 coinciding with the start of routine aircraft reconnaissance and a focal point of the Atlantic Hurricane Reanalysis Project (Hagen et al. 2011). Northeast Pacific ocean hurricane data is reliable since about the mid-1960s mainly due to routine satellite monitoring (NCAR ds824.1).

Counting Hurricanes Both Manually and with Software

Each individual hurricane lifecycle in the best-tracks is individually examined through complimentary computer automated and manual detection techniques in order to compile a global homogeneous landfall dataset. I adopt the current NHC (2010) online glossary definition of a hurricane landfall as the intersection of the surface center with a coastline. In our final analysis, I do not include a relatively small number of hurricanes that have grazed coastal land yet still caused hurricane force winds over land. These near-miss hurricane landfalls are responsible for only a small fraction of normalized economic losses and do not affect overall conclusions.

To automate landfall detection, a straightforward binary decision process between land and sea requires a very-high resolution geographical resource. Here I utilize an operational sea-surface temperature product (GHRSST OSTIA; Stark et al. 2007) as a land-mask with 1/20th

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[35]NCAR ds824.1 Notes on Tropical Cyclone Data available at
http://dss.ucar.edu/datasets/ds824.1/docs/format_ascii.html

degree global grid spacing (Appendix 1 Figure 1a & b). Coastlines and islands are very clearly demarcated at this spatial resolution. Since the IBTrACS best-track location points (latitude and longitude) are reported in increments of one-tenth degree, a ¼ degree square buffer is applied to allow for the expected uncertainty in reported hurricane locations at the 6-hourly intervals. I do exclude some small islands or chains of islands from our analysis. Land areas included in the study are found in Table 3.

Land Area	**Remarks**
Coastline of continental Africa	
Southern coastline of continental Asia from Yemen to Russia	Including Sri Lanka and China's Hainan Island
Mainland Australia	
Bahamas	New Providence Island only
Mainland Cuba	
Mainland Hispaniola (Dominican Republic and Haiti)	
Mainland Jamaica	
Japan	Excluding islands south and east of the main island of Kyushu
Mainland Madagascar	
Coastline of continental North, Central, and South America	Including MI/LA delta region, FL Keys, HI, US barrier islands, Puerto Rico, Nova Scotia and Newfoundland
Philippines	
Taiwan	

Table 3: Land areas considered for study

With each IBTrACS serial number from the software identified landfall candidates, visual verification of landfall location and intensity is performed with an associated online hurricane graphics repository[36] (for details on the visual verification and descriptive imagery see Appendix 1). As storms approach land, they tend to entrain dry air and their outer circulations may interact with mountainous terrain. To account for the effects of land-based weakening in categorizing hurricane landfall intensity, I also retrieve the 6-hourly observation time step

[36] Available at http://storm5.atms.unca.edu/browse-ibtracs/browseIbtracs.php

immediately prior to the first on-land observation and use the highest value. If a hurricane makes multiple landfalls, then it is only counted once and categorized at the highest determined landfall intensity.

Even with the above caveats, I still rely on the reported best-track locations that represent a contemporary real-time and/or post-season assessment. Furthermore, I discriminate between two groups of hurricane force hurricanes at landfall: Category 1 and 2 storms on the (NATL based) Saffir Simpson scale (one-minute maximum sustained winds of 64 to 95 knots) described as minor hurricanes, and Category 3-5 storms (wind exceeding 96 knots) often referred to as major hurricanes. Of course, the exact intensity at the point of landfall is often unknowable due an acknowledged under-sampling of the atmospheric environment, yet I have confidence in the discrimination between minor and major landfalls. The term hurricane is used generically across all global basins to denote a tropical cyclone with one-minute maximum sustained winds exceeding 64-knots.

The Role of Catastrophe Models in Characterizing an Affordable and Insurable Hurricane Risk

Developing a Structure for Narration

The Florida legislature mandates that Citizens Property Insurance Corporation (Citizens) provide "affordable property insurance." This means that the characterization of Florida's hurricane risk must meet the criteria of affordability and insurability. This study begins analysis with the year legislators created Citizens in 2002 and extends to 2011. Though the goal of affordable property insurance did not appear in the Citizens' legislation until 2007, beginning analysis earlier takes advantage of Citizens' publically available information to document relative perceived change of a risk in relation to constant metrics. Furthermore, the insurance industry and government have remained in a state of conflict over the policy changes made in 2007. Expanding the time period of analysis to cover the lifetime of Citizens looks beyond the changes in policy as the sole factor for change in perceived risk, focusing instead on the background context from which information about risk arises.

To guide the narration, I develop a 2x2 matrix of risk outcomes with affordability and insurability placed on intersecting (Figure 2). Each quadrant represents a possible outcome for defining hurricane risk in relation to policy goals. The reader should keep in mind that the axes form a continuum and each quadrant describes a *relative* situation. The first quadrant, dubbed *Risk Success*, describes a period of time where the hurricane risk was relatively affordable and insurable in comparison to the rest of the period of time analyzed. Again, quadrant two, *Affordability Crisis*, describes a period of time when the risk was relatively unaffordable yet insurable as compared to the rest of the time period analyzed. The third quadrant, *Homeowners Insurance Crisis*, describes a period of time when the hurricane risk was relatively unaffordable and uninsurable. Finally, the fourth quadrant, called *Insurance Crisis*, describes a period of time in which the risk was affordable but uninsurable.

One familiar with the long history of windstorm insurance difficulties in Florida may find it reasonable to suspect that the periods of time depicting relative conditions described in the narration differ over a longer time frame. Because my primary concern for the overall dissertation is with the Citizens policy, the time period of analysis begins with the year legislators created the company. I truncate analysis to 2011 due to limitations in data availability.

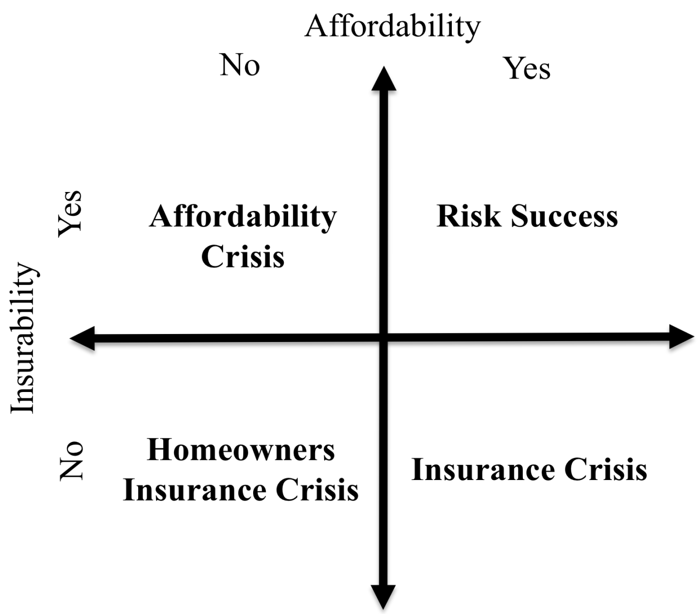

Figure 2: 2x2 Matrix of Risk Outcomes

Data for Assessing Affordability

The mandate that created Citizens never defined the idea of affordability resulting in a point of contention for insurers, legislators and the public. Common measures of insurance affordability include comparison to household income, household purchase choice, and housing "burden" guidelines established by the Department of Housing and Urban Development (HUD; (Grossi et al. 2005). In turn, so long as economic metrics indicate an ability to pay, the evaluators have considered the risk as affordable. This line of thinking about insurance affordability places the power to define risk solely with insurers and catastrophe modelers while neglecting the need and role for public acceptability in implementing insurance for managing risk. In contrast, I use risk affordability as a multidimensional social value (see below discussion on "values") used to enable public involvement in the political process of defining the hurricane risk which society chooses to insure against. From this viewpoint, risk affordability becomes a risk acceptability issue (Fischhoff et al. 1984a) whereby public debate- informed by technological and scientific expertise- defines the risk society manages. One way to think about this is to consider the hypothetical statement, “Jane can not afford to permit the organization to perform unethically.” In this example, the potential outcomes associated with unethical behavior is considered unaffordable for Jane, yet not just economically unaffordable. Instead, the risk associated with performing unethically is viewed as unacceptable and therefore unaffordable.

Newspapers are a common means of measuring the mood of the public because the journalistic relay of information both shapes and mirrors public concern (Edelman 1988; Boykoff 2011). I use the frequency of reporting on windstorm insurance in Florida’s widely circulated newspapers, adjusted to the mean, as a metric of affordability. Low frequency of reporting suggests relatively little to no public discontent and identifies periods of time that exhibit an affordable hurricane risk. Likewise, high frequency of reporting indicates heightened public discontent and an unaffordable hurricane risk.

Using reporting frequency as an indication of price affordability may not capture other concerns reflected in the content of the articles. That is, an article that mentions windstorm or hurricane insurance need not always be in the context of policy cost. Still, to the extent that newspaper reporting reflects public concern about the experienced or potential outcomes of the windstorm regime on any number of fronts it also reflects the acceptability of associated risk. In any case, I use the reporting frequency data not to develop a quantified point at which insurance coverage becomes affordable or unaffordable, but to develop an interpretive story about the evolution of the perceived hurricane risk. Admittedly, this methodology rests on the use of judgment to identify periods of affordability and unaffordability and the validity of using newspaper reporting frequency as a metric for this goal.

I used circulation numbers, area covered, and availability through search engines to decide which newspapers to use for analysis. Newspapers were searched over the period January 1, 2002- December 31, 2012 using the Boolean search phrase ((BODY((windstorm or hurricane) w/2 insurance) or HEADLINE((windstorm or hurricane) w/2 insurance)). The phrase finds instances where the term “windstorm insurance” or “hurricane insurance” appear in either the headline or the story. I include the following newspapers in this analysis: Tampa Bay Times[37], Orlando Sentinel, Miami Herald, and the Palm Beach Post (Table 4). The results for the Miami Herald were over two times greater than that for the next highest resulting newspaper. This most likely reflects the Miami area’s high concentration of Citizens policies and hurricane risk and perhaps, significant income disparity (Bee 2012). Also, several political representatives from the area spearheaded the creation of Citizens (Citizens Property Insurance Corporation 2002).

Newspaper	# of Articles
Orlando Sentinel	248
Miami Herald	851
Palm Beach Post	371
Tampa Bay Times	315
Total	*1785*

Table 4: Frequency of reporting by newspaper, January 1, 2002- December 31, 2011

Data for Assessing Insurability

In my conversation with insurance executives, they quickly redirected the topic of insurability towards one of insurance availability (Insurance Executive A 2012). One executive suggested analyzing risk insurability through use of market share data because Citizens’ market share is a mirror reflection of the private markets’ perceived insurability of the Florida hurricane risk (Insurance Executive A 2012). Upon this recommendation, this study uses deviations from the average Citizens’ market share of written premium from 2002- 2011 to identify periods of

[37] Prior to January 2012, the Tampa Bay Times was known as the St. Petersburg Times.

time when the private market perceived the Florida hurricane risk as relatively insurable or uninsurable. I gathered data from a combination of reports on the Citizens' website, public records requests, and the FLOIR's online reporting database (for further detail see Appendix 2). Table 5 provides Citizens' annual market share as a percent of total direct written premiums.

Berliner's (1982) criteria of insurability act as standards by which to judge the influence of catastrophe models on the evolution of the perceived risk demonstrated by changes in market share data. Because the models reflect the techno-socio-political context upon which people construct them, the discussion of how and why the models change reflects on prominent events in Florida politics, the hurricane hazard, and the scientific community.

Year	Market Share (%)	Index
2002	16.6	0.70
2003	19.97	0.85
2004	19.63	0.83
2005	18.81	0.80
2006	30.58	1.30
2007	29.25	1.24
2008	24.1	1.02
2009	21.87	0.93
2010	25.86	1.10
2011	28.81	1.22

Table 5: Citizens' Market Share by Direct Written Premiums

Commercial vendor catastrophe models are proprietary and largely unavailable to those outside of the insurance industry. However, the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) makes publicly available a great deal of reporting material for those models approved for use in the state of Florida. I collect data from the modeler submissions to the FCHLPM (www.sbafla.com/methodology; for further detail see Appendix 2) using reporting of AAL and 250 PML by modeling companies using the "hypothetical data set." I use this data because it is the most consistently reported. At times, the FCHLPM would change the hypothetical data set, but this has no bearing on my analysis because I look at differences between models within the same reporting period.

I develop a metric for uncertainty about the hurricane risk based on a financial report for the Florida Hurricane Catastrophe Fund (FHCF) that used a range of model predictions given by different financial companies to develop a perspective on the risk regarding the state's potential bonding capacity (Raymond James 2012). The report finds that the substantial disagreement between models demonstrated "fundamental uncertainty" about the risk (p. 12). Based on this means of measuring the ignorance about a risk, I use the range of catastrophe modeler's AAL and 250 PML as a proxy for scientific agreement/disagreement about the Florida hurricane risk. I measure the range by,

(Maximum estimate submitted by a modeling company) –
(Minimum estimate submitted by a modeling company)

I standardize the range to the average uncertainty range for the FCHLPM reporting standards years 2001-2009 (representing submissions dated 2002-2011). The way in which insurers use catastrophe models varies considerably.

The FCHLPM's standard years are not equivalent to the year(s) in which insurers use a model for ratemaking. The FCHLPM establish standards towards the end of the end of the year and catastrophe modeling companies generally make submissions the following year (e.g. standards year 2002, submissions dated 2003). This pattern differed under 2009 standards, where submission dates range from 2010-2011 because in 2009, the FCHLPM began updating standards only on odd years. On the contrary, the global (re)insurance industry readily incorporates new model releases into ratemaking and information about upcoming model releases. Although the uptake of new model information within Florida for ratemaking may be slower, I assert that insurers' perception of risk is nonetheless influenced by new model releases because of their connection with the larger industry. Moreover, when an insurer licenses a commercial model, many more non-FCHLPM means of analysis come with it and the modeling company encourages the insurer to assess its company risk using several different analyses. With this in mind, only three models are evaluated here. The first two, RMS and AIR I chose because they are the dominant models used by the global insurance/reinsurance industry. The third model, the Florida's Public Hurricane Loss Model (Public Model), I chose because legislators mandate that it "serve as the minimum benchmark[38]" for Citizens' rates and therefore, fundamental to discussions of Florida's hurricane risk. Public Model submissions date back to 2006 standards.

Policy Evaluation of Citizens Property Insurance Corporation

Method of Policy Evaluation

The method of policy evaluation I employ makes use of the policy sciences and follows a methodical process of identifying goals, evaluation of goal metrics, and attribution of responsibility for success and failure. It seeks to answer the question, "Is this policy working?" (Schneider 1986). While, Chapter 6 describes the role of catastrophe models in characterizing Florida's hurricane risk in respect to goals of affordability and insurability; in Chapter 7, I make use of the same affordability and insurability metrics, as defined above, to evaluate success and failure in Citizens' legislative mandate to provide "affordable property insurance." I evaluate trends in goals metrics in the context of historical conditions and in relation to stated goals (Schneider 1986; Lasswell 1971). Data used to understand the outcomes of the decision process that resulted in observed trends come from a wide variety of sources including: legislative hearings, media reports, interviews with key players, and economic data. Finally, the policy

[38] FL Statute 627.351(6)(n)3

evaluation makes judgments of responsibility for success or failure of policy performance and ultimately, aims to expand the scope of alternatives to improve the policy process and realize the "goal values of the public order system" (Lasswell and McDougal 1992a, p. 1247).

Policy evaluation distinctly differs from advocacy because evaluation differentiates what is "functionally" important to the public and civic order from that which is of only "conventional" importance (Lasswell 1971, p. 2). Evaluation begins by aligning contextuality of the study with publicly stated goal values expressed in law or policy and then takes a retrospective viewpoint in describing success or failure in meeting goals. The purpose of evaluation is to increase the scope of policy alternatives available to decision makers so as to improve outcomes in relation to stated goals. On the contrary, advocacy need not begin with stated goal values and takes a prospective viewpoint by depicting problems to arise in the future. Most critically, advocacy seeks to limit the scope of policy alternatives in favor of predetermined policies (Pielke 2007).

Using the Policy Sciences Framework for Analyzing the Implementation of Policy

The political science literature offers many frameworks or "maps" for use in performing a policy analysis (see e.g. Sabatier 2007). As with all maps, different frameworks focus the user to different areas of the policy arena. Therefore, the researcher must use care in selecting a map so that the map is useful, but does not predetermine research outcomes (Clark 2002). I employ the policy sciences framework for policy analysis and judging responsibility for outcomes. The framework rests on the philosophy of pragmatism and as such is problem oriented and contextual. Also, the framework enables the user to employ many methods of analysis (Lasswell 1971).

The policy sciences framework provides two interrelated structures for analyzing a policy problem, the social process and the decision process. The social process provides a means to categorize and understand social interactions that people employ in the decision making process and it is organized around the central tenet that 'participants seek values through institutions using resources' (Lasswell 1971, p. 18). Values may function as both ends and means. For instance, one may use power to gain economic wealth or they may use economic wealth to gain power. Table 6 provides Lasswell's eight value categories with associated explanations (Clark 2002; Lasswell and McDougal 1992b). I have been told, perhaps in what amounts to legend, that Lasswell assured students that the scope of human values sought and used in decision making need not be limited to eight. Though, he also challenged peddlers of additional values to demonstrate how his eight values did not already encompass all others.

Value	Explanation
Power	Power means the ability to make decisions about policy and influence policymaking. Common institutions of power in the United States are government and interest groups.
Enlightenment	Enlightenment means the accumulation or dissemination of information or knowledge. Institutions of enlightenment include research and media.
Wealth	Wealth means the control or distribution of resources, goods, or services. Those with wealth have a control of resources such as economic resources, natural resources, etc. Businesses and consumer groups are common institutions affecting the allocation of wealth in society.
Well-Being	Well- being is set of circumstances that provide safety, health, and comfort. Institutions that provide for well being include medical care facilities.
Skill	Skill as a value means the acquisition and exercise of talents of all kinds-professional, vocational, or artistic. Institutions specializing in school include schools and professional organizations.
Affection	Affection is the giving and receiving of intimacy, friendship, loyalty, and positive sentiments. Institutions of affection include family, friends, and community.
Respect	Respect is recognition and honoring of freedom of choice, and equality. Institutions of respect provide recognition of merit
Rectitude	Rectitude means responsibility for conduct. Institutions of rectitude create and apply standards of responsibility and justify particular norms.

Table 6: Social Values

The decision process provides seven functional continuous and interrelated activities of decision making. Lasswell (1956) introduced these seven processes through a series of questions that each process intends to answer. Table 7 provides describes each process in the decision process, the question the process serves, and some further description.

Functional Activity	Description
Intelligence	How is the information that comes to the attention of decision makers gathered and processed? The process seeks information about the past and predictions about the future.
Promotion	How are recommendations made and promoted? This process includes two related activities of recommending alternatives and promoting their acceptance. In accordance with democratic values promotion must occur as persuasion rather than coercion.
Prescription	How are general rules prescribed? This process includes the development of rules or laws that outline or guide future action.
Invocation	How are general rules provisionally invoked in reference to conduct? This process appeals to moral need or obligation for action, no action, or a choice of action over others. In accordance with democratic values invocation should act as persuasion rather than coercion.
Application	How are general rules applied? The application function is concerned with the means by which decision makers reach goals including, the use of values, so to remain consistent with higher order goals.
Appraisal	How is the working of prescriptions appraised? The appraisal function assesses trends in existing policy and the steps of the decision process and attributes responsibility for success and failure in reaching intended policy goals. An appraisal seeks to make use of all involved perspectives and the one conducting an appraisal must not perform the appraisal with "explicit expectations" of responsibility (Lasswell and McDougal 1992a, p. 1261)
Termination	How are the prescriptions and arrangements entered into brought to termination? As time passes and things change, previously existing conditions may cease or cease as a concern. The termination function works to repeal obsolete prescriptions.

Table 7: Seven Decision Process Functions

Context for Affordability

To better understand the context for decisions regarding affordability, I use the rates of change of Citizens' average policy cost and of average cost as a percentage of median household income to provide a context of real and relative policy cost to observed changes in perceptions of affordability. I gathered Citizens' premiums and policies from a combination of monthly reporting and annual reports found on the Citizens website from the 2002-2011 period (www.citizensfla.com; for further detail see Appendix 2). I calculate average policy cost as the total in-force premium divided by total policies in-force (Table 8). I obtained historical yearly median household income data for 2002- 2011 from the US Census[39]. The US Bureau of Labor Statistics' Consumer Price Index for all urban consumers in the South were used to adjust premiums and household income for inflation to constant 2012 dollars[40].

Year	Premium	Policies-In-Force	Cost/ Policy	Median Household Income
2002	$966,136,757	564,107	$1,713	$48,982
2003	$1,389,592,363	820,223	$1,694	$49,070
2004	$1,516,443,071	873,937	$1,735	$49,775
2005	$1,629,022,211	810,017	$2,011	$50,967
2006	$3,611,773,498	1,298,922	$2,781	$52,372
2007	$3,342,596,613	1,304,949	$2,561	$51,024
2008	$2,550,062,601	1,084,237	$2,352	$47,987
2009	$2,286,379,795	1,029,214	$2,221	$49,011
2010	$2,785,358,882	1,283,538	$2,170	$46,548
2011	$3,136,830,756	1,472,391	$2,130	$46,059

Table 8: Citizens Average Policy Cost and Median Household Income ($2012)

Assessing Citizens as Insurance

Though market share data provides a way to evaluate the private market perceived insurability of Florida's hurricane risk, an additional metric is needed to assess Citizens' success as a functioning insurance company. Berliner's criteria of insurability (1982; see also Chapter 4) necessitate that an insurer must charge enough in premiums to cover all of the cost of loss. Thus, one means of judging Citizens success or failure in meeting the legislative mandate of insurance it to evaluate the company's ability to cover all the cost of experienced losses. To this end, I use

[39] www.census.gov/hhes/www/income/data/statemedian/index.html
[40] www.bls.gov

Citizens' reporting year loss ratios (incurred loss/earned premium[41]) from 2002-2011 as a metric to judge success as an insurance facility regardless of public/ private market risk perspective (Table 9). Loss ratios greater than one represent a company that has experienced a greater loss in a year than it has earned in premiums that year (or some other predefined period). Loss ratios less than one indicate that the company has experienced less loss in a year than it has earned in premiums. For example, if a company has a loss ratio of 0.6 it means that for every premium dollar earned it spent $0.60 on losses and has $0.40 left over to cover its expenses and profit allowances. The statutory financial statements found on the company website[42] provided loss and premiums information for this calculation.

Year	Incurred Loss (Current Year)	Earned Premium (Current Year)	Loss Ratio
2002	$82,787,119	$522,624,908	0.16
2003	$203,559,758	$823,901,965	0.25
2004	$2,493,126,425	$1,022,502,662	2.44
2005	$2,401,938,689	$1,055,746,118	2.28
2006	$589,743,783	$2,054,284,673	0.29
2007	$711,238,213	$3,074,754,430	0.23
2008	$815,937,717	$2,256,627,536	0.36
2009	$498,999,129	$1,711,428,649	0.29
2010	$603,911,000	$1,971,649,000	0.31
2011	$1,107,600,000	$2,251,731,000	0.49

Table 9: Citizens Incurred Losses, Earned Premiums and Loss Ratio

[41] The insurance industry uses many metrics to evaluate the health of a company. The type of loss ratio I use is also known as the incurred loss ratio. No matter. The point I wish to make here is the difference between earned and written premiums. An earned premium means "The portion of premium that applies to the expired part of the policy period. Insurance premiums are payable in advance but the insurance company does not fully earn them until the policy period expires." On the contrary, a written premium means "The total premiums on all policies written by an insurer during a specified period of time, regardless of what portions have been earned" (III 2013a).

[42] https://www.citizensfla.com/about/corpfinancials-statements.cfm

Conclusion

This chapter provided the methodology for the independent research projects found in Chapters 6, 7, and 8. Overall, the methods provide a multidisciplinary and multimethod approach to policy analysis. I designed each study to provide insight into the process of using insurance as a tool to manage hurricane risk in Florida. Beginning with the social construction of hurricane risk, I use the existing record of hurricane track data to support or reject claims that the geophysical hurricane risk has changed. I design the second study to investigate the process of risk characterization. This study gives particular consideration of the role of catastrophe models in changing perceptions of Florida's hurricane risk insurability. Finally, the last study uses a classic method of policy evaluation. The study uses the policy sciences as a framework to guide inquiry and judge responsibility for the performance of Citizens Property Insurance Corporation. Collectively these studies address the construction, characterization and governing of Florida's hurricane risk.

CHAPTER 6: Are there trends in global hurricane landfall frequency or severity?

Introduction

In recent decades, economic damage from hurricanes around the world has increased dramatically. Scientific literature published to date finds that the increase in losses can be explained entirely by societal changes (such as increasing wealth, structures, population, etc) in locations prone to tropical cyclone landfalls, rather than by changes in annual storm frequency or intensity (e.g. Pielke et al. 2008; Crompton and McAneney 2008; Neumayer and Barthel 2011; Barthel et al. 2012; Bouwer 2011; Raghavan and Rajesh 2003). This chapter specifically focuses on a subset of the historical record of hurricanes with the most direct relevance to understanding economic losses: landfalling hurricanes of at least hurricane force[43]. To date, the scientific literature contains no global homogenized dataset of hurricane landfalls assembled using a consistent methodology.

Using currently available historical hurricane best-track records, I have constructed a global database focused on hurricane-force strength landfalls. This landfall dataset[44] is important for understanding trends in hurricane-related economic losses and can aid in the quantitative determination of the relative contribution to losses by societal and climatic factors. Logically, with a trend in annual frequency of landfalls and/or intensity at landfall, one would expect to see a trend in economic losses after normalizing for societal change. On the other hand, absent a trend in landfall characteristics, there would be no reason to expect a residual climate related trend in losses. Our analysis does not indicate significant long-period global or individual basin trends in the frequency or intensity of landfalling hurricanes of minor or major hurricane strength. This evidence provides strong support for the conclusion that increasing damage

[43] This chapter draws extensively from Weinkle et al. (2012).
[44] The landfall dataset is reproduced in Appendix 1

around the world during the past several decades can be explained entirely by increasing wealth in locations prone to hurricane landfalls, which adds confidence to the fidelity of economic normalization analyses.

Results

Overall, hurricane occurrence is a basin-dependent function of large-scale climate variability on interannual time scales (Gray 1984) as well as shorter-term fluctuations in atmospheric conditions favorable for the organization of convection (Emanuel 1989). While considerable research has been conducted on hurricane climatology in each basin, the annual number of collective global landfalls has not been previously quantified. From the homogeneous dataset, it is apparent that the frequency of global hurricane landfalls is dominated by the Western Pacific (WPAC), which is climatologically the most active basin (Maue 2011), followed by the North Atlantic (NATL). The typical steering flow in the Eastern Pacific (EPAC) does not favor tracks that would result in Mexico coastal landfalls. Australia and Madagascar are the most commonly affected large landmasses in the Southern Hemisphere (SH). Conversely, the Bay of Bengal in the North Indian Ocean (NIO) experiences few landfalls but they tend to cause extremely large social impacts Figure 3.

The collective global frequency of all global hurricane landfalls and the minor and major subsets shows considerable interannual variability but no significant linear trend Figure 4. Furthermore, when considering each basin individually during the entire time periods analyzed, it is not possible to ascertain a positive or negative trend in minor, major, or overall hurricane landfall frequency in all basins except the SH. In the SH a significant positive trend in major hurricane landfalls was detected; yet the sample size is still small Table 10. This result is not unexpected considering the known multidecadal signals in hurricane activity, which cannot be adequately resolved by our comparatively short historical record.

Thus, in the context of climate variability, it is important to recognize that certain shorter time-periods during the past half-century may indeed show significant trends (upward and downward) in hurricane landfall activity on decadal time scales (e.g. Callaghan and Power 2011). The NATL basin has been in an active period since about 1995 which some have attributed to the positive phase of the Atlantic Multidecadal Oscillation (Goldenberg et al. 2001). A linear trend analysis shows a significant upward trend in NATL activity (R^2=0.13, p=0.011) during the past several decades (1970-2010), consideration of the longer period of 1944-2010 exhibits no secular trend in hurricane landfalls (and even longer periods show no increasing trend, see, e.g., Pielke 2009). Intense hurricane frequency has also been shown in the WPAC to be modulated by multidecadal variability (Chan 2008) on time scales of 16-32 years associated with the Pacific Decadal Oscillation (PDO) and variability of the El Niño Southern Oscillation (ENSO), and no significant trend is found in hurricane landfalls during the period examined (1950-2010).

The conclusion of the NATL 2011 hurricane season sets a new record of days (greater than 2,321 days) between major US hurricane landfalls. The most recent major hurricane US landfall was Hurricane Wilma in 2005. For calendar year 2011, according to available NHC and JTWC best-track and preliminary information, a total of 10 hurricane force hurricanes made landfall with three at major strength (> 96 knots) including Yasi (Australia), Nanmadol (Philippines, Taiwan), and Nalgae (Philippines). Elsewhere of note, Irene in the NATL was a weak hurricane when it struck North Carolina and Jova impacted southwest Mexico in the EPAC. Characterized as a La Niña year, 2011 saw considerably fewer hurricane landfalls than, for instance, 1971, also a strong La Niña year with a record 32 global hurricane frequency landfalls. On a global scale, future research may shed light on the uneven distribution of hurricane existence and the proportion that make landfall.

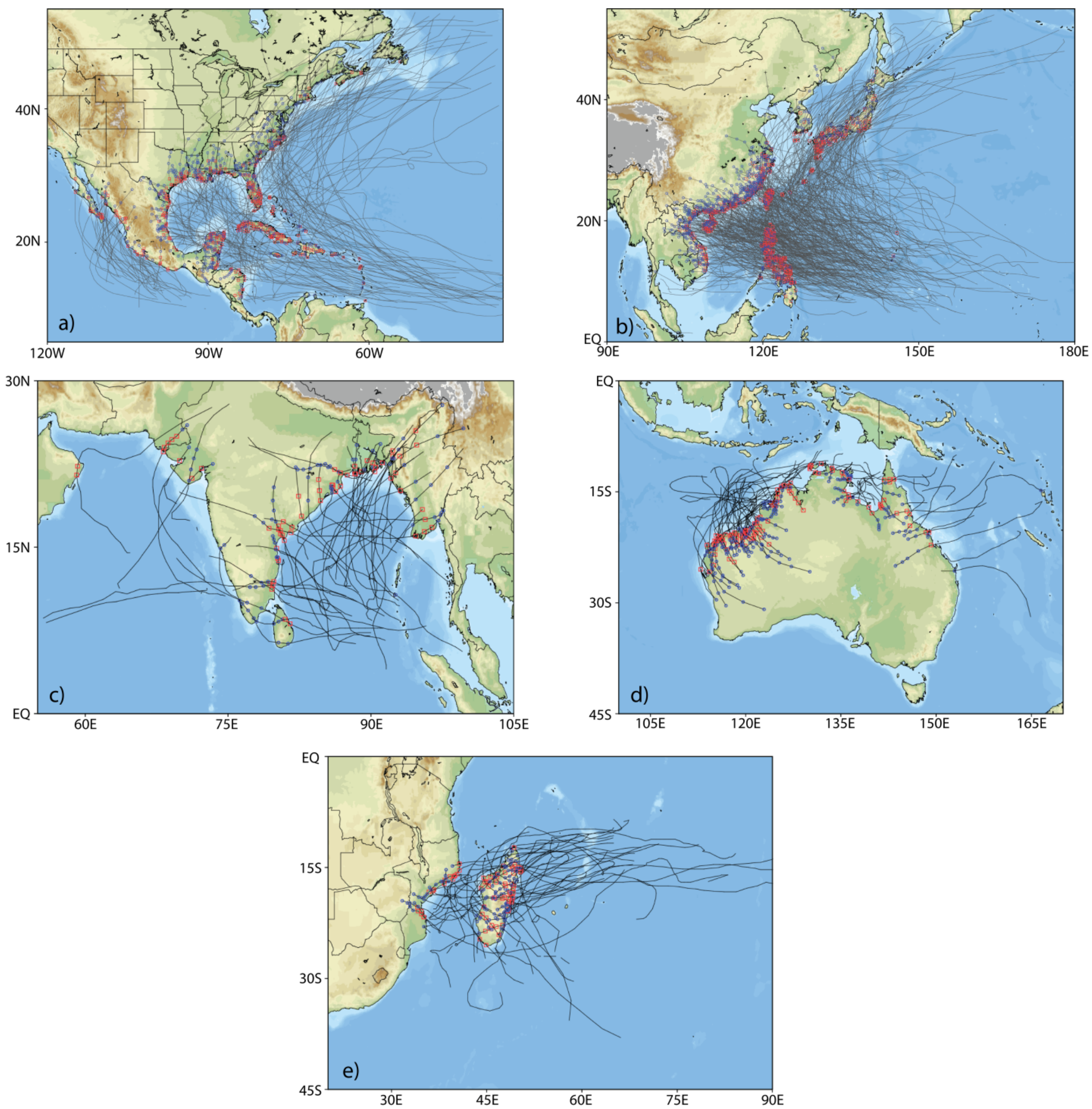

Figure 3: Hurricane tracks and landfall location points for storms that make landfall at hurricane intensity (maximum one-minute sustained ≥ 64 knots) for the (a) North Atlantic and Eastern North Pacific, (b) Western Pacific, (c) North Indian, and (d and e) Southern Hemisphere. Each hurricane track line connects the 6-hourly best-track positions with red squares indicating a hurricane force landfall location point and blue circles indicating over land observations of tropical storm strength (wind speed between 34-63 knots). For reference, non-tropical overland or extratropical positions are indicated with a black cross where such information exists in the best-track database.

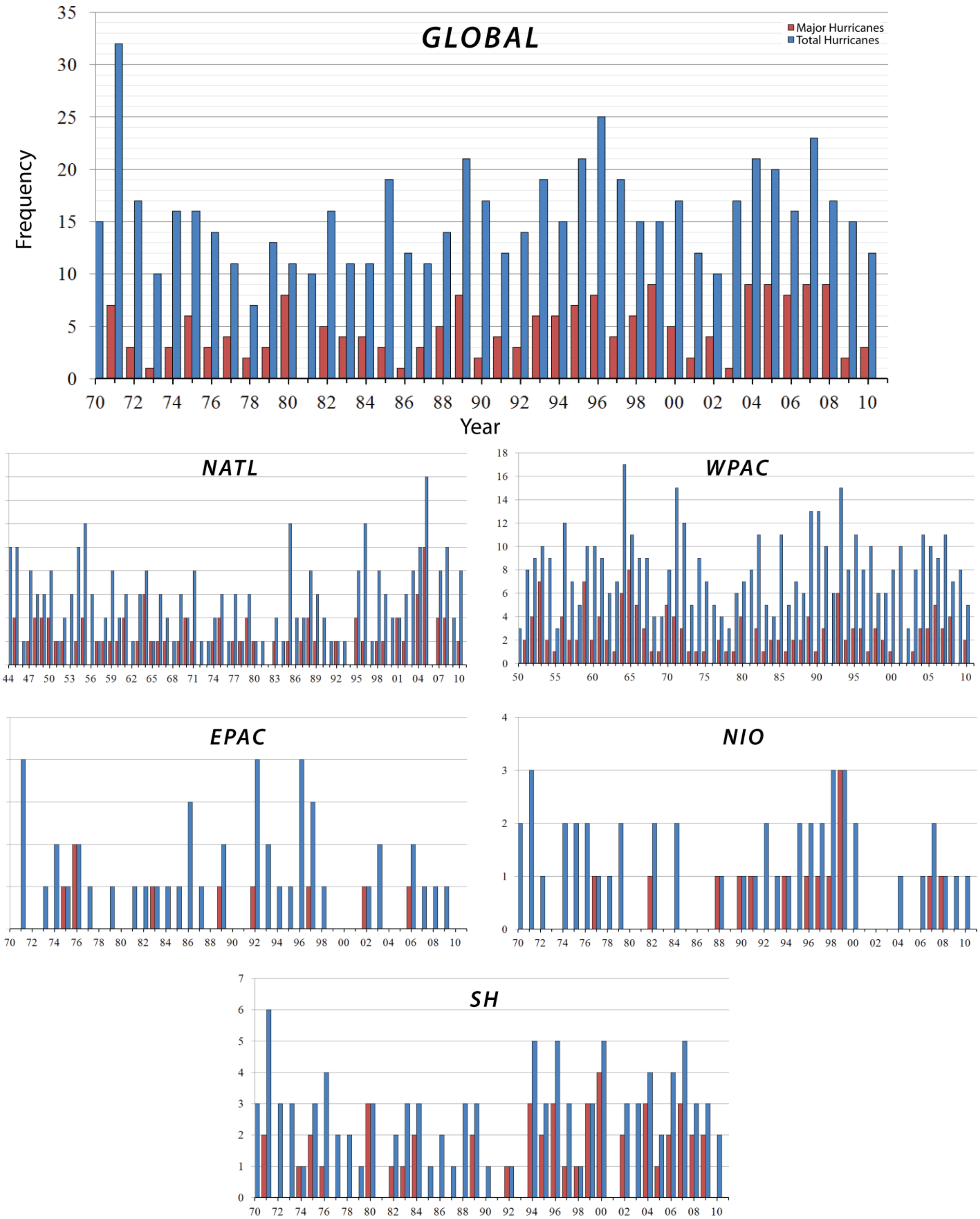

Figure 4: Global and basin hurricane landfall annual frequencies of storms of major (red) and both major and minor (blue) hurricane intensity at landfall.

Basin	Period of Analysis	Total Landfalling Hurricanes	Minor (Major)	Minor R^2 (p value)	Major R^2 (p value)	Total R^2 (p value)
NATL	1944-2010	180	111 (69)	0.0027 (0.68)	0.0013 (0.77)	0.0003 (0.89)
EPAC	1970- 2010	47	38 (9)	0.0034 (0.72)	0.0038 (0.70)	0.0063 (0.62)
WPAC	1950- 2010	494	345 (149)	0.0378 (0.13)	0.0397 (0.12)	0.0016 (0.76)
NIO	1970- 2010	48	34 (14)	0.0627 (0.11)	0.0484 (0.17)	0.0086 (0.56)
SH	1970- 2010	105	57 (48)	0.0725 (0.08)	0.1267 (0.02)	0.0087 (0.56)
Global	1970- 2010	637	442 (195)	3e-06 (0.99)	0.0889 (0.06)	0.0268 (0.31)

Table 10: Global hurricane landfall trend significance partitioned according to basin and minor/major hurricane intensity. Total hurricanes observed include all tropical cyclones observed with at least maximum lifecycle wind speed of 64-knots (Saffir- Simpson Category 1 and above).

Conclusion

From currently available and reliable historical hurricane records, I constructed a long-period global hurricane landfall dataset using a consistent methodology. I have identified considerable interannual variability in the frequency of global hurricane landfalls, but within the resolution of the available data, the evidence does not support the presence of significant long-period global or individual basin linear trends for minor, major, or total hurricanes within the period(s) covered by the available quality data. Therefore, the long-period analysis does not support claims that increasing hurricane landfall frequency or landfall intensity has contributed to concomitantly increasing economic losses. Due to documented multidecadal variations in hurricane frequency and intensity on global and basin scales, our findings strongly support the usage of long-period historical landfall datasets for trend analysis (cf. Liebmann et al. 2010).

While there is continued uncertainty surrounding future changes in climate (Knutson et al. 2010), current projections of hurricane frequency or intensity change may not yield an anthropogenic signal in economic loss data for many decades or even centuries (Crompton et al. 2011). Thus, my quantitative analysis of global hurricane landfalls is consistent with previous research focused on normalized losses associated with hurricanes that have found no trends once data is properly adjusted for societal factors (e.g. Pielke et al. 2008; Crompton and McAneney 2008; Neumayer and Barthel 2011; Barthel et al. 2012; Bouwer 2011; Raghavan and Rajesh 2003).

CHAPTER 7: The political process of ratemaking and the role of catastrophe models in characterizing Florida's hurricane risk

Introduction

This chapter characterizes the role of catastrophe models in the evolving perceptions of Florida's hurricane risk. I argue that, due largely to the time scales involved, evaluation of the models along traditional metrics of scientific quality is limited and generally, not possible. Because of this, decisions about models rely on preferences of decision makers. Invoking the conventional wisdom of scientific ratemaking neglects the vast array of value decisions underlying the decision making process about models and ultimately, rates. Decision makers with conflicting perspectives on the ratemaking process selectively choose modeling science to support desired goals. Unfortunately, making the entire debate about Florida's hurricane risk into one about modeling science undermines the democratic process. I conclude with a discussion of implications for turning all of Florida's difficulties with insurance into a debate about modeling science.

The term 'regulator' needs clarification. I use the term to mean those that make decisions that establish boundaries for estimating the Florida hurricane risk. This term includes a great many people and types of jobs beyond that of Florida's official insurance commissioner. For instance, I consider the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) as a type of regulatory body and its members as regulators. Legislators may also serve as regulators when they create policy that bounds the construction or characterization of the hurricane risk. I use this term in this way because those working to govern the hurricane risk act on behalf of multiple interests. For example, some legislators make decisions to remove regulatory binds on risk while some make decisions to put regulation into place. So I find it insufficient to use ‘legislator’ as a term to suggest those that make decisions in a particular way. However, when I use the term ‘legislators’ (e.g. legislators mandated that…) I mean a decision made with the authority of the Florida legislature regardless of how individual legislators may have voted.

This chapter continues in four main sections. The first section explains why catastrophe models cannot be evaluated along traditional metrics of scientific quality and the need to rely on value preference for decision making. Different estimates of risk imply the need for different policy solutions, such as changes in rates or the purchase of additional reinsurance. Without a unique scientific argument for choosing one model over another, a decision maker must choose a model based on outcome preferences. Still, without any indication that the estimates produced by the models reflect experience and some indication that users know this, the use of them as proof for decision making represents an odd policy paradox.

In the second section, I examine the myth of scientific ratemaking based on catastrophe models and present the ratemaking process as a wholly political process from the making of a catastrophe model to the final rate decision. The wealth of scientific information available for use in catastrophe models provides support for nearly any position on risk. Though, different estimates imply different policy needs. This means that decisions about models are decisions about preferred outcomes. In turn, catastrophe models act as political tools in the ratemaking process providing information for perspectives to use in influencing rate decision making. I describe two main groups of conflicting perspectives, the technocratic and the democratic.

The third section narrates perceived changes of Florida’s hurricane risk from a technocratic and democratic perspective. I divide Citizens’ history from 2002- 2011 into four periods for which the Florida’s hurricane risk exhibit a combination of relative affordability and insurability. I provide evidence supporting a significant role of catastrophe models in creating a perceived uninsurability of the hurricane risk by the private market.

The fourth section discusses implications for democracy. I argue that the intense focus on catastrophe modeling science as a means to manage Florida's hurricane neglects the underlying trade-off between insurers' insolvency risk and policy affordability. Neglecting this heart of the matter challenges the democratic process in three ways: it limits the scope of the debate to ratemaking, places scientists into the inappropriate role of policy maker, and reduces public participation in expressing value preferences and exploring policy options.

Finally, I conclude that the constant negotiation of Florida's hurricane risk has benefits by providing opportunity to assess the economic situation in the state and changing public policy goals. However, maintaining the guise of a valueless scientific approach to ratemaking that requires first 'getting the science right' invites controversy into the ratemaking. This occurs because a debate about modeling science offers no one any place else to look to achieve policy objectives. Because the underlying problem has little to do with the science, catastrophe models serve simply as political tools for negotiation.

The Inability to Evaluate Catastrophe Models Against Traditional Metrics of Scientific Quality Creates a Paradox for Decision Makers Who Rely On Them for "Proof"

Alarmed by the losses experienced from the 1992 landfall of Hurricane Andrew, insurers and regulators sought more information about Florida's hurricane risk from recently developed catastrophe models. The models gave new estimates of loss potential that "scared" insurers (Rep. John F. Cosgrove, Subcommitte on Consumer Credit and Insurance 1993). Public officials expressed great concern that the models altered power dynamics between the state and the private market in the decision making process about risk (Subcommitte on Consumer Credit and

Insurance 1993; Musulin 1997; Whitehead 1997). In a Congressional hearing, Rep. Joseph Kennedy (D-MA) argued that catastrophe models put the state into the position of relying on insurers for information about its own risk "like letting an accused wrongdoer pick his own judge and jury" (Subcommitte on Consumer Credit and Insurance 1993). But, the models appealed to insurer and regulatory desires to have a technologically sophisticated basis for establishing windstorm rates and decision makers became "increasingly dependent" on the models for ratemaking (Committee on Banking and Insurance 1999, p. 9).

Catastrophe models play a central role in routine decisions made by insurers and regulators, yet they are used without consideration of their scientific quality. Although catastrophe modelers originally developed the models to evaluate "what-if" catastrophe scenarios (Clark 1986) and had difficulty in validating the models (Clark 1986; West and Lenze 1994), the insurance industry rapidly and widely accepted the technology for use in making decisions about rates arguing that the models provided "the only alternative" to the "obviously disproven method" of estimating risk based on average losses (Schulte 1996). Ultimately, the legislature accepted catastrophe models for use in Florida's ratemaking procedure with regulatory oversight by the FCHLPM to assure that modeled risk estimates met the standards of "accurate" and "reliable." Insurers and regulators use the models to provide scientific basis and legislatively mandated "proof[45]" for the promotion of desired rate decisions. Catastrophe models have real world consequences because models impact insurers' judgment about needed rates. Rate decisions matter because they change the cost of insurance to policyholders; and they influence insurers' real and perceived insolvency risk, a significant consideration for their willingness to make insurance available (Cole et al. 2010). For several reasons though, the ability to evaluate

[45] FL ST 627.062(2)(g)

the scientific quality of catastrophe model predictions remains illusive, if not impossible (see also Oreskes et al. 1994; Tebaldi and Knutti 2007; Pirtle et al. 2010). Here, I discuss three common metrics of scientific quality: skill, accuracy, and reliability (Murphy 1993), and the barriers to evaluating catastrophe models along these lines.

Predictive models demonstrating scientific skill show improvement as compared to some baseline standard such as the long-term average (Murphy 1993). Difficulty in evaluating a catastrophe models for scientific skill arises from limited data availability and the time scales needed to evaluate predictions. Moreover, as knowledge changes so too does the baseline standard meaning that past and current predictions may not be consistent with future risk perceptions or measurements. Consider that scientists actively contest the reason for and the extent of the variability in hurricane frequency (e.g. Maue 2011; Vecchi and Knutson 2011; Crompton et al. 2011). As new information about the past and future hurricane record arises, predictions needing long time frames for verification become obsolete.

The scientific literature abounds with scientists' observed correlations between hurricane behavior and ocean-atmosphere processes that they use for prediction, but a limited number of observations makes it difficult to determine which of these predict best (Pielke 2009). This means that using these correlations, models showing skill in the short run can over a longer period of observation demonstrate to have no skill and its successful predictions made by chance alone (Pielke 2009; see also Tversky and Kahneman 1971). Likewise, a prediction without skill in the short run may prove skillful over a longer time period. In a correspondence with a Florida newspaper, Hemant Shah, CEO of the catastrophe modeling firm RMS, argued that there is no reason to expect the RMS hurricane catastrophe model to show skill in the short run because "the actual number experienced in a particular period will be just one sample from a broad distribution of possible outcomes" (Shah 2010). Yet for practical use in decision making, a broad distribution of possible outcomes without demonstrable skill has little difference from use of no model at all and the human learned wisdom that life consists of many possible outcomes.

The time frame necessary to confirm skill of the model's event catalog also frustrates evaluations of skill. Catastrophe models use large catalogs of hypothetical, events on the order of thousands, tens of thousands or even hundreds of thousands, under the premise that these catalogs are "representing the entire spectrum of plausible events" (AIR 2013). One needs an unreasonable amount of time, perhaps on the order of millennia, to acquire enough observations to evaluate the skill of event sets of these sizes, particularly when affiliated by such a boastful claim. For all practical purposes then, the ability to judge a catastrophe model's skill is quite limited at best.

An accurate prediction corresponds to observations (Murphy 1993). Unlike weather forecasts (e.g. hurricane forecasts) that estimate where and when meteorological events will occur, catastrophe models predict the outcomes of scenarios such as, "What is the loss potential of a Category 3 hurricane making landfall in Jacksonville, FL while heading north, northwest?" The accuracy of these types of predictions depend on the scenario considered and given the closed system abilities of a model compared to the open social-geophysical systems, producing an accurate prediction is likely impossible (Tebaldi and Knutti 2007).

Likewise, evaluating model accuracy has limitations of human knowledge about how the world works. Models are inherently theoretical and they vary by representing different takes on how different components of a system behave and interact (Morrison and Morgan 1999b; Oreskes et al. 1994). The FCHLPM describes the difficulty in evaluating a model for accuracy, "'accurate' cannot necessarily mean that a model conforms exactly to known facts since that contradicts the nature of the modeling process" (FCHLPM 2011, p. 39). Because of this, the FCHLPM redefines the traditional scientific notion of accurate[46] to mean that "the models meet the standards that have been developed" (FCHLPM 2011, p. 39). Under this new definition, predictions can run the gamut of imagination while still maintaining the semblance of accuracy. For example, (Cole et al. 2010) found a significant difference between loss estimates made by several accurate models approved by the FCHLPM. Given a different group of approved models, (Watson and Johnson 2004) demonstrated great differences in loss estimates and "extreme sensitivity" to small variations in input. Given that human knowledge about the complex world has limitations, evaluations of model accuracy depend upon the evaluators' judgment of the acceptability of the knowledge or hypothesis, represented in parameter choice, used to build the model (Boumans 1999; Tebaldi and Knutti 2007).

The reliability of a prediction relates to the consistency between observations and forecasts (Murphy 1993). The FCHLPM describes a reliable model as one which "will consistently produce statistically similar results upon repeated use without inherent or known bias" (FCHLPM 2011, p. 39). However, coupled with an inability to evaluate skill or accuracy the single dimension of reliability is not a sufficient to evaluate the predictions for scientific quality (Murphy 1993). Three reasons demonstrate how this is so. First, consider a model that annually predicts no hurricane landfalls in the state of Florida. Such a model meets the scientific quality standard for reliability and yet, it is counterintuitive. Alone, the metric of reliability permits for reliably wrong models. Second, judgment of consistency between observations and

[46] The redefinition of scientific accuracy aimed at evaluating the 'accuracy' of the model's internal assumptions perhaps has something to do with the way legislators worded the statute requiring model accuracy and reliability. The legislation directs the FCHLPM to evaluate the "accuracy or reliability of particular methods, principles, standards, models, or output ranges." From a scientific standpoint, the wording is odd at best (see FL ST 627.0628(3)a).

predictions can conflict amongst experts such as, model developers, their competitors, users, and regulators (e.g. Karen Clark & Company 2011; Willis Re 2012; and FCHLPM judgments vs. private market judgments). Without an ability to appeal to other metrics of scientific quality conflicting opinions of reliability amount to just that- a difference of opinion. Third, scientists often use model agreement as a proxy for reliability with the implied assumption that if the models agree then the prediction is likely correct (Pirtle et al. 2010). To the extent that models rely on the same underlying assumptions they will agree, but this does not make them "right" (Tebaldi and Knutti 2007; Pirtle et al. 2010). This strategy only provides a sense of reliability if the models arrive at a shared conclusion based on independent assumptions (Tebaldi and Knutti 2007; Pirtle et al. 2010; Raisanen 2007).

Because the nature of catastrophe models makes them resistant to evaluations of scientific quality their ability to predict future occurrence remains unknown. The extent to which the models disagree reflect disagreements in knowledge and differences in the model makers' choice in parameter inclusion and exclusion (Tebaldi and Knutti 2007). The extent to which they agree has little meaning without demonstrating model independence (Pirtle et al. 2010). This sets up a concerning paradox, insurers and regulators regularly use catastrophe models to inform policymaking about rates without any grounds for justifying that the models reflect empirical reality. Without any unique scientific basis upon which to make decisions about which model to use and how, decision makers must resort to considerations of desired value outcomes, using the models to represent hedges on the risk traditionally defined by the historical average (Pielke 2009). Decision makers may have many reasons to hedge the risk estimate but these types of decisions inevitably make considerations of personal preferences and feelings (Slovic et al. 2004; Loewenstein et al. 2001).

Scientific Ratemaking is a Myth. Ratemaking is a Political Process.

Conventional wisdom holds that hurricane catastrophe model predictions directly result from scientific knowledge and therefore, depict the true or real risk. As such, modeled risk ought to dictate rate decisions hence, “scientific ratemaking.” This wisdom assumes a linear relationship between science, risk and rate decisions and that more scientific information produces better risk predictions and better outcomes (Figure 5). A slogan from the catastrophe modeling firm, AIR, demonstrates the assumption, “Better Technology/ Better Data/ Better Decisions.” However, this idealized process of ratemaking exists as a myth (cf. Schulte 1996) because the process of constructing a model and choosing a risk estimate requires reflection on the decision makers’ desired outcomes. As a result, catastrophe models act as political tools to negotiate understanding about risk in the political process of ratemaking.

Figure 5: Linear model of ratemaking

Decisions about Models are Decisions about Preferred Estimates of Risk

Decisions about science are inherently value laden (Robinson 1992). Catastrophe models include many parameters, each one its own implicit hypothesis about the how a particular aspect of the world is best approximated (Tebaldi and Knutti 2007; Morrison and Morgan 1999b). For example, scientists attribute the above average Atlantic hurricane activity observed since 1995 to elevated sea surface temperatures (SST), but how the two are related and implications for the future has been a source of much scientific debate (Vecchi et al. 2008; Knutson et al. 2010). Scientists hypothesize and seek to demonstrate the ability of numerous quantified indices or “signals” in the ocean-atmosphere historical record to act as predictors of Atlantic SST (Pielke

2009; to name but a few: El Niño-Southern Oscillation (Gray 1984), North Atlantic Oscillation (Elsner et al. 2000), Atlantic Multidecadal Oscillation (Goldenberg et al. 2001), anthropogenic produced aerosols, (Mann and Emanuel 2006), and ocean color (Gnanadesikan et al. 2010)). Thus, inclusion of any one of these parameters requires the model maker to take a position on scientific knowledge of cause and effect relationships in the physical world. At the same time, the ample options to choose from the scientific literature offer the opportunity for nearly an infinite number of risk estimates.

The extensive availability of science and risk estimates create an "excess of objectivity" where "a huge body of knowledge whose components can be legitimately assembled and interpreted in different ways to yield competing views of the 'problem' and of how society should respond" (Sarewitz 2004). For example, hurricane catastrophe models approved by the FCHLPM, under 2009 standards, provided, with 95% confidence, an aggregate uncertainty range for the same portfolio for the 100-yr PML between $18- $146 billion[47]. This means that for an insurer seeking to manage this portfolio, the insurer faces an annual 1% probability of a loss anywhere between $18 billion and 8 times as much. The insurer may judge any number within this range as accurate, reliable and consistent with state-of-the-art science. Yet, the modeled estimates imply: the need for vastly different (re)insurance rates, contrasting conclusions about the economic stability of the insurance regime, mixed cost effectiveness of infrastructure decisions, and different sets of winners and losers.

Efforts to reconcile differences among modeled risk estimates by model users, such as individual insurance companies, exacerbate the excess of objectivity about the risk by increasing the number of risk estimates while invoking ever more expertise. Insurers develop personal

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[47] www.sbafla.com/methodology

techniques of modeling their own acceptable view of the risk by selecting/deselecting specific modifiers, "blending" the results of several models, and/or developing their own in house model based in part on commercially available models. Outside of Florida regulation, insurers widely consider these methods as valid interpretations of the risk based on expert judgment. Yet the extent to which any of these estimates reflect a consensus on scientific knowledge appears limited. To demonstrate the circular logic of appealing to experts to produce risk estimates with limited grounding in scientific knowledge I provide a short excerpt of an interview with an insurance executive, named here as Insurance Executive C (2012) to maintain confidentiality. I asked him a series of questions relating to insurers' decisions about models,

> **Insurance Executive C:** A lot of the big [insurance] companies and all of reinsurers take bits and pieces of them [i.e. the models] because they are trying to figure out- they are not trying to raise the rates- they are trying to figure out what's the best, who's got the most accurate estimation of the risk. And so, most companies use both models [i.e. two of the leading industry catastrophe models] and then develop sort of their own methodology to try and figure out how to blend those two together.
>
> **Author:** How do you know it's an accurate estimate of risk?
> **Insurance Executive C:** You don't. It's not. It never will be. That is the unpredictability, the variability of insurance pricing. They [i.e. the models] are the best tools that we have right now, but they are going to be wrong.
>
> **Author:** So how do you decide on how to blend them?
> **Insurance Executive C:** Well that's all, individual companies work on that and spend a ton of money and have PhD's of their own.

The conversation demonstrates the infinite assembly of scientific information to produce an increasing excess of legitimate risk estimates as insurers seek the best estimate. Though the choosing the best estimate depends upon expert judgment of accuracy, that the models cannot attain accuracy seems, according to Insurance Executive C, well known. Thus, involving scientific experts into the decision making process serves to legitimate the decision making (see also Jasanoff 1990), but without actually clarifying the state of scientific knowledge.

The interview with Insurance Executive C also demonstrates that given a range of scientifically sound risk estimates, some estimates appear "better" than others for substantiating a favorable position on risk (see also Moran 2000). I provide two examples of insurance interests consciously reflecting on values other than scientific quality for model choice. First, in 2011 RMS released a hurricane catastrophe model that produced markedly elevated estimates of risk by including a new method of modeling wind or "filling" (RMS 2011). Some in the insurance industry media advocated the use of the RMS model to address reinsurance struggles with a persistent soft market[48] because the model increased the amount of money that insurers had to hold onto in the event of a large loss thereby reducing the amount they had as 'excess' (Simpson 2011b). In this way, the RMS model view of risk offered a solution to a perceived market problem.   Another example of using one model over another because it provided an estimate perceived as better occurred in 2012 when Citizens sought investors for a very large catastrophe bond[49]. To provide a credit rate the bond, Standard and Poor's (S&P) chose to use an AIR model "conditioned" on warmer than average SST over AIR's model based on the standard catalog because the conditioned model "generated a more conservative (higher probability of attachment) result" (S&P 2012). By assuming a higher probability that Citizens would have a large enough loss that would require use of the bond, S&P hedged their risk estimate in a way that they perceived as better. In either the case of RMS's wind filling or AIR's conditioned SST, model users had to make a decision for using these amongst many others and

[48] A soft market is "an environment where insurance is plentiful and sold at a lower cost, also known as a buyers' market." In contrast a hard market is "a seller's market in which insurance is expensive and in short supply." The vacillation between the two is known as the property and casualty insurance cycle (III 2013a).

[49] At the time, the Citizens' bond ranked as the largest catastrophe bond sold at $250 million. It has since been surpassed. A list of catastrophe bonds can be found at www.artemis.bm/deal_directory.

in order to do so, they looked beyond considerations of scientific quality towards considerations of the financial market.

Decisions about Rates are Decisions about Preferred Outcomes

Decision making by nature is forward looking with the intent of reducing uncertainty about the future and ensure favorable outcomes (Lasswell 1971; Sarewitz et al. 2000; Pielke 2007). Insurers' and regulators' decisions about insurance rates are no different; and they set insurance rates to reduce unfavorable outcomes and increase favorable ones (Meier 1991). When those involved in the ratemaking decision process have perspectives on favorable outcomes that conflict then they must participate in politics, the process of bargaining, negotiating, and compromise (Pielke 2007), to maximize shared values and make a rate decision. In the ratemaking process politics comes into play at many decision points, such as the construction of models that "make sense" (AIR Worldwide 2012), selecting which models to use and how (e.g. Moran 2000), deciding an acceptable measure of risk (Fischhoff et al. 1984b), and choosing insurance rates to meet societal goals (see also Meier 1991). Consequently, the ratemaking process is non-linear and necessarily political (Figure 6).

Decisions about risk present trade-offs in society- a decision one way or another creates different sets of winners and losers. Risk scientist Kenneth Hammond (1996) argued that in situations of decision making under irreducible uncertainty, decision options represent trade-offs in types of error; and perspectives align around the favorability of false positives and false negatives. As the chance of a false positive (action when the future demonstrates that in hindsight that no action was warranted) increases, the chance of a false negative (no action when the future demonstrates that action was warranted) decreases. Likewise, increasing the chance of a false negative decreases the chance of a false positive.

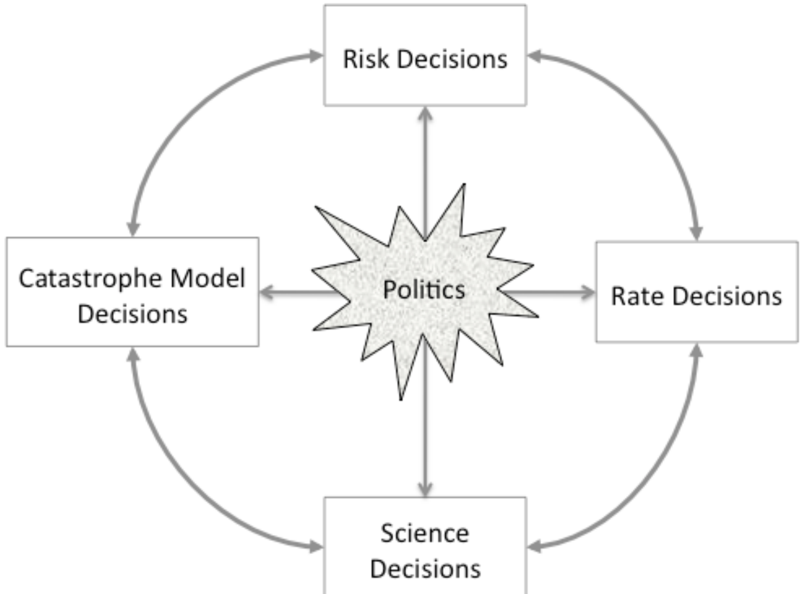

Figure 6: Ratemaking is a political process of decision making

I demonstrate how false positives and false negatives lead to risk bearing trade-offs in society by comparing several model estimates of Florida's annual insured hurricane loss[50] (Figure 7). In this exercise, each model estimate represents a prediction of the Florida's average annual loss (AAL)[51] for all lines of business. The Historic model uses normalized historic losses to calculate the AAL (Pielke et al. 2008). This represents a traditional estimate of risk- simply, the average loss. The Approved FCHLPM model is the approved FCHLPM created by a popular commercial vendor's catastrophe model. The Wind and Wind + Surge models are from the same commercial vendor but are not approved by the FCHLPM. Though the insurance industry commonly uses these models. The Wind and Wind + Surge models differ by the inclusion considerations of storm surge damage that is mistaken as wind damage in the latter model. The insurance industry often calls this "storm-surge leakage."

[50] For methodology on the creation of Figure 7 and Table 12 see Appendix 3.

[51] To reduce confusion I use AAL for this discussion. The pure premium and the AAL are equivalent concepts, but they are calculated differently. The pure premium is traditionally measured as the average loss; this metric has a long history in insurance. The AAL also represents an average loss but has a different calculation process and is unique to catastrophe modeling (Chapter 4).

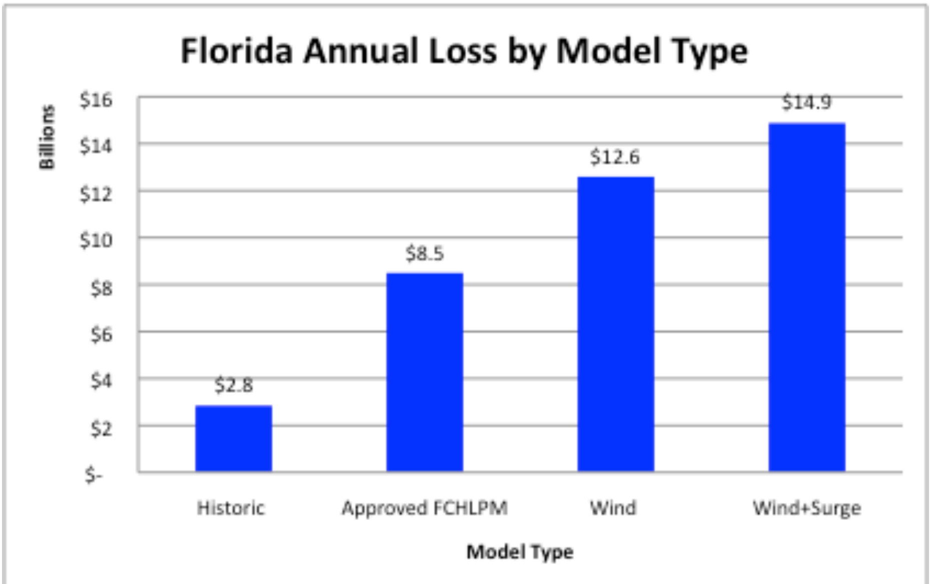

Figure 7: Florida estimated annual insured hurricane loss by model type

Table 11 shows the number of times that a given model's prediction is lower (i.e. false negative) or higher (false positive) than a normalized Florida historical loss event (i.e. observations). The annual loss estimate will rarely if ever be spot on, but will come in too high or too low when compared to experience[52]. The table demonstrates trade-offs in decision making about choosing a risk estimate. For example, using the AAL from the Historic model, policyholders pay too much 68% of the time but too little 32% of time. When policyholders do not pay enough to cover losses, they burden insurers with the risk of insolvency. In comparison, using the Wind model, policyholders pay too little 13% of the time but too much 87% of the time. This scenario sees insurers' decreasing the probability of not having enough money for a loss but increasing the likelihood that policyholders pay more than they need to more often. Interestingly, the Wind +Surge model estimates a larger AAL than wind alone, but with no change in the number of times the estimate comes up too high or too low. This scenario sees no added advantage for policyholders- they pay more for policies and the probability of their insurer

[52] I note a caveat in the comparison of AAL (also, pure premium) to event loss rather than loss year. For the demonstrative purposes sought here I overlook the incongruity.

becoming insolvent remains the same. But in so much that an increase in price benefits the insurer while not reducing the chance of insolvency, the scenario represents a benefit for insurers.

The Approved FCHLPM represents a compromise of risk bearing trade-offs in Florida. Certainly, the policyholders and insurers alike wish to reduce the chance of insurer insolvency. But at the same time, policyholders do not want to pay more than they have to for their coverage. The Approved FCHLPM decreases the chance of insurer insolvency as compared to the Historic model but not as much the non-approved commercial models. As well, the Approved FCHLPM increases the chance that policyholder pay too much but limits the frequency of this as compared to the non-approved commercial models.

Making a choice of one of these models for use in ratemaking influences the allocation of risk in society (Hammond 1996). Different groups in society have an interest in seeing that decision makers choose one way or another. The Historical model presents a clear disadvantage to insurers and to policyholders that value their insurers' solvency. Likewise, the Wind + Surge model represents a clear disadvantage to policyholders, while offering a slight advantage to insurers. In order to meet the shared goal of reducing the risk of insolvency while appealing to the policyholders' want for not paying more than necessary, the Approved FCHLPM provides a compromise.

Average Annual Loss…	**Model Type**							
	Historic		**Approved FCHLPM**		**Wind**		**Wind + Surge**	
	Count	%	Count	%	Count	%	Count	%
Too Small	26	32	13	16	11	13	11	13
Too Big	56	68	69	84	71	87	71	87

Table 11: Tradeoffs of various risk estimates

Catastrophe Models Act as Political Tools in the Political Process of Ratemaking

Catastrophe models act as a primary conduit of information about hurricane risk (Grossi and Kunreuther 2005). The multitude of catastrophe models available represent perspectives' unique positions on the information relevant for understanding and negotiating between interests about the risk (see also Sarewitz 2004; Carlile 2004). One need not understand how the model works in order to make use of the information it produces to represent a perspective (Star and Griesemer 1989). In this way, the models act as a "black box" representing a neat and compact conclusion based on select aspects of science while masking the controversy and debate underlying the conclusion (Latour 1987). Catastrophe modeling firms compete for business by providing different perspectives by way of estimates for the same risk (e.g. RMS 2013; Hemenway 2013). In turn, insurers use the models to compete in the marketplace. Global insurance broker, Aon, explains,

> If you don't do the catastrophe modeling, the underwriters do theirs and they tell you what the price for risk transfer is—and you have no basis for negotiation…Because there are several modeling firms, and the strengths of each vary by region of the world and the catastrophic event being modeled, it's prudent to work with a broker to carefully analyze and select the models that will deliver the optimum results for your portfolio (Aon 2010).

Aon demonstrates that the ability to define risk provides power in the process of negotiation (Fischhoff et al. 1984b) and that catastrophe models offer the opportunity to inform and persuade so that the user can maximize desired outcomes.

When one uses the catastrophe model to influence decision making one invokes scientific authority as a means to exercise power (Lasswell 1956, 1971). But in the case of catastrophe modeling science, the scientific authority is fractioned. The models provide a way for insurers to communicate despite disagreement about knowledge (Star and Griesemer 1989), influence perceptions of risk and influence rate decision (see also Elder and Cobb 1983). Though, without a means to judge the scientific quality of model output there is no way to decide who is "right." As such, catastrophe models act simply as political tools in the process of negotiating decisions in the ratemaking process.

The Role of Catastrophe Models in Evolving Perceptions of Florida's Hurricane Risk

Though perspectives use different catastrophe models and their different estimates of risk to support their position on desired rates, the information provided by them may not appeal to all interests. Many participants in the decision making process, such as the public, may view the information provided by the models as irrelevant and instead promote narrative facts on experience (Pielke 2007). For the purposes of this narrative then, I describe the technocratic and democratic process of decision making as two idealized, competing perspectives involved in Florida's ratemaking process (Jasanoff 1990). The technocratic perspective (TP) of decision making approaches ratemaking as a technical exercise (Pielke 2007). The TP lean heavily on catastrophe models as political tools to demonstrate the importance and validity of making particular rate decision. Though the TP also relies on value preferences, the appeal to science as a valueless enterprise to inform decision making often acts to hide these values (Jasanoff 1990; Robinson 1992; Pielke 2007; Oreskes and Conway 2010; Sarewitz 2004). The democratic perspective (DP) of decision making approaches ratemaking as a process of public policy making that requires considerations of multiple goal values. Though the DP often requires the production and consideration of technical information such as catastrophe models in the ratemaking process (e.g. Fine and Owen 2005), it also demands the incorporation of non-technical information about social values and public grievances (Jasanoff 1990).

This section provides a narrative of the role that catastrophe models have played in evolving the perception of Florida's hurricane risk. I focus on the political process of making decisions about rates for Citizens. Legislators mandate that Citizens provide affordable property insurance. Therefore, ratemakers must define a risk for Citizens that is both affordable and insurable. Because catastrophe models act as the main conduit of information about risk for the insurance industry (Grossi and Kunreuther 2005), catastrophe models serve as an ideal nexus to understand conflict and compromise between the TP and the DP. As well, to the extent that different models represent different perspectives on risk disagreement between models indicates value conflict and situation of active politics (Weingart 1999).

Each section of the following narration corresponds to a quadrant on the 2x2 matrix of possible risk outcomes. Figure 8 shows the same matrix as in Figure 2, but filled out with representative time periods. The reader must remember to consider the matrix axes as a continuum and each quadrant representing *relative* affordability/unaffordability and insurability/uninsurability. Figure 9 shows metrics used to understand and characterize the role of catastrophe models in risk affordability and insurability. The reader should keep in mind that a high incidence of media reporting on hurricane or windstorm insurance indicates perceived unaffordability.

Risk Success: 2002- 2003

Relative to the rest of the time period analyzed, 2002- 2003 demonstrated success in defining an affordable and insurable hurricane risk. The public expressed little concern about windstorm insurance and Citizens' market share was well below average indicating that the private market accepted Florida's hurricane risk as insurable. In 2002, the year legislators created Citizens, the models demonstrated above average disagreement about the AAL that could have invited controversy over rates. However, at the time, participants in the ratemaking process understood that Citizens would maintain the same rate structure as its predecessors, the Florida

Windstorm Underwriting Association (FWUA) and the Florida Residential Property and Casualty Joint Underwriting Association (JUA) (Deffenbaugh 2002). Several years prior, in 1999, regulators permitted a substantial rate increase for the FWUA with the intention of implementing the rate increase over a period of years and with the final increase in 2004. Thus, without catastrophic events and with an existing plan to steadily increase the cost of windstorm coverage Florida had little political controversy over rates in 2002.

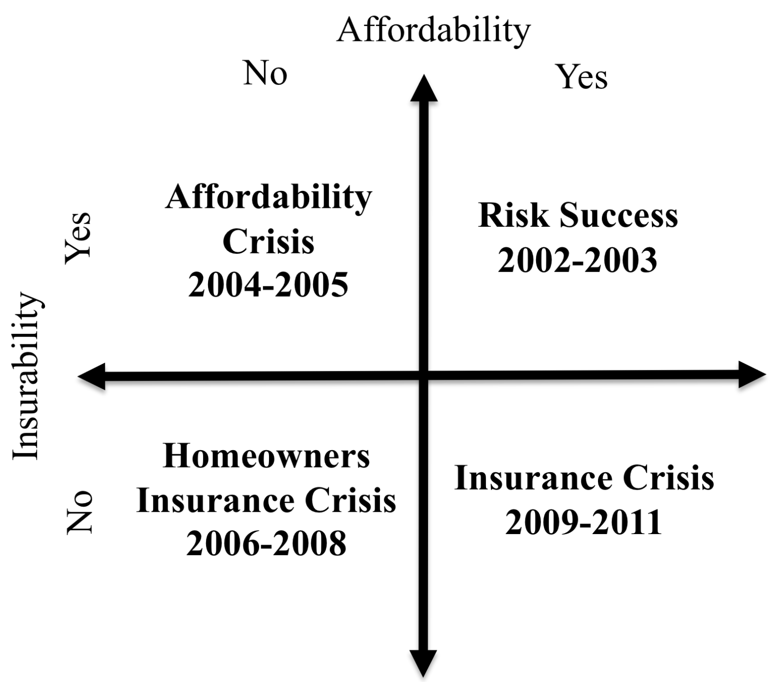

Figure 8: Periods of time when Florida hurricane risk depicted relative affordability and/or insurability

Affordability Crisis: 2004-2005

In 2004 and 2005, public concern about the windstorm insurance regime escalated, but perceived insurability of the hurricane risk remained constant. Disagreement about the Florida hurricane risk remained below average with a substantial agreement of the models in 2005. I attribute the rise in public perceived unaffordability to geophysical and social events.

In 2004, the final planned rate increase left over from the 1999 FWUA rate decision was set to go into effect. The increase became a controversial legal matter incorporating public debate. Ultimately, a Florida court terminated the planned rate increase (Mann and Bushouse 2004). But the year also had four landfalling hurricanes in Florida. The resulting claims from the storms caused Citizens to incur a deficit and levy assessments (House Majority Office 2009). The following year, in 2005, Florida experienced four more hurricane landfalls. The resulting insurance claims worsened Citizens' financial condition and assessments followed (House Majority Office 2009).

A review of the newspaper articles for these two years reveals a great deal of activity on Florida property insurance market, including rate increases (Mia 2005; Miami Herald 2005) and insurer attempts to withdraw from the market (Miami Herald 2004). This activity attracted public scrutiny of the markets management. The media raised political concerns over ethical behavior by Citizens chief operating officer (Bushouse 2005). Editors of the *Miami Herald* argued that the Florida government should use increased state revenue from sales taxes on repairs to homes damaged from the storm to help alleviate the Citizens deficit (Editorial 2005). At least one newspaper reported hopefully that Florida's Public Model would soon help policymakers better understand catastrophe models (Garcia 2005). Still, controversy over rates appeared limited to concerns of affordability.

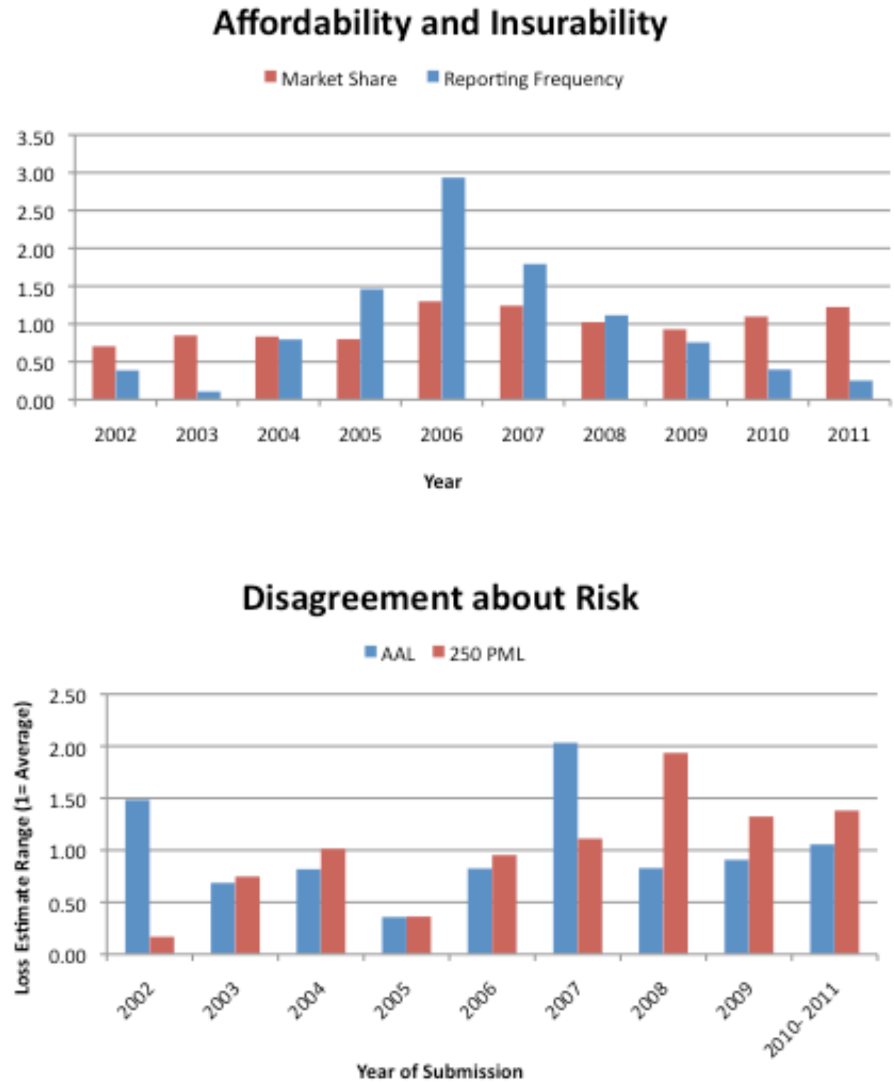

Figure 9: (top) Florida hurricane risk affordability and insurability; (bottom) Model disagreement about the hurricane risk

Homeowners Insurance Crisis: 2006-2008

In the several years following the 2004/2005 hurricane landfalls, Florida's hurricane risk remained unaffordable and became uninsurable. In 2007, approved models demonstrated a doubling of disagreement about the AAL caused by the first submission of the Public Model, but then a sudden decrease by the same amount in 2008. Though disagreement about the 250 PML in 2007 changed little from the year prior, it nearly doubled in 2008. I explain the changes in the models by looking at the social and political context. Then, I attribute the model changes to conflict between the TP and DP of ratemaking leading to insurer perceptions of hurricane risk uninsurability.

Catastrophe modeling firms came under criticism by their clients for under predicting the hurricane activity of 2004/2005. The reinsurance group, Munich Re, publicly expressed concerns for an exacerbated hurricane risk and claimed that in order to "only accept business at risk-adequate prices" there was "no doubt that the models used to simulate the hurricane risk in the North Atlantic need adjusting" (Munich Re Group 2006). In response, the catastrophe modeling firm, RMS, used an "expert elicitation" to weight several predictive signals of hurricane frequency and severity to create a hurricane catalog representing hurricane activity five years into the future (Muir-Wood 2006). The resulting model, released in 2006, produced a 30% increase in activity rates with larger increases for more intense hurricanes (Muir-Wood 2006). By incorporating a view of heightened Atlantic basin hurricane activity, catastrophe modelers satisfied their clients desire for a model that reflected their new perception of a heightened risk (Muir-Wood 2006). The reinsurance industry quickly adopted the new "near term" estimated risk which created an immediate $82 billion increase in the cost of reinsurance (St. John 2010).

In 2007, the FCHLPM rejected the RMS near-term model for use in Florida residential windstorm ratemaking on the basis that expert elicitation methodology did not constitute a scientific estimate of risk. Howard Eagelfeld, a member of the FCHLPM at the time, explained that, "Concerning their elicitation methodology process, the team couldn't verify that it was an acceptable technique. The mission did not have an absolute process that rejects the five-year model, but it requires scientifically sound practices" (Kern 2007). In response an RMS executive argued that the FCHLPM model rejection acted to "artificially constrain" the view of Florida's hurricane risk (Hemant Shah cited in St. John 2010).

The FCHLPM rejection of the RMS model established a conflict between the TP and DP of ratemaking. While the TP argued the need for rates to reflect standard private market judgments of risk, the DP attempted to reduce costs for policyholders and advanced different model information. The decision challenged nearly all the criteria of insurability because the hurricane risk as the insurance industry had newly come to understand it was now against public policy and its means of calculating risk violated legal restrictions (see Berliner 1982). Changes to reinsurer perception of risk trickled down to insurers operating in the state of Florida. Fifty-two of Florida's 167 property insurance carriers requested rate increases over 25% primarily due to "the considerable increase in their cost to purchase reinsurance and the heightened expectations of future losses related to hurricanes (wind losses arising from hurricane loss models)" (FL House of Representatives 2007). In 2006, Citizens' governing board requested rate increases in order to align its rates with the new view of risk on the private market, but regulators denied part of the request[53] using the newly available Public Model to defend their decision making (FLOIR 2006). Florida's insurance commissioner, Kevin McCarty, argued that the request did not consider the cost burden on policyholders and was based on unacceptable science, "Many Floridians are struggling to pay rapidly rising hurricane insurance costs… [the Florida Office of Insurance Regulation] will continue to aggressively scrutinize all rate requests and where we find that rates are not justified we will not allow them" (FLOIR 2006). The

[53] Citizens wanted to raise rates in Monroe County by 25.9 % for homeowners' policies and mobile home rates by 20.4%. Instead, McCarty ordered it to reduce rates by 32.2% for homeowners and a lesser increase of 15.2% for mobile homes (FLOIR 2006).

statement clearly demonstrates the use of catastrophe models as a political tool to support the DP need to control the rise in Citizens' rates.

The conflict between the TP and DP over relevant information and acceptable science for ratemaking continued into 2008. Two of the largest insurance companies in Florida, State Farm and Allstate, requested rate increases of over 40% (FLOIR 2008a,b). In both instances, legal battles ensued over their use of models. For State Farm, a judge found that the company "did not show by a preponderance of the evidence that either the indicated rate or requested rate in the rate filing is not excessive, inadequate, or unfairly discriminatory" (FLOIR 2008b). In the case of Allstate, a leaked internal document written by Allstate Floridian Vice President Bonnie Gill revealed the insurer's use of the near-term model to estimate rates (Patel 2008). Legislators criticized Allstate for attempting to undermine efforts to reduce insurance costs by their use of the "unapproved" near-term model to support the need to raise rates (Patel 2008). Consequently, the Florida Office of Insurance Regulation [FLOIR] demanded that Allstate "explain to [the FLOIR] their relationships with rating agencies, modeling companies and trade groups and how these relationships might have influenced the huge rate increases they have requested" (FLOIR 2008a). In defense, Gill explained the that the near term model directly affected insurers perception of the risk and in accordance with the TP, "We had an indication at the time that we were underestimating" losses due to hurricanes (Gill quoted in Patel 2008). As primary insurers that need to purchase reinsurance, State Farm and Allstate had an interest in maintaining a view of risk that aligned with the international insurance industry's new perception of risk based of the near term model. But this view increased the burden on policyholders in the state just after a series of cost increases from 2004 and 2005. Thus, the TP and DP conflicted in their preference for risk estimate and both used the available science as tools to support their competing interests.

Insurance Crisis: 2009-2011

Between 2009- 2011, the Florida hurricane risk demonstrated relative affordability but continued uninsurability. Though the extent to which models disagreed about the AAL and the 250 PML changed little over this time period, disagreement about the 250 PML remained above average. As a metric of potential large loss, persistent model disagreement about the 250 PML implies different perspectives about the sustainability of the insurance regime (Berliner 1982, 1985). For example, if Citizens managed its risk to a low estimate of 250 PML[54], then those using a high estimate view the company as unsustainable and in competition with private insurers. I attribute the continued view of Florida's hurricane risk as uninsurable to two factors. First, new changes to the RMS admitted model heightened insurers' concern about the amount of ignorance about the risk in any of the models. Second, regulators control on insurance rates by rejecting the near term models available for use outside of Florida continued to enforce conflict between the TP and DP of ratemaking.

The evolving nature of catastrophe models and their effects on changing the perception of hurricane risk led to a pronounced skepticism amongst, at least some, insurers' that the model estimates constituted risk and not ignorance. In 2011, the FCHLPM approved RMS's new model version, called RiskLink11 (or RMS11). The model incorporated new parameters that, among other things, dramatically increased measures of hurricane risk inland (RMS 2011). This startled insurers by increasing companies' estimated portfolio loss potential by 100- 300% and caused sudden downgrades in the rating of other risk transfer products, such as catastrophe bonds (Simpson 2011a,b; Florida Actuary 2012). The jump created the sense that the models themselves presented a source of uncertainty. As one Florida actuary explained to me, "All we

[54] I do not mean to imply by this example that Citizens' manages to a low estimate of 250 PML or even to any estimate of a 250 PML.

know is that the models are wrong. But how are they wrong?" (Florida Actuary 2012). She expressed concern about her ability to estimate the hurricane risk and make decisions about the risk because the dramatic change in risk estimate implied that RMS had to be wrong either in the old model or in the new model (Florida Actuary 2012). Concern of the models as a source of uncertainty causes a risk to fail the insurability criteria directed towards calculating the odds of loss and the necessary policy cost and moves the hurricane risk into the realm of uninsurable ignorance (Berliner 1982; Bernstein 1996). Faced with a great deal of ambiguity about the hurricane risk, insurers generally request higher premiums (Kunreuther et al. 1995; Cabantous et al. 2010).

Still Florida's restriction on the use of near term models means that the characterization of risk applied to ratemaking by Citizens' and other private market insurers operating in the state differs significantly from that on the private market. For those using the near term model, Florida's rates seem inadequate and therefore the hurricane risk uninsurable. RMS's success with the first near term model drove market competition and other modeling firms developed similar model types (St. John 2010). Though used widely they "have not demonstrated any skill in projecting near term hurricane losses" (Karen Clark & Company 2011). Without any demonstrable skill regulators have no reason to accept the near term models for use except to remain in line with TP of ratemaking. Doing so however, conflicts with demands to relieve the burden of cost in policyholders and maintain a DP of ratemaking.

Implications for Democracy

Limiting Florida's debate about managing the hurricane risk to a matter of finding the right science to establish the right measure of risk and thereby charge the right rates disregards underlying value conflicts. On one hand, the TP presents modeling science that supports a view of hurricane risk that aligns with their primary goal of maintaining solvency. On the other hand, the DP presents modeling science that supports a view of the risk and aligns with a primary goal of maintaining affordability. In this situation, the science is irrelevant because the point of conflict is that the final rate decision which necessarily leads to success for one perspective and failure for the other (Pielke 2007).

By limiting the debate to a discussion about models, decision makers place scientists (including actuaries and catastrophe modeling companies) into the inappropriate role of policy maker. The role is inappropriate because insurance scientists are ill equipped to make public policy decisions (Musulin 2006). The role is also inappropriate because it limits the scope of values and options debated to those values of concern by participating scientists (Pielke 2007, Jasanoff 1990; Fine and Owen 2005) or simply to the status quo (Robinson 1992).

But the concerns of technology experts, such as private insurers, may not reflect those of public policy objectives. For example, in 2011, the TP and DP took the intense focus on modeling as a pivotal component to managing Florida's hurricane risk to an extreme when they debated the appropriateness of state funding for the Public Model. Florida Rep. Bryan Nelson sought to terminate state funding of the Public Model on the premise that commercial models were better, "If insurance companies didn't think they were a good model, why would they use them?" (Sun Sentinel 2011). However, Audrey Brown, chief of staff of the Florida Office of Insurance Regulation (FLOIR), argued that the Public Model is important because it provides "huge savings" in licensing costs and "If we needed to use private models, the cost would be enormous and we probably could not" (Sun Sentinel 2011). The implication of doing away with the Public Model is that the FLOIR would then have to rely on insurer estimates of risk.

As to whether or not the legislature continues to fund the Public Model matters little for resolving conflict between the two end goals of affordability and insurability of the hurricane risk. That is, resolving a conflict about the Public Model will not provide the public with affordable property insurance. It does however, mean a great deal for political power in the ratemaking process. If the Legislature did away with the Public Model then the TP would then "win" power to define Florida's hurricane risk. Though this has little to do with resolving public policy objectives of affordable property insurance it does resolve TP value concerns regarding the ability to reflect market judgments in estimating Florida's hurricane risk.

Conclusion

Insurers consider catastrophe models as necessary to the proper pricing of catastrophic hurricane risk. But, due to the time scales involved, evaluation of catastrophe models on the basis of scientific quality is not possible. The amount of acceptable information available for use in modeling and the inability to select one model estimate over another on a scientific bases means that those building the models must reflect on their own preferences for outcomes when making decisions about the construction and use of catastrophe models. The value laden decision process continues down the line from choosing a model for use to making a rate decision. Thus, ratemaking is a political process.

Routine negotiation of the hurricane risk has benefits. It provides government the opportunity to evaluate changing social and economic conditions. Likewise, it provides insurers the opportunity to evaluate changing market conditions. However, turning the entire political debate about managing the hurricane risk into a rate war fought through competing modeling science has negative consequences. First, it invites public debate into the ratemaking process where insurers find it unwelcomed and policy makers can make little use of it to create options.

Second, it places insurers, actuaries, and catastrophe modelers into the inappropriate position of public policy maker. Both of these factors threaten the democratic process by limiting the ability of policy makers and the public to weigh in on matters geared towards alleviating persistent conflict between affordability and insurer economic sustainability. The intense political and public focus on ratemaking serves only to neglect ongoing conditions that place affordability and insurability at odds.

Overall, without a means to evaluate catastrophe models for scientific quality, they have served simply as political tools to support different interests perspectives in the ratemaking process. Conflict between the technocratic and democratic perspective of decision making has resulted in a decline of perceived insurability of the hurricane risk. Moreover, changes to modeling science that causes sudden changes in risk estimates creates additional perceived risk for insurers. This also impacts hurricane risk insurability by pushing the uncertainty about hurricane loss from the realm of insurable risk into uninsurable ignorance.

CHAPTER 8: A policy evaluation of Florida's Citizens Property Insurance Corporation

Introduction: Defining the Risk Playing Field by Technocracy or Democracy

This chapter applies a classic form of policy evaluation to Citizens Property Insurance Corporation (Citizens) in respect to its legislative mandate to provide "affordable property insurance." A policy evaluation follows a standard format of identifying policy goals, assessing trends related to goals, and assigning responsibility for policy success and failure. The metrics used for evaluation of trends include Citizens' market share, media reporting on windstorm or hurricane insurance, real and relative rate of change of the average cost of a Citizens' policy, and Citizens' loss ratio. A difference in perspective on the proper role of a residual market creates difficulty for evaluation of trends in goal metrics for policy success or failure. I attribute Citizens' struggle in reaching its mandated goal to conflicts in the Florida's political process including unclear policy objectives, unattainable legislative requirements, and a situation that favors politics over policy. Overall, the current situation threatens democratic accountability and obstructs legislative efforts to serve the public interest.

Citizens is a multibillion dollar public residual market in the state of Florida. Though the company offers several types of policies, legislators created Citizens in response to the public need for affordable catastrophic windstorm coverage[55] that includes the hurricane peril. However, since legislators created the Citizens policy in 2002, the company has been the target of rancorous debate for insurers, political interest groups, and the public. In this chapter I demonstrate several reasons why the policy has struggled to satisfy its mandate. In order to facilitate this discussion, I introduce two conflicting perspectives that lead to disagreement

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[55] Readers are reminded that, for the purposes of this dissertation that focuses on Florida, I use the term windstorm insurance and hurricane insurance interchangeably.

between insurance experts and regulators[56] on what the outcomes of a successful residual market look like.

I apply an idealized differentiation between technocratic decision making and democratic decision making (Jasanoff 1990). Insurance experts have a technocratic view of a residual market such that the authority to define risk lies with the insurance industry and they define risk in accordance with market judgments of risk. This perspective understands the purpose of a residual market as a means to provide insurance where the private market views the risk as uninsurable. Regulators have a democratic view of a residual market such that the authority to define risk is shared by multiple interests and they define risk in accordance with social acceptability. This perspective understands the purpose of a residual market as a means to provide insurance where the private market defined risk is politically unacceptable. This conflict in perspective plays out during debates about the appropriate rates for Citizens and during debates about responsibility for policy success and failure. Ultimately, the disagreement reflects a power struggle between insurers and government for control over the construction and characterization of Florida's hurricane risk. Regulators use Citizens to defend against insurers' market judgments of risk for the sake of affordability. But in doing so, Citizens moves away from conventional understandings of insurance.

The conflict in perspective for the proper role of a residual market has ramifications for the implementation of the Citizens policy preventing legislators from improving the availability of affordable property insurance in the state. First, due to Citizens ancestral legislation, insurers and some public policy makers assert the need for Citizens to have "actuarial sound" rates.

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[56] In this chapter, I use the term 'regulator' in the same way as I did in Chapter 7. Briefly, by regulator I mean those that make decisions that establish boundaries for estimating the Florida hurricane risk. This term includes a great many people and types of jobs beyond that of Florida's official insurance commissioner.

However, based on the conventional definition of actuarially soundness it is logically impossible for a residual market to have actuarially sound rates. Efforts to create Citizens' rates as actually sound are ill-conceived attempts to shift Citizens view of risk towards aligning with market judgments of risk and quickly create contention with those seeking a view of risk that is politically acceptable. Second, as multiple interests involve themselves in the conflict between insurers and regulators the interests politicize the hurricane risk by supporting some measures of risk over others to make gains in influencing public policy change. Politicization of the hurricane risk deflects attention away from root causes of large losses- Florida's traditional means of wealth creation using real estate and land development.

In order to reconcile the conflict between economic policies and efforts to provide affordable property insurance, a dialog needs to develop around public values for Florida's future economy. Hiding this issue in a power struggle over control of defining the right measure of risk detracts from the economic unsustainability presented by Florida's economic policies in relation to policy to provide affordable property insurance. Without democratic debate that presents ideas for new ways forward, the cost of hurricane risk remains burdensome to the public. The current situation threatens the democratic process on two fronts. First, without consensus on what Citizens is intended to achieve, the process of democratic accountability breaks down. Second, a lack of accountability ushers in the politicization of hurricane risk which obscures the ability of public policymakers to create policy that achieves public policy objectives and resolve underlying economic conflicts. Overall, the state of affairs undermines legislative efforts to provide the public with affordable property insurance.

Policy Success Depends On How Insurability is Determined

In 2007, Florida legislators responded to the increasing cost of insurance covering the hurricane peril by changing Citizens' mandate to "increase the availability of affordable property insurance[57]." Opposing views on the intended role of Citizens as a residual market create conflict in opinion as to how Citizens should go about meeting this goal and how well Citizens performs. Private market insurance experts view a need for residual markets when private market insurers perceive a risk as uninsurable and do not offer coverage or stop offering coverage. For example, the Insurance Information Institute (III) is an organization that promotes the industry interest with the mission to "improve public understanding of insurance" by providing, self-proclaimed, "definitive insurance information" (III 2013b). The III glossary states that residual markets "exist to provide coverage for those who cannot get it in the regular market" (III 2013a). The private market perspective holds that the ability to 'get it' on the private market is determined by the willingness of insurers to provide coverage. In contrast to the private market view, James Newman, Jr. (2010), who writes on behalf of the Florida Catastrophic Storm Risk Management Center, a research group created by the legislature at Florida State University's business school[58], that the purpose of a residual market "is to make insurance coverage available to those individuals and businesses that are not able to obtain the coverage they need from private insurance companies." The public policy perspective holds that the ability to 'obtain' insurance coverage can be subjective to the potential policyholder. That is, limited resources of the consumer or some other subjective value can restrict the ability of a potential policyholder to access insurance coverage.

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[57] Florida Statute 627.351(6)(a)1
[58] Florida Statute 1004.647

The subtle differences between the two definitions are significant for judging policy outcomes because they imply different goals for a residual market. The former describes residual markets as providing coverage when such coverage on the private market does not exist (e.g. Klein 2009). In this sense, the private market has sole authority in defining risk and residual markets serve to provide coverage for risks that the private market perceives as undefinable or otherwise uninsurable. I call this perspective a *technocratic residual market* (TRM) because the power to define risk lay with technological experts, such as actuaries (Jasanoff 1990). The "residuals" in a TRM are those that do not fit within an arithmetical model of potential loss. The creation of the Florida Windstorm Underwriting Association in 1970 to serve areas in Florida where private insurers had left the market is thus, an example of a TRM[59].

The Newman (2010) definition describes residual markets as providing coverage for a risk not only when the private market does not do so but also, when consumers lack the ability to access the available private market coverage. Often, consumers' ability to access coverage is limited by their financial resources (i.e. income). By creating a residual market to provide coverage for a risk that falls within consumers' income constraints, public policy makers enable others outside of the private market, namely the public, to participate in the process of characterizing risk. Limiting the cost of a policy also places limits on how the risk is quantified and ultimately the size of risk insured against (Chapter 7). The risk resulting from this process of decision making reflects the perspectives and demands of multiple interests and is thus, a politically acceptable risk. For this reason, I call this perspective of a residual market a *democratic residual market* (DRM) because multiple interests, including the public, share the

[59] Generally, these areas were within a 1,000 ft from the coast in designated counties. But, in Dade, Broward, and Palm Beach counties, the areas east of I-95 were eligible and all of Monroe County.

power to define risk (Jasanoff 1990). In a DRM, the residuals are those individual risks that do not fit within a desired arithmetical model of potential loss. Legislative changes to the Residential Property and Casualty Joint Underwriting Association (JUA) in 1993 enabling flexibility in its ratemaking (Mittler 1997) is thus, an example of a DRM.

The difference between the TRM and DRM definitions is in who gets to decide the acceptable knowledge about risk. Put another way, the difference between the definitions is in who gets to decide the model and the size and shape of the probabilistic tail distribution. When legislators create a TRM they are responding to the insurance industry designation of the distribution of loss and the identification of some potential policyholders as falling outside of the realm of risk as a measurable uncertainty. When the legislature creates a DRM they enable the government and its associated political process to influence the definition of the probability distribution through first determining politically acceptable (i.e. affordable) rates. In so doing, policymakers define the uncertainty about the future claimed as measurable and known and that which is relegated to ignorance.

In some cases, especially Florida hurricane risk, decision makers can assimilate available scientific information in various ways to result in many different but scientifically sound estimates of hurricane risk (Chapter 7). The delineation between known risk and ignorance is debatable (Chapter 4). Because the price private market insurers can charge is a limiting factor of the risk they can take, a DRM can appear as competitive with the private market. So, when the legislature develops a residual market to satisfy concerns of availability due to price, that is when they establish a DRM, private insurers may view the residual market as misconstruing the science of risk. The resulting residual market fails as an ideal TRM to “function as a market of last resort," (Klein 2009; Lecomte and Gahagan 1998) and instead is perceived by the private markets as a competitive force.

Trends in Affordability and Insurability

In the previous chapter, I discussed trends in affordability and insurability in relation to changes in catastrophe models. In this chapter, I evaluate the same trends but in the context of authoritative decision making by the private insurance industry and Florida insurance regulators. Additional metrics provide context for understanding TRM and DRM perspectives of Citizens trends in meeting its mandate. Figure 10 (top) reproduces the affordability and insurability graph shown in Chapter 7. Frequency of newspaper reporting on hurricane insurance or windstorm insurance serves as a metric of affordability. Citizens' market share of direct written premiums serves as a metric of insurability. As a reminder, I measure both criteria on a relative basis in comparison to the rest of the time period of analysis. The average cost of a Citizens policy and average cost relative to Florida median income provides a metric for understanding public concerns about affordability (Figure 10, bottom left). Lastly, I use Citizens' loss ratio from 2002-2011 as a metric to understand technocratic concerns about the company's successful function as insurance (Figure 10, bottom right). Chapter 5 offers further explanation on methodology.

This evaluation focuses on the two separate social constructs of 'affordable' and 'insurance' imbedded within the mandated goal of affordable property insurance. Both ideas directly relate to ratemaking because the elements considered when one thinks of the hurricane risk contributes to how one pursues measuring it and thereby determines the price necessary for the successful application of insurance. However, the social construction of risk and beliefs of necessary responses to measurements of risk differ amongst people including, experts and laymen (Slovic 1987, 1999). So, judging Citizens' success as affordable insurance has to do with how perspectives view the hurricane risk in respect to value considerations (e.g. market competition or cost of living) under each criterion of insurability (see also Berliner 1985).

Is Citizens Property Insurance Corporation insurance?

The academic literature offers several examples of criteria of insurability. I use the criteria established by Berliner (1982) throughout this dissertation (see also Chapter 4). Criteria offer guidelines for which to judge success of outcomes. Criteria of insurability help to identify an ideal insurable risk and in turn the successful application of insurance. In general, insurers find ideal risks hard to come by (Berliner 1982) but without criteria one has no way to even arrive at this conclusion.

The academic literature appears largely void of discussion on the criteria for insuring a residual market risk. This brings attention to important considerations for the notion of a residual market as "insurance." First, we must consider how and why residual markets come into being. Then, we must consider the differences between private market insurers and residual markets in their ability to spread risk. In general, criteria of insurability present a basis for understanding disputes over insurance and as guidance for managing a residual market however, *only if* one keeps in mind that a residual market differs in key ways from conventional insurance.

First, legislators create residual markets to manage risk that the private market views as unmeasurable or otherwise uninsurable (e.g. due to regulatory constraints on price). When legislators create a TRM, a residual market that responds to technocratic definitions of risk, then the residual market provides coverage for a risk that by conventional standards is unmeasurable and uninsurable. When legislators create a DRM, a residual market that responds to democratic definitions of risk, then the residual market provides coverage for a risk by conventional standards has a different measurement. The DRM looks to conventional insurers as not accurately representing the state of knowledge about risk. This means that from the start, residual markets and private insurers have a different view of the risk and in turn, will draw different conclusion as to the risk's insurability and the residual market as insurance. As a consequence, the two will draw different conclusions to the appropriate outcomes of implementing a residual market.

Second, residual markets as a part of government have a unique ability to spread risk over time so that a large loss cannot cause insolvency (King 2009). That is to say, a residual market, as government entity cannot 'go out of business.' Instead, when a residual market experiences a loss that causes a deficit it has the ability to incur debt such as, through the sale of government bonds, and pay back that debt in the future perhaps by collecting assessments from policyholders. The ability to spread risk over time and incur debt is not consistent with insurability criteria of charging a premium that covers all costs associated with loss (Berliner 1982). For private insurers, their inability to pay claims may cause them to 'go out of business.' Still, no insurer can eliminate the possibility of experiencing a loss that exceeds capacity to pay-if they could, they would not have any risk to manage. The difference in the ability to respond to deficit between private market insurers and a residual market causes different social experiences for the two groups in regards to catastrophic risk. In turn, information about risk triggers different demands for action by the two groups, say for example in regards to pricing (Renn et al. 1992).

Perhaps, one of the reasons that the academic literature does not discuss residual market insurability criteria is because residual markets are not conventional insurance. In some instance, such as when governments offer coverage for unmeasurable risks, the residual market does not amount to insurance at all. Still, for the sake of understanding conflict between public policy and private insurers in insurance regimes criteria of insurability offer a basis for understanding points of conflict. As well, the regulators and public policy makers may find criteria useful for establishing and managing a residual market. However, given the caveats above, using insurability criteria to judge the success of a residual market necessarily leads to conflict between private market and government or rather, the TRM and the DRM perspectives.

Evaluating trends from the TRM and the DRM

From the perspective of a TRM, Citizens' does not have insurance rates reflective of hurricane risk and fails as a residual market in three ways. First, Citizens' market share of direct written premiums increased suddenly in 2006 and has remained near or above average since. The increase in market share suggests that Citizens acts as a competitive force by developing insurance rates inconsistent with hurricane loss potential and experience. Second, the stability in the rate of change in policy cost since the change in 2006 suggests that Citizens' pricing of risk does not consistently consider changes in the private market pricing and evaluation of risk. If Citizens functioned properly from the perspective of a TRM then average policy cost would reflect the increased cost of capital seen after the 2005 hurricane season (I discuss details of market changes further below and in Chapter 7). In doing so, Citizens functions in the contrary to the idea that a TRM works in the periphery of the market established by private insurers. Third, Citizens' loss ratio appears fairly consistent, except for the years 2004 and 2005 where losses exceed premium by roughly 240%. In the private market, the loss ratio experienced by Citizens in 2004 and 2005 would have caused an insurer to become insolvent and perhaps forced out of business.

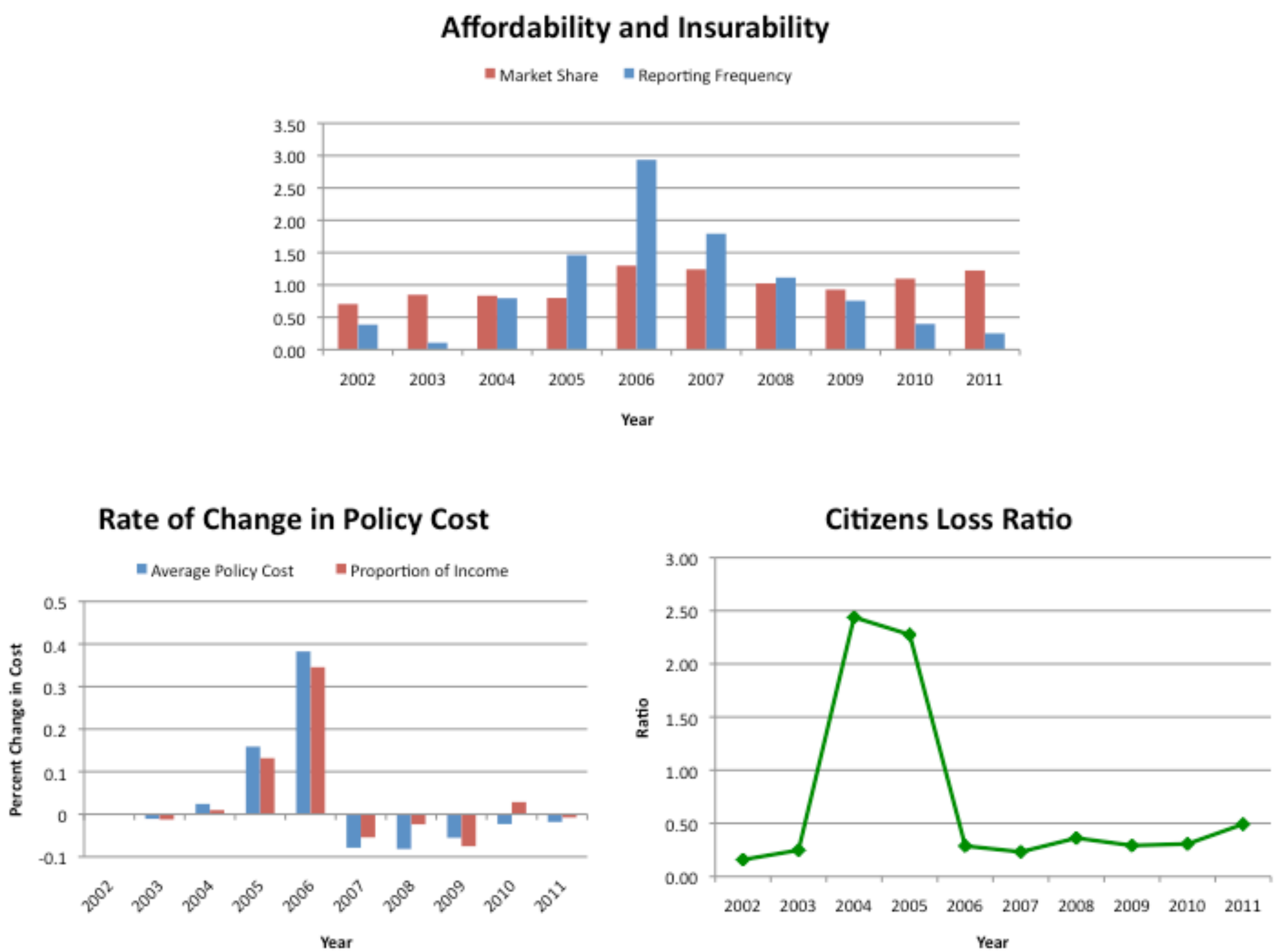

Figure 10: (top) Florida hurricane risk affordability and insurability; (bottom left) Real and relative changes in policy cost; (bottom right) Citizens loss ratio

Given a technocratic view of the criteria of insurability, Citizens failed to act as insurance by failing to maintain enough funds to pay all claims. As for the overall trend in loss ratio, the average loss ratio for all years excluding 2004 and 2005 is 30%. Judgment of individual insurers plays a significant role in determining the desirability of a given loss ratio (Mehr et al. 1985). For companies with a high catastrophe exposure, insurers seek a more conservative loss ratio and include a special risk load so that they can purchase or accumulate the capital needed to cover the loss of catastrophic events (Musulin and Rollins 2001). Given Citizens' potential for catastrophic loss, insurance experts may consider Citizens' loss ratio as too high (e.g. Rollins 2012). From a TRM perspective, Citizens has failed.

Things look quite different from the perspective of a DRM because success is determined relative to political acceptability. The data show three indications of policy success from a DRM perspective. First, a successful DRM ensures public access to insurance, which means that Citizens' increasing market share is not inherently a problem. Instead, increasing market share suggests that Citizens, as public policy is serving a larger share of the public. Second, sudden increases in real and relative cost of Citizens' policies coincide with an increase in frequency newspaper reporting suggesting that the public viewed the cost of insurance as unacceptable. In this light, regulators may interpret the steady decrease in newspaper reporting beginning in 2007 as a policy success because public distress over the issue abated. Third, the loss ratio data indicate that Citizens worked as planned. Citizens' ability to spread risk over time using debt and assessments enabled the company to handle back-to-back catastrophic loss without a collapse in the property insurance market. Citizens continued to ensure the availability of property insurance in the state of Florida. From a DRM perspective, Citizens can be judged a success.

From the perspective of public policy evaluation, the trends in goal metrics indicated that implementation of the Citizens policy had a mixture of success and failure over the period of analysis. Citizens experienced the greatest success at the beginning of its existence. This quickly gave way to a dramatic spike in unaffordability between 2004 and 2008. Unaffordability peaked in 2006, as did the rate of change in the cost of policy and cost in respect to incomes. Since 2008, affordability of policies shows relative success. Likewise, perceived uninsurability peaked in 2006. Though unlike affordability, success in this metric did not follow in the subsequent years. Time frames that show complete success (2002-2004) or complete failure (2006-2008) indicate that the goals of affordability and insurance are not *inherently* at odds. If they were, the two metrics would be inverses of one another. Instead, only at times do the criteria come into conflict. Furthermore, complete policy failure demonstrates that public resistance to cost increases is not the sole impediment to a well functioning insurance regime because despite a rapid increase in policy cost, the private market perceived the risk as uninsurable.

That the analysis of goal metrics can convey opposite interpretations of a policy gives reason for concern about how the political process implements the policy because when a powerful group such as the insurance industry considers a state of affairs as somehow reprehensible, the political situation is unstable (Lasswell 1971). In turn, the data suggests that in order to understand Citizens mixed performance we must look at the context and process for decisions about policy implementation.

Responsibility for Performance: TRM vs. DRM

Just as viewing the data from a TRM or DRM perspective offers different conclusions about how well Citizens performs, so too do they place responsibility for performance in different places. Assimilation of specific material to reference in developing the argument as to how the TRM and DRM perspectives place responsibility is difficult because I develop the idea of two different perspectives on a residual market in this chapter. Based on my experience studying Citizens and research on the use of science to measure risk for decision making (e.g. Fischhoff et al. 1984b; Weingart 1999; Sarewitz 2004; Pielke 2007), I argue potential views of responsibility from the two difference perspectives. The TRM perspective views a need to respond to market judgments of risk when pricing Citizens' policies, whereas the DRM perspective views a need to respond to Florida's economy when pricing the hurricane risk[60].

TRM: Citizens' rates do not consider market judgments

The TRM perspective attributes trends in Citizens' performance to regulatory failure to consider market judgments of risk. Citizens' perspective of risk diverged markedly from the private market view after the hurricane seasons of 2004/2005 during which Florida experienced several major landfalling hurricanes. As a result, from a technocratic perspective of risk Citizens' rates underestimate Florida's hurricane risk and charges rates that compete with the private market.

The frequency and severity of landfalls during the 2004 and 2005 hurricane seasons caused a heightened perception or hurricane risk in the insurance industry (Munich Re Group 2006). Climate change science, an overtly politicized enterprise (Pielke 2010), fed these fears while asserting that given a warming climate, a "substantial increase in hurricane-related losses" could be expected (Emanuel 2005) and that climate change would cause "adverse impacts on

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[60] The technocratic residual market perspective and the democratic residual market perspective also conflict in their views on the implementing mitigation to manage the hurricane risk (Thanks to Rade Musulin for this comment). A full discussion of how these views conflict and the potential for mitigation to play a more prominent role in the risk management process is beyond the scope of this dissertation.

insurance affordability and availability" (Mills 2005). In turn, reinsurers demanded catastrophe model adjustments to account for their new concerns about the hurricane risk (Munich Re Group 2006). RMS, an industry-leading catastrophe modeling firm, responded by developing a "near term" model. The modeling firm used predictive theory about future hurricane activity developed in the climate change science community to produce increased annual loss estimates on the order of 30 to 50 percent (Muir-Wood 2006).

All models used for ratemaking in Florida's admitted windstorm insurance market must have FCHLPM approval. Prior to approval, recognized scientific experts review submitted models to assure that they meet FCHLPM standards of accuracy and reliability (FCHLPM 2011). When RMS submitted their near term model for approval, the FCHLPM rejected the model on the basis of unacceptable methodology (Kern 2007). Yet, the insurance industry had widely accepted the model and competition drove other modeling firms to develop similar model types (St. John 2010). The insurance industry does not view the near term models as made to any lesser scientific standard because catastrophe modeling firm and industry experts review the near term models to make sure that they meet company standards (e.g. Lloyd's Market Association 2012). Consequently, the FCHLPM approved models and the near term models present equally valid but conflicting views of Florida's hurricane risk. Rejection of the near term model for defining Florida's hurricane risk for ratemaking resulted in severely inconsistent understandings of the risk between Florida and the international insurance industry because, as one Florida actuary explained to me, "Only Florida uses Florida's models" (Florida Actuary 2012). While the global insurance industry used the near term type catastrophe models to price risk, Florida's rejection of the models meant that the state's current and future rate decisions, including those made for Citizens did not reflect conventional actuarial practices of estimating risk.

Figure 11 provides a demonstration of the inconsistencies between Florida's view of risk and the insurance industry's. The graph compares loss exceedance probabilities for the same portfolio of Florida residential properties. The blue curve reflects a commercial vendor's FCHLPM approved model. The red curve shows the same vendor's model using a near-term catalog of events. The near-term model estimates much higher probabilities for a given loss amount compared to the FCHLPM model. For example, consider that the residential portfolio used for the model runs belongs to a certain admitted Florida insurance carrier, Sunshine Insurance. Suppose further that Sunshine Insurance wishes to manage the business to a 200-yr PML meaning that enough capital must be available to the insurer to manage a loss that has a 0.5% annual chance of occurrence. Sunshine Insurance uses the FCHLPM approved model to estimate the 200-yr PML as $77 billion. However, the conventional view of risk based on the near-term model estimates Sunshine Insurance's 200-yr PML as about $122 billion. From the conventional perspective, Sunshine Insurance appears undercapitalized by $45 billion.

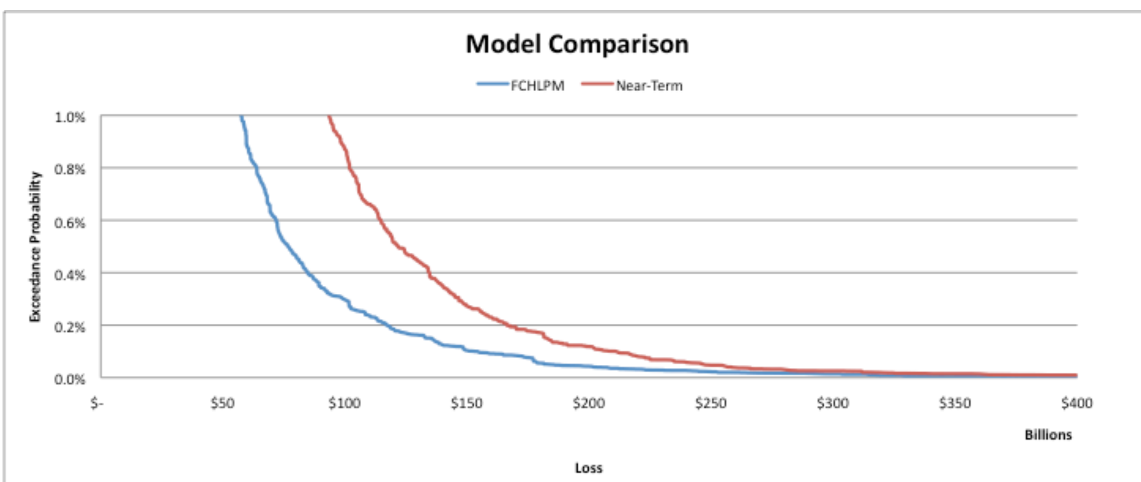

Figure 11: Comparison of loss exceedance curves using a commercial vendor's FCHLPM approved model (blue) and the same vendor's near-term model (red)

While use of a FCHLPM approved model may cause admitted Florida insurers difficulty in working with the conventional private market, Citizens' unique abilities as a residual market assures that it has an easier time in managing the conflict in views of risk. For example, consider that Sunshine Insurer seeks to purchase reinsurance on the international market. Reinsurers base the cost of their capital on the near term view of risk so, they see the probability of a certain loss amount for Sunshine Insurance as higher than indicated by the FCHLPM model. In turn, Sunshine Insurer may have difficulty raising enough money to cover the cost of capital through its insurance rates to purchase the reinsurance it desires. Sunshine Insurer may also have difficulty with credit rating agencies that use a near term model to evaluate the company. While Sunshine Insurer's rates and other metrics reflect the view of risk depicted by the FCHLPM model, the rating agency may view the insurer to be at risk of insolvency and communicate that through a lowered credit rating.

However, Citizens' ability to incur debt and spread risk over time means that it need not reconcile the conflict between its insurance rates and the cost of reinsurance. Whatever risk Citizens cannot transfer to reinsurance due to limitations presented by the cost of capital it can simply retain. Furthermore, some rating agency reporting suggests that Citizens ability to assess policyholders in the state improves the facility's credit rating (S&P 2012). Citizens' ability to manage the conflict in views of risk between FCHLPM approved models and insurance industry standard models provide Citizens with the ability to offer lower rates than those possible on the private market.

DRM: Citizens' rates considers Florida's economy

The DRM perspective attributes trends in Citizens' performance to a need for insurance rates to consider Florida's economy. The insurance industry perceives Florida, especially Miami-Dade County as having the "peak zone for cat, wind anyways, in the world" (Insurance Executive C 2012). At the same time, Miami-Dade County has one of the worse levels of income inequality in the nation. Neighboring counties in South Florida also have significant income inequality (Bee 2012). Decision making for windstorm rates needs to consider the ability of Floridian's to afford insurance coverage. Hence, public policy makers viewed private insurers' change in the perception of the hurricane risk after the 2004 and 2005 hurricane season as incompatible with Florida economic policy in real estate development. From a democratic perspective of risk Citizens', rates must respond to fluctuations in the state economy.

Florida's economy has long been concentrated in real estate and land development (Cumming 2006). At least 20% of Florida's economy directly depends upon real estate and land development (Figure 12). In 2012, real estate transactions accounted for 16% of total state GDP[61] and construction accounted for 4% of state GDP. Figure 13 shows Florida's economic model, produced frequently by the Florida legislature's Office of Economic and Demographic Research[62] (Office of Economic and Demographic Research 2013). The model indicates that public policy makers will continue to rely on these sectors of the economy at least for the foreseeable future; and further, continuous population growth and tourism drives the model's success.

Because banks require windstorm coverage to obtain a mortgage, public policy makers understand the availability of affordable property insurance as vital to the real estate sector of both the state and national economies (Subcommittee on Consumer Credit and Insurance 1993; Committee on Banking and Insurance 1999; Subcommittee on Oversight and Investigations 2008). Given Florida's heavy economic reliance on real estate, the importance of market judgments of hurricane risk may fall second to that of maintaining a supply of affordable

[61] Data from www.bea.gov.
[62] http://edr.state.fl.us/Content/presentations/index.cfm#economic

property insurance in the state. This means that Citizens rates may have more to do with the state of the Florida's economy than with actuarial or scientific measures of hurricane risk.

By 2001, the year before legislators created Citizens, the Federal National Mortgage Association (better known as Fannie Mae) made zero down payment loans widely available. This helped drive increases in real estate development and prices throughout the nation (Committee on Oversight and Government Reform 2009). As a result, most cities in South Florida experienced substantial housing development (FIU Metropolitan Center). Lenders targeted mortgage lending to Latino borrowers and Latino homeownership increased by 47% between 2000 and 2007 compared to the national homeownership rate increase of 8% (Committee on Oversight and Government Reform 2009). Concurrently, national incomes fell and disparity between high and middle-income families grew significantly in Florida (Bernstein et al. 2008).

The multiple landfalls and catastrophic losses from the 2004/2005 hurricane seasons coincided with a slowing of the housing boom caused by mortgage lending practices and the Florida and US economies began to show signs of rapid decline and a rash of foreclosures (Committee on Oversight and Government Reform 2009). By 2006, Florida developed one of the highest percentages of mortgaged homeowners with housing burden in the nation[63,64] (Schwartz and Wilson 2007). In Miami, where Florida's Latino population is concentrated (Florida Legislature Office of Economic and Demographic Research 2011b), over 20% of burdened households were paying 50% or more of household income to housing costs (Schwartz

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[63] Housing burden or housing-cost burden is defined as a household with housing expenditures (including insurance) that exceed 30% of household income. Historically and conventionally, this measure is a public policy indicator of housing affordability.

[64] Hawaii, Nevada, Florida, New Jersey, Rhode Island, and Massachusetts had the highest burden after California, although burden for those states are similar (see (Schwartz and Wilson 2007).

and Wilson 2007). As a result of Florida's economic decline due to a slow down in the real estate sector of the economy, the insurance industry's new catastrophe model estimates of hurricane risk worsened the health of the state's economy by increasing homeowners' cost of maintaining their mortgage and increasing the possibility of foreclosure.

Florida House Bill 1A, passed in 2007, structured Citizens rates so that they were lower than those on the private market. Legislative deliberation of HB1A demonstrated public policy makers concern about the incompatibility of the rapidly inflating conception of hurricane risk coming from the private market with state of the economy. Much of the questioning of Rep. David Rivera, a co-sponsor of the bill, centered on the ability of Citizens under the proposed changes to respond to the highly unstable and rapidly declining mortgage market. Rivera assured legislators that it would:

> **Rep. Rivera** (R-FL)**:** That is certainly the intent, to make sure that the entire mortgage is covered, when the premiums, when the policy begins whatever point of the year that is.
>
> **Rep. Jack Seiler** (D-FL)**:** And whether the mortgage goes up or down that's meaningless of the essences at the date you purchase, pay that premium and purchase that policy, that's going to be the amount that is paid to the homeowner?
>
> **Rep. Rivera:** Absolutely (Rivera 2007).

Rivera further emphasized the legislation's goal to assist the financially struggling middle and low-income homeowners,

> **Rep. Rivera:** What we need to deal with is allowing the consumer to have options. Making sure that not just affluent consumers that are homeowners have options, but every homeowner irrespective of the value of their home or the amount of their mortgage can have that option voluntarily… to perhaps lower their property insurance (Rivera 2007).

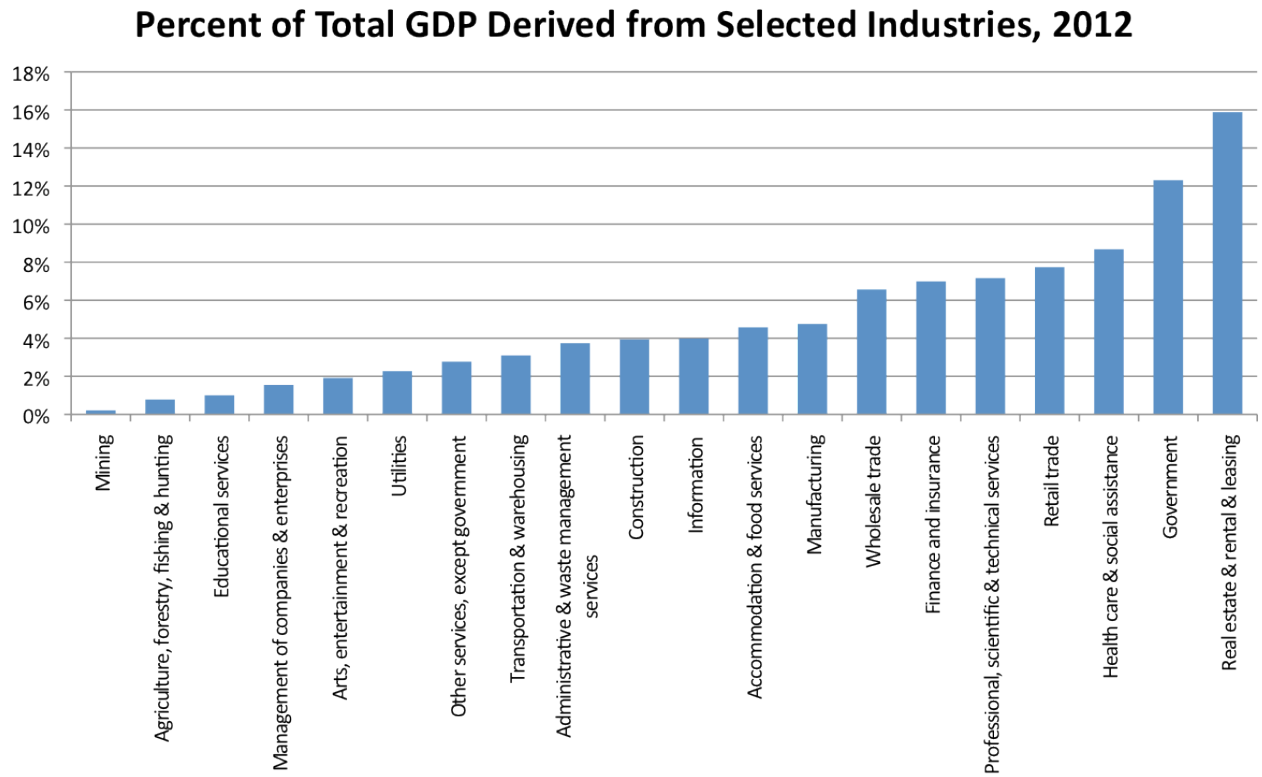

Figure 12: Percent of Florida GDP by Industry, 2012

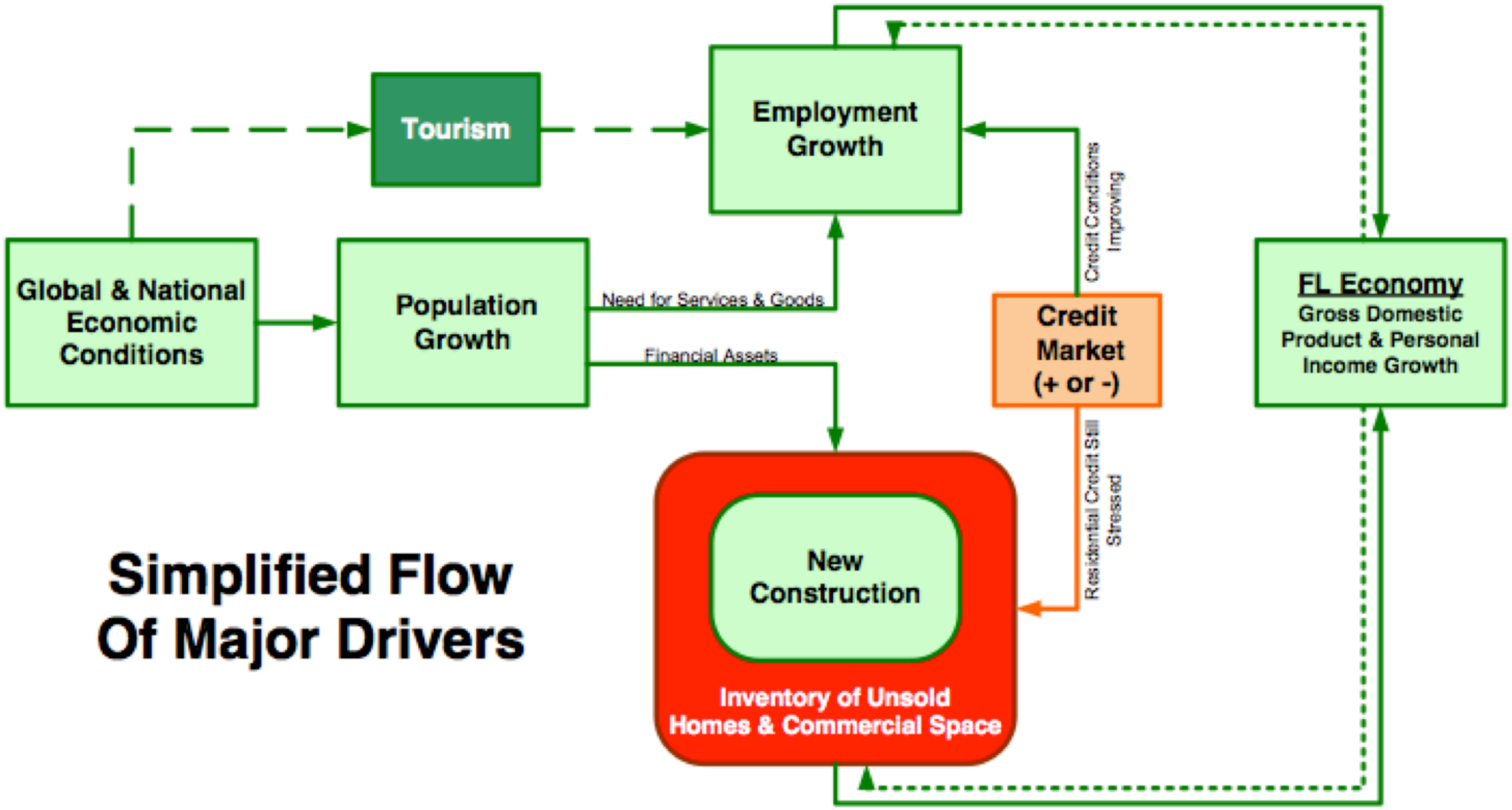

Figure 13: Florida's economic model, as depicted by (Office of Economic and Demographic Research 2013, p. 2)

From a DRM perspective, Citizens performance reflects changes in the Florida economy. When the public and policy makers perceive market judgments of hurricane risk as a threat to the Florida economy decision makers respond by setting Citizens' rates to support the state's economic stability.

Responsibility for Performance from the Perspective of Public Policy Evaluation

From the perspective of public policy evaluation four reasons stand out as to why Citizens struggles to meet its legislative goals. First, the legislature uses Citizens as a defense against market judgments of risk and involves the public in characterizing an acceptable estimate of hurricane risk represented by Citizens' rates. In doing so, the goal of affordability comes into conflict with conventional ideas of insurance and the TRM perspective of the proper role of Citizens in the market. Second, left over legislation from Citizens' predecessors mandating "actuarially sound" rates perpetuate industry expectation that the company ought to function as a TRM and consider market judgments of risk. But, for logical reasons, the idea of actuarially sound has no applicability to residual market ratemaking because a residual market by definition does not share conventional views of risk with the private market. The misplaced wording builds into the legislation a power conflict over Citizens' risk. No outcome of the Citizens policy provides success because when Citizens moves towards becoming in line with the TRM perspective it becomes unaffordable and as it moves towards becoming in line with the DRM perspective it functions less as conventional insurance. Third, environmental and fiscal and budget political interests have involved themselves in the ratemaking process, politicizing the hurricane risk. As a result, political interests judge estimates of hurricane risk, not in regards to what the estimate means for reaching the goal of affordable property insurance, but on the basis of potential gains in other areas of policy making. Fourth, Florida's economic model is economically unsustainable and conflicts with legislative efforts to provide for the public welfare by ensuring the availability of affordable property insurance.

Citizens as defense against market judgments of risk

After Hurricane Andrew and the broad acceptance of catastrophe models by insurers for use in ratemaking, disagreement about a proper measure of Florida hurricane risk drove the private market perspective of risk uninsurability and the subsequent efforts of some insurers to leave the market (Musulin 1997). In 2002, under the administration of Governor Jeb Bush, the Florida legislature passed Senate Bill 1418, known as the "Windstorm Bill." The bill merged the roughly 410,000 policies in the FWUA with the 110,000 policies in the JUA and renamed the JUA as the Citizens Property Insurance Corporation (Citizens)[65]. Senator Rudy Garcia, from the Miami area, co-sponsored the bill and promoted it as a means to streamline the residual market and save on operating expenses by acquiring Federal tax-exempt status,

> The principal goals of restructuring the Florida property coverage market are to provide homeowners with a residual market that provides one policy, one agent, one adjuster for all the perils of their home. The structure of the residual market entity to be eligible for the tax exemption and IRS authorization to issue tax-exempt debt, assure that the residual market entity provides coverage comparable to private market and streamlines residual market operations to achieve administrative savings. Also, to maintain existing financing arrangements with the FRPCJUA [JUA] with the FWUA. And to create a broader and more equitable assessment base by including surplus lines, insurers and policyholders and a residual market assessment base in the same manner as authorized insurers and policyholders (Garcia 2002).

However, Citizens guiding mandate did not state a need for a reduction in operating costs. It identified a problem with the perception of hurricane risk and argued that "actual and *threatened* catastrophic losses[66]" limited the availability of private market property insurance in the state (emphasis added). Comments made to the press indicated that Citizens was intended,

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[65] One of the primary sponsors of the Windstorm Bill that created Citizens was Representative Jeff Atwater. He is currently the Florida's Chief Financial Officer.

[66] SB 1418, 2002 Legislature

not simply as a means to reduce overhead expenses, but as a tool for bounding the market conception of risk being imposed upon the public. In signing the law, Governor Bush announced that the "legislation will help contain insurance-related costs;" and, the company promoted itself as a means of "capping windstorm rate increases" (Citizens Property Insurance Corporation 2002).

The sudden surge in the insurance industry's perceived risk caused by the hurricane events of 2004 and 2005 caused conflict between reinsurers, primary insurers, and the public. Again, disagreement about the risk led to instability in Florida's insurance market and by the end of 2006, the number of companies actively writing residential coverage in Florida had been declining[67] and the number of policies admitted into Citizens increasing (FL House of Representatives 2007). Citizens tried to sue the Florida Office of Insurance Regulation (FLOIR) for higher rates so that the company could be more in line with the private market idea of hurricane risk and to account for the growing number of Citizens policies. The lawsuit was prohibited by the then Attorney General, soon-to- be-elected- governor, Charlie Crist. He argued that Citizens had an obligation to keep the conception of hurricane risk from growing beyond public acceptability,

> Citizens Property Insurance Corporation seems to have forgotten that it was created to serve people during their time of great need. It seems to have forgotten that the people of Florida are the boss, and the corporation is there to serve them – not the other way around. It's time we remind Citizens Property Insurance of its statutory and moral duty to the people of Florida (Attorney General Charlie Crist 2006).

Faced with the insurance industry's rapidly evolving conception of the Florida hurricane risk, a housing market that had begun to slump, and a disgruntled, financially strained populous, the newly elected Florida Governor Charlie Crist signed into law, House Bill 1A in January

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[67] Five insurers dominated the market: Citizens, State Farm Florida, Allstate Floridian, Nationwide of Florida and United Services Automobile Association.

2007. The bill did many things, but most notably it enabled consumers to enter Citizens if the cost of private market coverage was 25% greater than Citizens' cost of coverage. Advancing Citizens as a means to defend against the conception of hurricane risk being created on the private market was perceived to "place Citizens in more direct competition with the voluntary market" (Deffenbaugh 2007).

During deliberation of the bill, Rep. Denise Grimsley, a co-sponsor of the bill, argued that HB1A responded to a "competitive disadvantage" policyholders' had when dealing with their insurance providers due to information asymmetry and industry folly:

> Policyholders have too few options, too few protections, and too little information. Today, policyholders no longer stand on a level playing field with their insurers. The purpose of this legislation is to restore balance and common sense to the market (Grimsley 2007).

As the months passed, the economy worsened and the private market's conception of hurricane risk continued to grow- exacerbated by the new Citizens legislation, its existing debt, and the upcoming 2007 hurricane season. In June, the ratification of Senate Bill 2498 expanded eligibility for Citizens further by allowing entrance into the residual market if the cost of private market coverage was 15% greater than Citizens' cost of coverage (Deffenbaugh 2007). Deliberation of the bill emphasized the need for a competitive insurance market. But a statement made by Gov. Crist exemplified the underlying power struggle between the insurance industry and the public over definition of the risk,

> It does turn things on its head; and that's the whole idea. It gives more power back to the people for them to have the opportunity through Citizens and other competition as a result of this good legislation to be able to get lower rates. I applaud the amendment that takes it down to 15%, maintains our tax-exempt status (Crist 2007).

The final legislation, however, did not mention a need for competition. Like all the previous legislation, it emphasized the need to control the conception of hurricane risk with the

Legislature finding that "private insurers are unwilling or unable to provide *affordable* property insurance coverage in this state to the extent sought and needed[68]" (emphasis added). As such, Citizens new goal became to "increase the availability of affordable property insurance." Although the legislation did not define 'affordable,' it directed Citizens to achieve its goal through "affordable rates[69]." Emphases on the insurance rate, a tangible symbol for risk (see Chapter 4), placed emphasis on the scientific process of characterizing Florida's hurricane risk.

The impossibility of an actuarially sound residual market

Citizens inherited the legislative requirement to maintain actuarially sound from its FWUA predecessor[70] (Deffenbaugh 2002). Specifically, the legislature mandated that FWUA rates be "actuarially sound and not competitive with approved rates charged by authorized insurers [71,72]." However, the phrase is not applicable to ratemaking for residual markets because the residual market view of risk inherently contradicts with conventional measurements on the private market. Consequently, inclusion of the wording in the legislation means that whoever has control over deciding Citizens' rates can determine Citizens' role in the market as a TRM or DRM and no matter how that person sets the rates, Citizens remains consistent with legislative requirements. That is, legislators have built into the legislation a power conflict for control of the definition of hurricane risk.

The *American Academy of Actuaries*, an interest group for the actuarial profession, defines actuarially sound "as a general term, assumed to be understood to mean reasonable and

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[68] Florida Senate Bill 2498ER, 627.351(6)(a)1
[69] *ibid*
[70] Florida legislators had at one time mandated the JUA also have actuarially sound rates (Mittler 1997).
[71] Florida Statute 627.351(2)5b
[72] I was not able to determine if this wording appeared in the original 1970 legislation, but my impression is that it did not. Based on the analysis in Gorrie (1998) I believe it appeared in the FWUA legislation in 1997.

consistent with generally accepted actuarial principles and practices" (American Academy of Actuaries 2012, p. 24). From here we can begin to see the contradiction in applying actuarially sound to a residual market because legislators create and use residual markets when insurers' generally accepted principles and practices do not support public policy goals either in insurance availability or price. Table 12 provides four principles of ratemaking defined by the *Casualty Actuarial Society*. Based on these principles, a facility with actuarially sound rates is capable of covering all costs associated with loss, signifying the facility functions soundly as insurance.

	A Rate…
Principle 1	is an estimate of the expected value of future costs.
Principle 2	provides for all costs associated with the transfer of risk.
Principle 3	provides for the costs associated with an individual risk transfer.
Principle 4	is reasonable and not excessive, inadequate, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future costs associated with an individual risk transfer.

Table 12: Principles of Ratemaking (adapted from CAS Statement of Principles Regarding Property and Casualty Insurance Ratemaking)

Under these criteria an actuarial sound residual market is impossible from both the TRM and DRM perspective. From a TRM perspective the facility offers coverage where generally accepted practices view a particular risk as unmeasurable and therefore uninsurable. Decision makers accomplish this by setting residual market rates as higher then those on the private market thereby ensuring that the residual market consider market judgments of risk, operates in the periphery of the private market and does not compete against it. However, judging actuarially soundness on the basis of non-competition with the private market misconstrues the meaning of the term. A TRM cannot have actuarially sound rates for two reasons. First, offering insurance coverage for a risk that the private market views as unmeasurable or uninsurable goes against generally accepted practices because the accepted practice is to not offer insurance. Second, if insurers consider the risk as unknown, then a TRM has no way to judge its ability to cover future loss and has no ability to judge the adequacy of its rates. In either case, actuarially soundness is an inappropriate metric to judge the rates of a residual market.

From a DRM perspective, the facility offers insurance where generally accepted practices estimate the risk as larger than socially acceptable. Decision makers accomplish this by setting residual market rates in a way that helps control the conception and characterization of risk imposed upon the public by the private market. In so doing, DRM rates necessarily conflict with generally accepted practices that view DRM rates as unable to cover the cost of loss. Logically, if DRM rates could be actuarially sound then there would be no reason for the residual market's existence.

With the inclusion of the unattainable goal into Citizens' legislation, legislators built into the statute a power conflict over defining risk. In order for Citizens to have actuarially sound rates it must adopt a view of risk consistent with the private market, but the public views as unaffordable. Likewise, in order for Citizens to provide affordable insurance it must adopt a view of risk not consistent with the private market and therefore not actuarially sound. So, whoever decides Citizens rates also decides if the company functions as a TRM or a DRM because aligning Citizens' ratemaking with the private market view of risk diminishes the company as a DRM and pushes it towards a TRM. Yet, regardless of how the person in charge decides, the decision will be consistent with some part of legislative intent. In a series of quotes, Barry Gilway, President of Citizens, demonstrates the inherent conflict that the legislation presents. Upon requesting a Citizens rate increase from regulators, Gilway, stated the need for "selectively moving rates higher in a very measured way so that, over time, [Citizens] can be appropriately positioned in the marketplace" (Olorunnipa 2012a). For Gilway, accepting a larger estimate of risk is consistent with policy objectives for the residual market. In another quote, Gilway demonstrates that the regulative decision about rates defines how the company functions but even still, any decision is consistent with legislation. He explains that, "Citizens' position is: from a statutory standpoint, we are required to file actuarially sound rates." And yet, the Citizens' governing board[73] "believe it is basically up to the Legislature and the (Office of Insurance Regulation) to determine how aggressive they would like to be in getting from where we are today to an actuarially sound level" (Gilway cited in (Buck 2013). Presuming that the legislature and the Florida Office of Insurance Regulation (FLOIR) make decisions that support policy objectives, then increasing or decreasing rates are all acceptable decisions.

Politicization of the hurricane risk

Some political interests, namely those of environmental and fiscal and budget, use Florida's hurricane risk as the latest rationale for resolving existing political conflicts about desired policy for Florida's future. For example, David Hart, the executive vice president of the Florida Chamber of Commerce, argued that higher insurance rates (i.e. a larger hurricane risk) are needed "[t]o secure Florida's future" (Hart 2012). In contrast, Sen. Mike Fasano has argued for a smaller hurricane risk because Florida's future "economy just can't withstand" increasing rates (Olorunnipa 2012b). The politicization of the hurricane risk, the weighting of one measure of risk against another based on the political advantage offered, circumvents the opportunity for public debate about moral concerns (Pielke 2007). In some cases, interest take the politicization of risk to such an extreme as to entirely replace the democratic decision making process with

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[73] Florida's Governor, the Chief Financial Officer, the President of the Senate, and the Speaker of the House of Representatives each appoint two members to Citizens' governing board. At least one member appointed by each appointing officer must have expertise in insurance (Florida Statute 627.351(6)(c)4a). As a result, the board may be studied under the framework of technical or science advisory boards. The role of technical or science advisory boards often play an integral role in the process of constructing, characterizing and governing risk (e.g. Jasanoff 1990; Pielke 2010; Pielke and Klein 2009); however, the topic is beyond the scope of this dissertation.

desired measures of risk. The James Madison Institute, a Florida think-tank, promoted "comprehensive reform of the state's dysfunctional property insurance system" in regards to how the state manages hurricane risk to force resolve in other areas of ongoing debate and "improve the state's economy and better protect taxpayers, while also helping to preserve Florida's environment (Lehrer 2011)." Environmental policy and fiscal and budget policy are two of the most prominent areas of public policy commonly conflated with the politics of Florida windstorm ratemaking.

Environment

Environmental groups, think-tanks, and insurers promote rate policy as a means to address concerns of the environmental impact from 'irresponsible' or 'reckless' development. The argument holds that "cheap" insurance has encouraged extensive land development,

> Risky coastal development, which we are all underwriting through subsidized insurance and related programs, not only is a burden to taxpayers, but it promotes development in the very areas that are the most prone to storm damage…No reasonable person can conclude that anything but a fundamental change is overdue, and that we are most fortunate that our luck has held out as long as it has (quoted in Lehmann 2012).

Following this argument, pricing the risk appropriately would mean for Citizens to adopt a view of risk in line with its role as a TRM because such a view of risk would be unaffordable thereby forcing people to move out of Florida or to not move into it.

This argument presents at least two main logic problems. First, to intentionally price the risk as unaffordable is politically unacceptable and against stated public policy. Second, there is no reason to believe that the high cost of risk would necessarily discourage development rather than facilitate the creation of an economically elite society. Consider that building activity need not be directly tied to demand (FIU Metropolitan Center). And even though much of the Florida public already considers the cost of windstorm insurance as unaffordable or too expensive, an article in the *New York Times* describes a Florida real estate “boomlet” (Barrionuevo 2012) on the luxury real estate market along the coast. Furthermore, current buyers of real estate often pay in cash. Cash transactions accounted for 40% of the real estate sales statewide in April 2012 (Florida Legislature Office of Economic and Demographic Research 2012b). Cash buyers do not carry a mortgage and therefore need not purchase windstorm insurance. These trends give no indication that increasing the cost of insurance discourages coastal development, only the type of development and who gets to live there.

Though the actual ratemaking process that takes place in Florida’s capital, Tallahassee, makes little if any direct use of climate change as a guide for rate decisions (Insurance Executive R 2012), others most certainly do. Several reasons exist as to why the highly politicized issue of climate change has become conflated with insurance rate policy politics. Hurricanes act as focusing events, bringing heightened public attention, concern, and support for dramatic policy change (Birkland 1997; see also Kingdon 1984). Political scientist, Roger Pielke, Jr. (2010) documents the use of hurricane risk science to support evidence of “adverse effects of climate change” for the purposes of international negotiations on climate change policy. In this sense, hurricane events, and any subsequent struggles with the insurance regime act as demonstrable proof of a climate change causing adverse effects.

Other examples provide direct arguments of interests using climate change to influence perceptions of hurricane risk and implications for insurance ratemaking. For instance, in the midst of controversy over insurance industry measures of risk using catastrophe models insurers and reinsurers held a conference in Miami where they argued, “The potential of climate change is an issue that affects many industries but in particular the insurance industry because weather has always had a major impact on our bottom line” (Zaneski 1997). After the 2004/2005 hurricane season, some reinsurers asserted that "the only plausible explanation for the rise in weather-related catastrophes is climate change" (Munich Re 2010). Climate change policy activists treat such claims as fodder for making the connection that rising insurance rates mean that hurricanes are getting worse due to climate change. Mike Tidwell, a climate change activist in the Washington D.C. area, reflected on the increase in the cost of windstorm insurance and some insurers' attempts to withdraw from coastal markets and posed a rhetorical question in *The Washington Post*, "Why would private insurance companies lie about climate change?" (Tidwell 2011). Most recently, *Rolling Stone Magazine* made Miami a charismatic symbol of the climate change threat,

> The financial catastrophe could play out like this: As insurance rates climb, fewer are able to afford homes. Housing prices fall, which slows development, which decreases the tax base, which makes cities and towns even less able to afford the infrastructure upgrades necessary to adapt to rising seas. The spiral continues downward. Beaches deteriorate, hotels sit empty, restaurants close. Because Miami's largest economies are development and tourism, it's a deadly tailspin. The threat of sea-level rise bankrupts the state even before it is wiped out by a killer storm (Goodell 2013).

For climate change policy activists, increases in the cost of windstorm insurance conforms to fears that climate change has made hurricanes 'worse.' From this perspective, the acceptability of hurricane risk estimates depends upon ones expectations of climate change impacts.

Some economic interests promote insurance as a 'free market' way to adapt to climate change by incorporating climate change risk into insurance pricing. Ceres, a prominent environmental investment group, is an outspoken advocate of this perspective. Following the argument that climate change could create large hurricane losses and such losses could cause public insurers incur a deficit, Ceres uses Citizens as an example of insurance conditions under climate change if rate policy is not changed to incorporate a view of a larger hurricane risk (Mills et al. 2005; Khalamayzer 2012; CERES 2012). By doing so, Ceres conflates current climate change politics with Florida's ongoing political conflict over the governing of hurricane risk that began in 1970s.

The conflation of climate change politics with ratemaking politics is misleading of the science of disaster losses. As discussed in Chapter 6, climate change cannot yet be detected in the hurricane loss data. The historical record shows no long term trends in hurricane frequency or severity (Weinkle et al. 2012). In addition, "it is indisputable that the recent rise in damages…is heavily influences by the concentration of people and property in geographically vulnerable areas" (Nutter 2013). Raising insurance rates to incorporate climate change risk is inappropriate because one has nothing to do with the other. (McAneney et al. 2013) argue that due to the time scales involved and the public interest involved in establishing insurance pricing, using insurance to manage climate change is illogical.

Fiscal and budget

Because of Citizens' ability to spread risk over time through the use of assessments- what has been coined "hurricane taxes"- to fund any occurring deficit, the conflation of ongoing national and state political debate on fiscal and budget policies with the politics of ratemaking has fallen within three broad realms: debt, taxes, and entitlements. Florida Sen. Alan Hayes (R-FL) went so far to present Citizens as a direct threat to ideals of capitalism. He said that the Citizens is "nothing more than Socialism, and we need to stamp out Socialism in this country as soon as we can" (Channel 7-WJHG 2011).

Two generally competing schools of thought have arisen. The first group promotes scientific and actuarial information to support desired rate policy. For this group, scientific information forms the basis for determining the rate and in turn, the appropriate role of Citizens as a TRM. The second group appeals to morality and public values to support desired rate policy (see also Pielke 2007). Scientific information is irrelevant to this group and the appropriate role of Citizens as a DRM. Yet, whether or not values are directly invoked they play an active role for both groups because "a shift to actuarial or demographic ways of thinking does not eliminate appeals to the good, true, or beautiful, it simply introduces a different frame for those appeals" (Baker 2000)

For example, John Rollins (2012), member of the Citizens Board of Governors, proclaimed a need to "refocus on the facts" which presumably leads the way to good rate policy. He characterized the issue of rate policy in the context of probable hurricane loss statistics that were "according to scientists." Likewise, Governor Rick Scott argued that public discourse about Florida's hurricane risk and Citizens' rate decision should be placed in the context of "making sure people understand the risk of hurricane taxes" (Anderson 2012). To Rollins, Governor Scott, and those that would agree with their perspective, decisions about Citizens rates should be determined based on fiscal and budget concerns (see also Pielke 2007). Rollins took this a step further by referring to heated debate about Federal budget policy. Rollins said that if Citizens incurs a deficit then,

> Florida will be further in debt, future generations can anticipate decades of assessments, and all those property insurance policies must still be renewed using someone's money to back the promises. Sounds like the "plan" right now in Washington, doesn't it? (Rollins 2012)

For Rollins, Citizens represents just one example of a national budget crisis stemming from the cost of social programs.

Contrary to these arguments, some appeal directly to morality to guide rate decisions. Facing a lawsuit brought by Citizens seeking a rate request, then Attorney General Charlie Crist, refused to allow the suit arguing that Citizens had a "statutory and moral duty to the people of Florida" (Attorney General Charlie Crist 2006). Senator Anitere Flores (R-Miami), has echoed this sentiment claiming that raising Citizens rates was "nothing short of immoral" (Olorunnipa 2012a). Morality has also been invoked as a reason for raising rates as well. Barney Bishop, CEO of Associated Industries of Florida, a business interest group, said that Citizens was "acting irresponsibly by failing to raise rates" (Citizens Property Insurance Corporation 2011). Akin to these are ethical arguments of affordability and access to one's "home." For instance, narrative information from the public often depicts stories of difficulty in one homeowner wrote to the governor that because of Citizens rate increases, "It is really sad that after 37 years of living in Miami, I'll be forced to move out because I cannot afford my home insurance" (Olorunnipa 2012b). While homeowners' accounts of difficulty with the cost of windstorm insurance is not a quantified fact, it no less represents a fact about the concerns of Florida residents.

Florida's economic model assumptions are false, shortsighted and economically unsustainable

The Office of Economic and Demographic Research (OEDR), a part of the Florida legislature, frequently creates the economic model shown in Figure 13 for reporting on the state of Florida's economy. The frequency of its production and its association with the legislature indicates the model as a mainstay of legislative decision making and a good representation of how government decision makers understand Florida's economy. However, the model fails to give a realistic representation of the relationship between factors in the state's economy[74]. First,

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[74]The economic model uses increasing GDP as an end goal. The use of GDP as a metric of the economic wealth of a state or nation is common practice but the practice has come under extensive criticism for not capturing the economic well-being and quality of life of society, families, and individuals (Stiglitz et al 2009). The issue of GDP as a poor indicator of economic well-being and quality of life is important in respect to the debate about affordable insurance because increasing GDP may not reflect ongoing social economic disparity. Building activity that contributes to increasing GDP also increases the value at risk and requires the cost of of insurance to increase to remain in accordance with the criteria of insurability (Berliner 1982). However, while GDP may increase, household incomes may not thereby causing strain on the

the model makes false assumptions about the relationship between population growth, employment growth, and new construction. Second, the model fails to consider impacts on the credit market that come from the increasing catastrophic hurricane risk produced as a result of population growth, new construction, and employment growth. Third, the relationship between new construction and tourism appears underestimated. Finally, in light of the model's false assumptions and shortsightedness, it is economically unsustainable in respect to legislative efforts to provide affordable property insurance.

The economic model depicts population growth as the primary driver of the Florida's economy through its effects on employment growth and new construction. Available data does not support these model assumptions on two fronts. First, employment and population growth are not directly related. The state lost over 700,000 jobs due to the real estate market collapse that began around 2007, yet Florida's population continued and continues to grow- expected to reach 20 million by 2016 (Florida Legislature Office of Economic and Demographic Research 2012a). The OEDR reports that the unemployment "hole is deeper than it looks" (Florida Legislature Office of Economic and Demographic Research 2012a, p. 8) because the state's population of "prime working age" (ages 25-54) is also increasing. If population and employment were directly related then one would not observe the lag of employment behind population. Second, population does not drive new construction. Despite the increasing Florida population, the OEDR writes that the "overall Florida economy is unlikely to significantly improve until new construction comes back to life, and that won't happen until the existing inventory is reduced" (Florida Legislature Office of Economic and Demographic Research 2012b, p. 7). Yet, Florida has a glut of vacant housing units on the market and in 2011, the state

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ability to provide affordable coverage that is also in line with conventional insurance practices. Thanks to Max Boykoff for bringing up this issue.

had the highest vacancy rate, 17.5%, in the nation (Trigaux 2011). The OEDR expects the number of number of vacancies on the market to increase,

> Originally related to mortgage resets and changes in financing terms that placed owners in default, more recent increases have been boosted by the persistently high levels of unemployed persons in financial distress expected to increase along with an expected increase in foreclosures… Today, slightly less than half of all residential loans in Florida are for homes that remain underwater. Absent some intervention, these homeowners are the most likely to move into (or already be in) delinquent status (Florida Legislature Office of Economic and Demographic Research 2012b, 6–7)

Furthermore, a research group at Florida International University found that the pace of new construction has had nothing to do with population growth because the "housing development that occurred in the years leading up to the collapse of the housing market were built without regard for actual demand" (FIU Metropolitan Center). Overall, the data describing trends does not support the economic model assumption that population growth drives Florida's employment and new construction.

Florida's economic model directly relates conditions on the credit market to growth in new construction and employment but does not consider the reciprocal relationship of how population, employment and new construction affects the credit market through Florida's hurricane risk. Researchers have demonstrated that socioeconomic factors such as inflation and increasing concentrations of wealth and population or housing units have caused the observed increase in hurricane related losses (Pielke et al. 2008; Schmidt et al. 2008); see also Chapters 4 and 6). Even if one accepts that population growth, employment growth and construction growth are not directly related the model's view of Florida's economy still depends on growth of these three factors. Consequently, Florida's economic model presents an implicit forecast of continuously increasing hurricane losses through the drive for increasing population, construction and employment[75]. Increasing disaster losses in real terms has implications for the credit market because estimating catastrophe risk is an integral component to financial industries' assessment of credit risk.

Though a full exploration of the impacts of catastrophe risk on Florida's credit market is beyond the scope of this dissertation, I provide two examples demonstrating the relationship between the credit market and catastrophe risk. First, for those insurers and reinsurers in any way bound to or affected by European Solvency II regulations, catastrophe risk must be considered in company management. Catastrophe model output serves as an input to capital models, driving expectations of company capital requirements and credit ratings (e.g. Munich Re 2011). A second example shows the relationship between catastrophe risk and mortgage lending. Eqecat, a popular catastrophe modeling firm, specifically predicts the probability of mortgage default as a result of natural catastrophe events (e.g. hurricanes),

> Homeowners impacted by the negative economic effects of a natural catastrophe may be forced to default on their mortgage loans due to extensive damage to their property, insurance shortfalls or repair costs exceeding their home's equity or market value. Mortgage impairment risk, when aggregated over concentrations of risk in an affected area, can translate into catastrophic losses to mortgage lenders. Managing the risk of massive mortgage default resulting from natural catastrophes begins with quantifying the likelihood and the amount of exposure and loss (EQECAT 2013).

That Eqecat produces this product gives reason to believe at least some mortgage lending institutions consider catastrophe risk directly in evaluations of credit risk in a market. By not fully considering the feedback between assumed drivers of the economy, Florida's economic model is shortsighted.

Given these false assumptions and shortsightedness, legislators working with an idea of the economy based upon the economic model undermine their own efforts to provide the public

[75] Provided that one who is employed earns an income affording one the ability to purchase goods, employment serves as a proxy for tangible assets and personal wealth.

with affordable property insurance. First, infinite growth in population, wealth, and construction will undoubtedly increase hurricane losses. Under conventional views of the criteria of insurability, insurance pricing must increase in response to increases in loss potential (ie. increasing risk concentration). As a result, insurance affordability declines. Affordability also declines as employment lags behind population growth because people do not have the incomes to support the cost of insurance. Second, without consideration of catastrophe risk effects on the credit market, then as population, construction, and employment continue to increase, according to Florida's economic model, the entire state economy may suffer. This will exacerbate insurance affordability issues.

Responsibility for Citizens' Performance has Implications for Florida's Democratic Process

A healthy democratic process enables broad public engagement in the process of public policy decision making. Political scientist, Robert Dahl (1998), identifies five criteria for a successful democratic process: 1) Effective participation, 2) Voting equality, 3) Enlightened understanding, 4) Control of the agenda, and 5) Inclusiveness. Challenges in meeting any of these criteria also indicate constrained public engagement (Chapter 4). While Citizens functions as an insurance facility it is also an authoritative public policy and its implementation is representative of Florida's governing practices.

Conditions that serve as explanations for difficulties in meeting Citizens' legislative mandate also represent trends in Florida's democratic process. First, the inclusion of contradictory and inapplicable goals to guide the implementation of Citizens as a residual market prevents public ability from holding its elected officials accountable for their actions. A lack of accountability undermines the legitimacy of the governing system as a democracy. Second, as a result of the lack of accountability, the measures of hurricane risk rather than public policy determine winners and losers in society. This causes a politicization of the hurricane risk that hinders effecting policy making about Florida's economy.

Legislative failure to reach a consensus about preferable outcomes of the Citizens policy leads to a lack of democratic accountability. Accountability matters because it legitimates the actions of authoritative government officials (Young 2002b). Political scientists, Amy Gutmann and Dennis Thompson (1996, p. 129) explain that in a democracy "representatives are expected to justify their actions in moral terms… they give reasons that can be accepted by all those who are bound by the laws and policies they justify." The impossibility of an actuarially sound residual market prevents accountability because legislators cannot be held accountable to unattainable goals. Moreover, the legislation establishes a conflict over control of how Citizens functions whereby satisfying the goal of affordable property insurance means failing the goal of actuarially sound, and *vice versa*. Consequently, regardless of how a regulator establishes Citizens' rates he or she can always support the morality of the decision based on legislative wording (Gutmann and Thompson 1996). Without accountability, implementation of Citizens is vulnerable to the whim of political power (Lasswell 1971).

The lack of accountability has led to a politicization of the hurricane risk because decisions about measures of hurricane risk, not public policy, determines who wins and who loses in society. Politicization occurs when decision makers weigh the value of decision option by the political advantage offered to the neglect of public policy objectives (Weingart 1999; Pielke 2007). Severe politicization threatens the democratic process by reducing the ability of political power to make decisions that effectively address public policy problems and reducing opportunity for public participation in policy making (Pielke 2007).

While policymakers occupy themselves with weighing decisions about Citizens' rates, they neglect the conflict between economic wealth creation policies in respect to policy goals of affordable property insurance. Considering that the legislature intends for the Citizens policy to help support the "economy of the state"[76] the conflict between the two economic policies presents an unsustainable situation. The economic model directs policy making towards encouraging increasing concentration of population and wealth in the state. In order to remain in accordance with conventional ideals of insurance, these economic policies will lead to increases in insurance costs and thus a decrease in affordability.

Policy makers cannot resolve this conflict in economic policies through ratemaking. In order to reconcile conflict between efforts to provide affordable property insurance and policies of economic wealth production, a public discourse needs to develop about the future of Florida's economy. The politicization of the hurricane risk hides the need for this discussion and perpetuates advancement of a subset of economic interests while removing the opportunity for public participation in deciding the desirability of future economic policy (see also e.g Fine and Owen 2005; Robinson 1992; Pielke 2010).

Conclusion

Determining the success or failure of the Citizens policy depends upon one's perspective on desirable outcomes. Regulators have created and used Citizens as a policy mechanism for deflecting a great deal of insurance market judgments of hurricane risk that the public perceives as unaffordable or otherwise unacceptable. This conflicts with technocratic perspectives of the proper role of a residual market as supplemental to the private market. As power shifts back and forth from the insurance industry to the public Citizens moves from being under technocratic

[76] FLA. STAT. §627.351(6)(a)1

control with what is perceived as unaffordable rates to under democratic control and acts less like conventional insurance.

Unfortunately, the legislature created the power conflict between technocratic and democratic perspectives by its inclusion of the phrase "actuarially sound" into the legislation guiding the management of Citizens. As a residual market, Citizens view of risk necessarily conflicts with private market convention which means that the goal of actuarially sound is logically impossible to attain. This presents significant challenges for the democratic process by limiting the accountability of public policy makers and politicizing the hurricane risk.

Concentrating political efforts on ratemaking avoids confronting Florida's underlying problem in its public policies regarding economic wealth creation in the state. Florida's economic model provides an implicit forecast that the state's hurricane risk will continue to increase unabated. Furthermore, past experience demonstrates that population growth and new construction does not necessarily lead to employment growth or increased wages. Taken together, policies stemming from Florida's economic model are unsustainable in respect to legislative efforts to provide affordable property insurance. The politicization of Florida's hurricane risk and the state's economic model challenges the ability of the democratic process to include public participation and consider policy alternatives. This fixes political power with select economic interests that potentially do not align with the public interest.

In order to address the problems with Citizens, Florida needs to develop a public debate about its future economy and the moral values the public wishes to maximize. Conceivably, such a moral discourse may reveal favorability for the status quo. If so, perhaps, continuous negotiation of insurance rates is the best that anyone can hope for. Of course, it may also reveal a demand for public policy change consistent with contemporary feelings of risk about the environment, government budgets, income inequality, and real estate and land development. Without these discussions, Florida falls short on its commitment to democracy.

CHAPTER 9: Alternatives

Introduction: Anywhere Else To Go from Here

The upside to the narrow debate about increasing or decreasing hurricane insurance rates plaguing Florida for several decades is that there remains a vast potential for policy alternatives that policy makers have yet to explore. This chapter presents research areas that may result in fruitful options. The goal here is to expand the scope of alternatives rather than promote my favorite policy as a solution to Florida insurance woes (Lasswell 1971). As with most complex policy problems policy makers will likely need to implement several different types of policies to appeal to various policy preferences (Verweij et al. 2006).

This chapter proceeds in three parts. The first part describes some of the current alternatives often discussed to alleviate difficulties in the availability of affordable property insurance. For each alternative, I explore potential advantages and drawbacks. The second part reflects on the research in this dissertation and makes specific policy recommendations. In some instances, I give an example of potential policies. The final section provides a conclusion.

Current Alternatives

By current alternatives, I mean policy options that tend to reappear on the policy agenda. These fall within four general categories: 1) Free market ideals, 2) Innovation in risk transfer, 3) Backstops and Risk pools, and 4) Reduction in vulnerability vs. Disasters are good for the economy. The first two are closely related because if one decides to accept free market ideology then ushering in the wellspring of financial transfer mechanisms seems unobjectionable. However, I consider them separately because I think they present different types of difficulties. Category 3 is closely related to the category of Innovation in Risk Governance discussed in the next section. I present them separately because current alternatives seem to focus almost exclusively on risk pool size whereas I explore other areas of innovation.

Free market ideals

A common solution advanced for improving risk management of Florida hurricane risk revolve around the idea of a "free market." This policy option seeks to rid the insurance market of at least most, government intervention. From the perspective that Florida must reduce its regulatory involvement in the market, accusations that Florida has a "hostile regulatory environment" (Insurance Information Institute 2012) or that Citizens rates are "immoral, irresponsible and socialistic" (Tobia 2012) can better be understood as disputes about the role of government in market regulation. In the United States, the dispute dates back centuries to conflict of British rule over the colonies and represented in such influential scholarly works as Adam Smith's *The Wealth of Nations* and *The Federalist Papers* written in support of the Constitutions. Free market ideology as a means to improve management of hurricane risk in Florida is impractical. It implies that in order to make headway on a current pubic problem, one must first resolve a centuries old conflict about the role of government in market regulation.

American government intervention in the economic market has a long precedence. Political scientist, Eric Shattschneider, argued in his renowned essay, *The Semisoverign People*, that

> The function of democracy has been to provide the public with a second power system, an alternative power system, which can be used to counterbalance economic power…This is why government and business so often seem to be alternative ways of doing the same things (1960, p. 119).

Numerous examples exist of social policies that work to buffer market judgments of risk or the social effects of market judgments (e.g. social security, health care, public housing, bankruptcy protection, etc). Democratic societies cannot sustain an economy based on market judgments alone because the market needs law and order to function and without intervention harm befalls some portions of the population who inevitable demand government involvement (Dahl 1998). While perhaps a worthy intellectual debate, so long as market judgments of risk remain politically unacceptable, debating the appropriate role of government in market regulation has little practical significance for developing contemporary public policy to better manage Florida's hurricane risk.

Innovation in risk transfer

Currently, the insurance industry actively promotes several new or relatively new means of risk transfer. These include technological innovations like catastrophe bonds, sidecars, derivatives and insurance linked securities (Froot 1999; a more general overview in King 2013). To some degree, the decline in perceived private market insurability may indicate a failure of Florida government to successfully encourage sufficient innovation in the insurance industry (e.g. Stahel 2003). Perhaps, successfully innovating the private market can achieve competition sufficient for the public policy goal of affordable property insurance. To the extent that legislators created Citizens to achieve this goal (e.g. Garcia 2002; Crist 2007) this dissertation demonstrates that it has led to undesirable innovation (I discuss this further below). In any case, it behooves the Florida legislature to consider policies that foster insurance market innovation that has the promise to achieve public policy objective.

However, public policy makers need to approach these types of innovation with caution, public debate, and examination of alternatives. Recent experience with financial risk modeling indicates that the perceived value of certain financial technologies may be incongruous with societal benefit. For instance, the use, misuse, or misunderstanding of risk models by rating agencies to evaluate mortgages led to the 2008 global economic crisis (Kiff and Mills 2007;

Lewis 2010). Law and finance professor, Frank Partnoy (2012), attributed the misuse of the Value-at-Risk (VaR) model to several historic financial loss event[77]. As this dissertation demonstrates the rapid and widespread acceptance of catastrophe models has caused increased difficulty in maintaining the availability of affordable property insurance. To the extent that new risk transfer technologies rely on modeled risk output, they are subject to the same or similar misgivings.

Backstops and risk pools

At least since the early 1990s, Congress considers bills that would increase the risk pool for catastrophic loss or commit the federal government to establishing a backstop (King 1994, 2005, 2008, 2009, 2013). In general, proposed policies that increase the size of the risk pool do so on a regional or national level. Proposed policies that commit the federal government to establishing a backstop involve multiple options for the federal government as a provider of catastrophic insurance, reinsurance, loans, etc. (King 2013). I discuss these generally and separately.

The Florida Insurance Commissioner Kevin McCarty has, over recent years, actively advocated for a policy that would expand the catastrophe risk pool to the national or regional level (FLOIR 2007). State participation in the pool varies from voluntarily to mandatory depending on the bill (King 2013). These policies seek to ensure the availability of affordable property insurance coverage by taking advantage of spreading risk over space and managing different types of catastrophic perils. To the extent that they achieve public policy objectives they are beneficial to the public.

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[77] Barings Bank (1995), Long-Term Capital Management (1998), Enron (2000), Lehman Brothers and AIG (2008), and JPMorgan Chase (2012)

Their drawback of these plans is that they do not resolve underlying value conflicts. Under new pooling regimes, existing conflict between the private market and government perpetuates, perhaps exacerbated by the limited ability of private market insurers to pool risk across state lines. As well, controlling the cost of insurance does not address the underlying increase in exposure created by other economic policies. That is, creating a larger risk pool may only serve as a temporary fix.

The federal government whether contractually bound or not, acts as the *de facto* insurer for catastrophe stricken states (King 2013). This is an appropriate role for national governments as the provider of security in times of crisis (Madison 1787). In recent years, as disaster losses have increased, political interests have objected to the burden this government role places on the national budget (e.g Knudsen and Mayer 2013). Officially establishing the obligations of the federal government provides the opportunity for the collection of premium or to ease the concerns of state and private market insurers (King 2013) see also renewing riot reinsurance (Fritzel 1982). A drawback to this policy option is that to the extent insurance encourages risk taking, it exposes the national government to moral hazard from state risk management policies (see for e.g. Baker 2000). The public may or may not consider this as a concern.

Reduction in vulnerability vs. Disasters are good for the economy

Two approaches to the same idea reflect current policy option actively debated in Florida. On one hand, interests advocate for a reduction in vulnerability to hurricanes (Insurance Expert B 2012). On the other, some see no problem to disaster losses because "War and disasters are good for the economy" (Insurance Executive L 2013). This conflict centers on building codes and building mitigation as policy options. Implementing policy that encourages homeowners to reduce the likelihood of hurricane damage to their homes has demonstrated some difficulties (e.g. FCHLPM 2010). Still, any reduction in vulnerability that translates to decreases in hurricane losses (Pielke 1997) would serve to aid in lowering insurance costs. However, mitigation and more stringent building codes have associated costs to homeowners. Therefore, the reasonableness of pursuing policies that encourage decreases in economic vulnerability depends upon the extent to which disasters do not offer an economic advantage to society. The following reviews, in brief, the literature on effects of disasters on economies. The research suggests that disasters do not have beneficial effects for the economy.

Researchers actively study the effect of disasters on the economy in large part to determine if observation can support such an uncomfortable belief, at least in regards to disasters. In general researcher findings falls along into two competing conclusions: 1) Disasters have little to no impact on the economy (Albala-Bertrand 1993); and 2) Disasters, on average, have adverse impact on the economy (Hochrainer 2009). Yet, other researchers find more mixed results, indicating that the effect of disasters on the economy varies by sector and though smaller disasters can have positive effects on some sectors, severe disasters do not (Loayza et al. 2009). After a review of the literature, researchers with the Inter-American Development Bank conclude "the emerging consensus in the literature is that natural disasters have, on average, a negative impact on short-term economic growth" (Cavallo and Noy 2010). As a result, the research on impacts of disasters on the economy does not support the conclusion that disasters, broadly speaking, are good for the economy.

In addition, Florida's continued growth of the hurricane risk implied by the economic model threatens the social stability needed to implement democratic criteria of effective public participation (Dahl 1998). Writer and social activist Naomi Klein (2007) argued that powerful groups take advantage of the social instability following large scale disasters to instate publicly contentious economic and social policies. Perhaps, then, in consideration of goals of economic growth, the use of insurance to manage hurricane risk and democracy, public policy decision makers may consider managing to an some optimal level of disaster loss (see related Pielke Jr. 1998). Already this appears as an underlying point of contention in political debates about Florida building codes (Morgan 2012).

Expanding the Scope of Policy Options

This section reflects on the research in this dissertation and makes specific policy recommendations. In some instances, I give an example of potential policies. These recommendations fall within four categories: 1) Tax on building materials, 2) Economic policy, 3) Innovation in risk governance, 4) A role for federal government, and 5) Public discourse.

In the third category I revisit the idea of innovation in the insurance industry, mentioned above, to more greatly consider the role of government.

Tax on building materials

Call it what you will, assessments, hurricane taxes, deficit, etc. the concern in all these value laden terms is that Citizens and insurers will not have the ability to indemnify their policyholders. Some expand this concern to the state with the fear that the government will not have the ability to indemnify Florida policyholders when their insurers can not pay (e.g. Rollins 2012). This means that Florida needs the ability to build up cash quickly without further burdening its income strapped population.

To this end, I propose a small tax on building materials. Such a tax would only burden those actively building or purchasing new built structures that that lead to an increase in exposure to the entire state. Exemptions can be made for those mitigating. The tax must be small enough so that homeowners are not additionally impacted by the cost of routine home repairs. Some have advocated for policymakers to use the increased revenues from sales tax generated from home repairs after a hurricane to help alleviate any deficit Citizens experiences (Editorial 2005). But policy makers met the suggestion with some objection. A specific tax on building materials would alleviate this conflict.

Economic policy

Conflict between Florida's economic model and experience indicate that growth in population does not necessarily lead to employment nor new construction (e.g. FIU Metropolitan Center). Problems with affordability appear to arise, at least in part, from income disparity in the state or a failure of incomes to keep pace with the cost of homeownership in the state (Schwartz and Wilson 2007; Bee 2012). Given the continued increase in real risk and changes in perceived risk, public policy makers can do little to improve conditions for the private market without improving the public's ability to pay for the cost of insurance.

To this end, Florida should seek to strengthen its economy and improve incomes. However, it should do this by diversifying its economy that is currently and historically heavily dependent upon real estate development. Continuing with a monoculture economy rested in real estate development is economically unsustainable in relation to goals of affordable property insurance to manage the hurricane risk.

Innovation in risk governance

I discuss the efforts by the Florida legislature to use Citizens as a means to promote competition in the insurance industry in Chapter 8. I consider these efforts as intending to promote innovation in the insurance industry so that it can manage more risk at a more affordable price. However, the opposite appears to be occurring. The ability of catastrophe models to incorporate a large number of predictive variables leads to the creation of smaller and smaller risk pools (see also Cummins et al. 1983). As a result, private market insurers have achieved market competition by refining risk pools with the consequence of designating large numbers of the population as undesirable risks[78].

Though full development of these argument is beyond the scope of this dissertation, potential for public policy to lead to undesirable innovation deserves examination. One potential avenue for improving insurer innovation without creating small risk pools is at the nexus of mortgage lending and insurance requirements. Homeowners need more financial options for satisfying "insurance" requirements for a mortgage. That is, the marriage between mortgages and windstorm insurance (Chapter 3) may need a divorce. This could alleviate pressure on the insurance industry and perhaps provide incentive for innovation that meets the needs of mortgage lenders and affordability needs of homeowners.

Another possible avenue of innovation concerns the representation of knowledge. Catastrophe models depict select information about Florida's hurricane risk and do not reflect the multidimensional nature of society's understanding of the risk. The emphasis on these models reflect insurers' power in the decision making process (see also Carlile 2004). By innovating how knowledge is represented in the decision making process will encourage considerations of additional value preferences.

[78] A review of the scholarly literature demonstrates that the interjection of predictive climate information into vulnerable societies without consideration of unique sociopolitical context has caused harm to those communities and exacerbated social inequities (Lemos and Dilling 2007). This creates a challenging paradox for the production and use of scientific information. As scientists pursue research to improve societal well being the implementation of findings into decision making about insurance challenges society's ability to meet public policy goals. Thanks to Lisa Dilling for brining up this issue.

A role for federal government

I propose that the federal government, rather than the state, regulate catastrophe models. I propose this based on three reasons: the interest of the national public in the solvency of the individual states, the political power of the federal government is more on par with the global insurance industry than individual states, and defragment the mixed acceptability of models in the states. In the case of catastrophic risk, where the public has a reasonable expectation for the federal government to aid in loss that surpasses the abilities of the state's risk management scheme, the federal government may play an active role in regulating how risk is characterized. Regulating models at the national level would help simplify the characterization process. Mortgage lending policies that foster building booms originate at the Federal level. As well, the Federal government will ultimately be called upon in the event that any state cannot meet its indemnity responsibilities. It is in the interest of the national public to maintain the difference between the public and market conception of risk at the Federal level.

Public debate

Throughout this dissertation I have demonstrated a lack of public discourse about the underlying values at stake represented in Florida's difficulties providing affordable property insurance. I have argued that the lack of public discourse not only prevents public policy makers from addressing things that really matter but also threatens Florida's democratic process. To this end, public policy makers can work towards expanding public participation in discussions about the use of insurance to manage risk in society.

These sorts of debates need not be technical in nature. Consider that the public routinely debates the acceptability of risks in implementing policies for technologies such as stem cell research, nuclear energy, and hydrologic fracturing for petroleum. Placing insurance in the context of public policy including considerations of potential negative consequences to insurance and alternatives to using insurance provides for a values centered political debate.

Conclusion

This chapter presented a general discussion for policy alternatives to improve the management of hurricane risk in Florida and increase the availability of affordable property insurance. I reviewed several policy options that commonly appear in political debates directed towards addressing Florida's insurance difficulties. However, several of these policies perpetuate the status quo and will likely exacerbate issues that currently exist. The implicit policy options represented by the conflict discussed under "Reduction in vulnerability vs. Disasters are good for the economy" are those of changes in building codes, mitigation, and land management. This deserves further investigation, though as a separate long-standing political conflict, it is beyond the scope of this dissertation.

Though the Florida legislature seeks to provide affordable property insurance to the public it does so as a means to manage the hurricane risk. This broader policy objective needs continued consideration when legislators consider policy alternatives for Florida. I recommended several specific areas to explore for policy alternatives for improving the management of Florida's hurricane risk, though these recommendations focus on improving the implementation of insurance. In some cases, I offered specific policy options. The importance of opening up the debate to additional value concerns in society serves to improve Florida's democratic process. As well, it helps prevent the adoption of policy that favors only a certain subset of the population to the neglect or harm of all others.

CHAPTER 10: Conclusion

There must be some way out of here, said the joker to the thief
There's too much confusion, I can't get no relief

-*"All Along the Watchtower," Bob Dylan, 1967*

Something is amiss

This dissertation detailed the prediction racket by taking a close look at Florida's implementation of Citizens Property Insurance Corporation (Citizens), the state's residual market for windstorm[79], to provide "affordable property insurance." I find that Citizens struggles to satisfy its mandate because disagreement about the risk detracts from constructive debate needed to reconcile conflict between insurer economic sustainability and insurance affordability. Through independent research projects, I demonstrate that while ratemakers spend their time debating the true measure of hurricane risk, they fail to address underlying value conflicts. Ultimately, this represents a breakdown of Florida's democratic process. Value conflicts arise at many points decision points, from deciding relevant aspects of the hurricane risk, to negotiating a shared understanding of the risk, to implementing policy that satisfies public objectives for its management. The science of hurricane risk and the use of catastrophe models to do not provide directives on the best way for resolving these value conflicts. Persistent fixation on the science of risk in the policymaking process reduces opportunity for constructive political debate of public value preferences for Florida's economic future.

In Chapter 1, I introduced the idea of the prediction racket as both a noisy ordeal over Florida's insurance rates and a situation in which insurance rate decision makers look to catastrophe models to reduce uncertainty about future loss and in the process characterize ever

[79] Readers are reminded that I use hurricane insurance and windstorm insurance interchangeably.

more risk. This occurs because science cannot uniquely define Florida's hurricane risk. It can only provide estimates based on different sets of closed systems defined by theoretically relevant parameters, none of which scientists can demonstrate represent Florida's true risk. Catastrophe models enable insurers to consider more data and more theoretically relevant parameters than ever before. In this sense, they have an increased ability to construct different ideas and characterization of catastrophe risk useful for developing different views of risk and competing in the market place. But, this does not mean that insurers or their models have any unique scientific ability to define risk. On the contrary, without any ability to determine the scientific quality of modeled risk predictions, as to whether or not modeled estimates represent measurable uncertainty (i.e. risk proper) or scientific theory still within the realm of ignorance remains a matter of perspective and opinion.

The story of the prediction racket has implications for how reinsurers' developed a 'too much money' problem. The global insurance industry adopted new catastrophe models creating an elevated view of risk in 2006 and again in 2011. Their doing so proved burdensome on the public (Chapter 7 and Chapter 8) and difficult for maintaining an orderly insurance market in the state of Florida because the cost of hurricane insurance increased substantially. That reinsurers have not experienced the equivalent in losses suggests something in the risk transfer system has gone amiss. Particularly so because 2011 "was the costliest year ever in terms of natural catastrophe losses. At about $380 billion, global economic losses were nearly two-thirds higher than in 2005, the previous record year with losses of $220 billion" (Munich Re 2012). It suggests that insurance rates do not represent the risk of loss as experienced by society. Instead they represent the risk as perceived by the market, constructed in the process of commodifing risk for trade and competition. It further suggests that the market view of risk has become detached from the physical world.

Chapter Recap

In Chapter 3, I described federal, state, and insurance policy that has led up to Florida's current difficulties with windstorm insurance. This chapter documented the value laden decisions by each of these groups that has led Florida to rely disproportionately on the real estate sector and as a consequence, on the availability of affordable property insurance in the state. The incompatibility of growing exposure while maintaining affordability of insurance became particularly difficult after Hurricane Andrew in 1992. Several events that year led to a new political importance to the hurricane risk as sign of climate change and a threat to the economic well being of insurers and the Florida economy.

In Chapter 4, I provided a review of the pertinent literature that guided my inquiry for this dissertation. I belabored the literature demonstrating risk as a value laden social construct and the implications for distinguishing scientific measures of uncertainty as risk or ignorance. As a result, the process of defining risk is akin to the political process of defining public problems and creating policy oriented towards achieving value preferences. The chapter ended by reflecting on the insurance industry's perceived problem that people don't understand how insurance works. I present an orientation of insurance as public policy, insurance rates as a political symbol, and catastrophe models as political tools for negotiating understanding. I suggest policy makers may find improvements for public understanding of insurance by placing insurance into a public policy context of benefits, drawbacks, and options to using insurance as a means to manage risk.

In Chapter 5, I presented the methodology for the independent research studies in Chapters 6, 7, and 8. The methods represent a multidisciplinary and multimethod approach to policy analysis. I designed each study to provide insight into the process of using insurance as a tool to manage hurricane risk in Florida. Collectively these studies address the construction, characterization and governing of Florida's hurricane risk.

In Chapter 9, I reviewed policy options for improving the availability of affordable property insurance in the state. I first discussed common policy options and identified potential drawbacks where appropriate. In several cases, the policies actively discussed by public policy makers may exacerbate current difficulties. In the second part of the chapter, I recommended several areas worth exploring for potential policy alternatives. In some cases, I offered ideas of specific policies. The overall goal of the chapter is to expand the scope of alternatives for policy makers and is not intended to be prescriptive.

Independent Research Projects and Implications

The findings presented in Chapter 6 contribute to the literature on trends in hurricane activity and compliments the literature on normalized hurricane economic losses. I find no long period trends in global landfalling hurricane frequency or severity. Barring a demonstrable trend in the hurricane landfall data there is no reason to expect a climate signal in hurricane economic losses. The findings are consistent with economic normalization studies of loss data that show socioeconomic changes entirely explain the increase in losses experienced over recent decades.

The findings have implications for governing hurricane risk in society. Societal concern about the affects of climate change has led to a prominent social construct that hurricanes have become more frequent and severe due to human activity. Though scientists may one day demonstrate a connection between anthropogenic climate change and hurricane activity they have not as of yet. Thus, invoking construct as reason for model changes or increasing insurance rates has moral and technical ramifications. It has moral ramifications because perpetuating the construct intentionally misrepresents the state of scientific knowledge. It has technical ramifications because an undetectable risk is also an unmeasurable one. Insurance can only manage measurable and therefore detectable risks.

Chapter 7 and Chapter 8 were closely related and made use of some of the same data used to measure trends in affordability and insurability of Florida's hurricane risk. In Chapter 7, I demonstrated the use of catastrophe models as tools to influence outcomes of the political process of ratemaking. Invoking the myth of scientific ratemaking neglects imbedded value preferences and the democratic process breaks down as all of policymaking about risk becomes a technical exercise of debating the state of scientific knowledge. In Chapter 8, I evaluate the Citizens policy in respect to the stated goal of "affordable property insurance." I find that the ability to judge the progress of the policy is difficult because determining success or failure largely depends on interpretation of desirable outcomes of the policy. As it currently stands, the legislature has written into the Citizens legislation a power conflict over how the policy should operate with the use of the phrase "actuarially sound." The phrase has no applicability to the management of a residual market and creates an inability to hold policymakers accountable for the outcomes of the Citizens process. This lack of accountability has led to a deep politicization of the hurricane risk. Further, false assumptions and shortsightedness in Florida's economic model undermine efforts to provide the state with affordable property insurance.

Together, Chapter 7 and 8 imply a need to expand the debate about ratemaking to one that encompasses public values for Florida's economic future. As it currently stands, Florida's economic policies, including those that stem from the economic model and the Citizens policy, work in opposition to one another. Increasing population and concentrated wealth in the state of Florida will continue to increase hurricane disaster losses. In order to maintain conventional forms of insurance in the state, insurance rates will necessarily need to increase thereby decreasing affordability. That Florida public policymakers have not expanded the debate about windstorm insurance in the state to encompass the difficult moral decisions necessary to move forward implies an inability or unwillingness of political power to carry out democratic ideals of governance.

Further Areas of Research

This section discusses some broader implications of this research in the interrelated processes of constructing, characterizing and governing risk. The first area of research looks at the construction and characterization of risk through the use of computer simulation modeling. This virtual risk has real world consequences and implications for power relationships. The second area considers the "fetish" (Bernstein 1996, p. 7) of risk modeling in decision making. I consider the implication for governing societal morals through numerical parameterization. The third area of research considers the conflict in the perceived value of insurance between insurers and the public. I propose that the value the public holds for insurance may not equate to the price value of insurance for the industry. Finally, I consider some historical events in the real estate sector and public responses. I wonder about the implications of public values for the future of the real estate sector of the economy. All of these research areas are potentially vast, but the represent some of the issue that have come to my attention while pursuing this research.

How does virtual risk affect the value of human experience?

The manipulation of perceived catastrophic risk using computer modeling brings forward questions about the influence of power in the real world based on virtual depictions of risk. How has changes in the use of prediction in science affected the value of human experience and observation? What are the implications for power relationships in defining knowledge? Consider this recent example from personal experience.

On a rainy September 13, 2013, with flood sirens going off periodically in the distance, I sat bleary eyed with two computer screens in front of me. On one, I chugged away endlessly on this dissertation. On the other, I watched a stream of updates from Boulder's Office of Emergency Management and stream of rapidly changing flood gauge measurements of the main creeks and ditches in the Boulder area. Throughout the day, I fielded phone calls and texts from friends and family around the country who wanted to know how I was doing- they saw in the news that Boulder was experiencing widespread flooding. From this flow of current information, I knew that Boulder, and surrounding areas were experiencing catastrophic flash flooding.

However, when I checked the popular insurance industry magazine, *Insurance Journal*, to see what the insurance industry thought of Colorado floods, I found an article from the same day reporting that,

> Three days of intense rainfall in many areas of Colorado has resulted in severe, widespread flooding and collapsed homes, **according to Boston-based catastrophe modeler AIR Worldwide…**Essentially all water bodies in these areas including ditches, canals, and streams are at capacity with many of them at flood level, **according to AIR**. (Insurance Journal 2013; emphasis mine).

I emphasize the *Insurance Journal*'s consultation with a modeling firm because seeking information about the present from one that predicts the future appeared counterintuitive to me. The senior scientists with AIR interviewed for the article did not provide any information that I could not have provided from looking out my window. The reporter could have found more facts and understanding about the situation in Boulder through any number of venues monitoring the event. Yet, the *Insurance Journal*, in order to understand the present, appealed to one who provides information about the future of questionable scientific quality.

How has the use of predictive modeling for defining risk affected existing social vulnerabilities?

The governing affect of the insurance industry and its reliance on predictive modeling of unknowable scientific value has implications for the democratic governance of risk. In many ways, the dependence on predictive modeling as a form of truth reflects a rise in a type of faith-based approach to science often referred to as "scientism" (e.g. Hughs 2012). In founding the United States, policymakers took great care to prevent religious doctrines from dominating over public objectives for governing morality. Yet, as predictive modeling becomes more ingrained into the decision making process the democratic process comes into competition with moral governance through predictive parameters.

In Florida moral governance through predictive modeling has exacerbated existing social vulnerabilities and inequities. Efforts to manage hurricane losses lead to the introduction of new variables into the models creating new risk pools causing the cost of insurance to climb for subsections of the population and the cost of homeownership to become burdensome. The decision to use the models to influence public policy decision making instead of first considering a range of alternatives has enabled Florida's financial and social vulnerability to the hurricane risk to continue unabated. As well, the models have created a new vulnerability to fluctuations in changing estimates of the hurricane risk produced by the insurance market.

Insurers are not the only ones to use simulation models. Many policymaking processes use them. However, only at times to do they become a source of controversy. In Chapter 6, I demonstrated that catastrophe models act as political tools to influence outcomes of the decision making process. Other literature argues that objects such as models act to solidify and maintain power by controlling acceptable knowledge of a situation (Carlile 2002, 2004). Therefore the nature of controversy that surrounds the use of models is telling of power relationships in society. Comparison studies that look at the way controversies arise around catastrophe modeling as compared to say, global circulation modeling, provides insight into who has power to define societal risk.

How does the value of insurance differ among perspectives?

During the course of this research, several insurance experts explained to me that people do not understand the value of insurance. This concern is quite similar to the lament that people do not understand how insurance works (Chapter 7). Is this simply a form of advocacy for the insurance interest?

Moreover, over at least the past several decades, the topic of insurance has consumed national and state political debate demonstrating that the public does indeed understand the value of insurance. But the value of insurance to the public perhaps does not equate to the value of insurance to the capital markets. The comparably long history of the National Flood Insurance Program may offer insight into the value of insurance to the public and other lessons.

How have societal value preferences changed in relation to economic goals for the real estate sector?

Some historical events regarding real estate development suggest that while new construction drives population growth and tourism, it occurs to the disregard of residents' value preferences. For example, in the case of Miami Beach, a barrier island considered highly to hurricane landfalls, the city government adopted development plans with the specific intent of removing lower income residents and increasing real estate density along the oceanfront to cater to visiting populations (Daoud 2006). Janet Reno, a Florida state attorney at the time, who would one day be Attorney General to the Clinton Administration attacked the development plan on the premise that ultimately did not serve the public interest, "The purpose of this (redevelopment) plan is not to clean up a blighted area. The plan makes clear that primary purpose is the construction of a 'tourist-oriented area'" (Reno quoted in Lubitz 1979). Over time, as real estate tycoons invested into the area and built higher high rises along the beach, residents continued fought changes in zoning codes allowing for taller buildings and more population density on Miami Beach (e.g. Semple 1997).

Policy supporting real estate development in the nation has been in place since the 1930's. The nation has certainly prospered from these policies. But recent events in the national real estate market leading to a global economic downturn (Committee on Oversight and Government Reform 2009) suggest a need to reconsider this all "eggs in the housing basket" (Kennedy 2009) federal approach. National economic policy regarding real estate has driven all of Florida's real estate booms barring that of the early 1920's (Chapter 3). But the state's heavy dependence on the real estate sector of the economy makes it particularly vulnerable to the market's highs and lows (Schwartz and Wilson 2007). Furthermore, to the extent that public distaste for the deficit potential of residual markets for wind (and flood) reflects concerns about economic policy for real estate is worth exploring[80].

Conclusion

This dissertation serves to expand debate about the democratic governance of risk in Florida and the United States. It serves not as a means to promote specific policy options but to refocus political debate towards an entire world of policy options available to improve outcomes

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[80] jessicaweinkle.blogspot.com/2013/01/disasters-debt-and-public.html

in relation to public objectives of well-being. The decisions that policy makers need to make are not those of deciding who has the most favorable or unfavorable depiction of the future. Alleviating and managing societal risk demands that public policymakers employ the human capacity of ingenuity and community to create a future that supports an expansion of human dignity.

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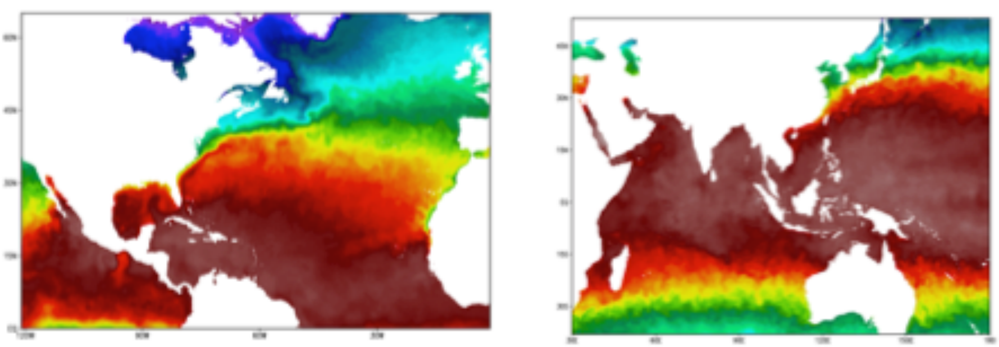
Appendix 1: Supporting Information for Chapter 6 and Global Landfalling Hurricane Dataset

In this supporting information, I provide detailed documentation of the methodology and additional descriptive information on the findings. This information can also be found in Weinkle et. al. (2012).

Land Masks

We utilize an operational sea-surface temperature product (GHRSST OSTIA; Stark et al. 2007) as a land-mask with 1/20th degree global grid spacing

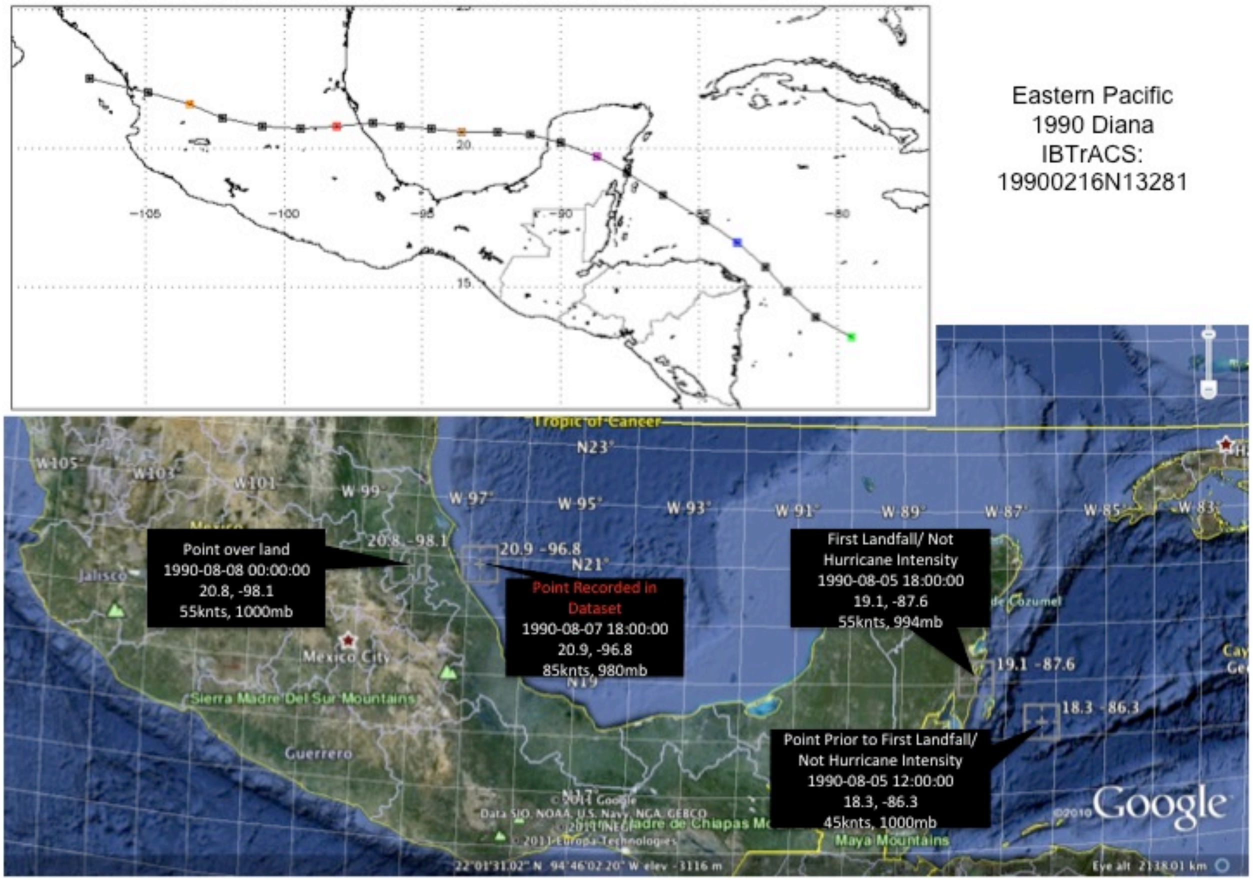


Appendix Figure 1: Land mask used for western hemisphere and (right) eastern hemisphere

Visually Verifying Landfalls

To visually verify landfall locations and intensity, we used the IBTrACS database and an associated online graphical browser (available at http://storm5.atms.unca.edu/browse-ibtracs/browseIbtracs.php) using the unique serial code assigned to each hurricane. When the IBTrACS graphical data was not sufficient to determine if a storm made landfall or at what time, intensity and location it did so, Google Earth (available at www.google.com/earth) was used to locate the latitudes and longitudes reported in the storm's best track archive (Appendix Figure 2). Identifying the point of "landfall" is a bit more complicated than one may assume and can vary by the researcher or organization collecting data. For the purposes here, the authors use the NHC definition of landfall, stated as follows: "The intersection of the surface center of a tropical cyclone with a coastline" (http://www.nhc.noaa.gov/aboutgloss.shtml). It should be clear though that intensity estimates are taken from the reported interval *prior* to landfall.

It is at times difficult to determine what should constitute as "land." For instance, barrier islands are narrow strips of land paralleling the mainland coast. Barrier islands are heavily exposed to weather coming in from the ocean and left unmanaged, will change shape over time. For these reasons, they are less ideal to build upon and in many regions of the world, are left uninhabited or are only sparsely populated. But in many heavily urban areas, barrier islands are intensely built upon with high dollar real estate stemming from spectacular ocean views. Indeed any storm crossing over barrier islands such as Miami Beach, Florida or the Outer Banks of North Carolina may result in considerable damage and would be considered to have made landfall. Where barrier islands are not built upon, landfall by a storm crossing the narrow strip of shifting land is questionable. Another example of questionable landfall is that of river deltas. In Bangladesh, the Ganges River delta is heavily populated demanding that a hurricane that crosses the edge of the country's seaboard be considered landfall. However, in the United States the Mississippi River delta is not nearly as populated, but it is of significant agricultural importance. Landfall of a strong hurricane can have economic impact but little population impact. Hence, the declaration of landfall is again questionable. To resolve these various subjectivities in the most objective manner possible, our analysis maintained a strict adherence to the landfall definition, irrespective of geographic location.



Appendix Figure 2: Identifying landfalling storms. Screen shots of IBTrACS browser image (upper left) and Google Earth (bottom)

Global landfall dataset

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1944	MISSING	(1944213N23290)	08/01/18Z	80	1	ATL
1944	MISSING	(1944230N12303)	08/20/12Z	105	3	ATL
1944	MISSING	(1944253N21302)	09/15/00Z	75	1	ATL
1944	MISSING	(1944263N19276)	09/20/06Z	70	1	ATL
1944	MISSING	(1944287N15280)	10/18/06Z	105	3	ATL
1945	MISSING	(1945172N18274)	06/24/06Z	80	1	ATL
1945	MISSING	(1945236N19266)	08/27/18Z	120	4	ATL
1945	MISSING	(1945255N19303)	09/15/18Z	120	4	ATL
1945	MISSING	(1945276N15280)	10/04/06Z	70	1	ATL
1945	MISSING	(1945284N13282)	10/12/06Z	70	1	ATL
1946	MISSING	(1946278N18273)	10/07/00Z	85	2	ATL
1947	MISSING	(1947221N14285)	08/15/06Z	95	2	ATL
1947	MISSING	(1947231N24280)	08/24/18Z	70	1	ATL
1947	MISSING	(1947247N15340)	09/17/12Z	135	4	ATL
1947	MISSING	(1947282N15278)	10/12/00Z	70	1	ATL
1948	MISSING	(1948246N24265)	09/04/06Z	65	1	ATL
1948	MISSING	(1948262N18281)	09/21/18Z	105	3	ATL
1948	MISSING	(1948278N15278)	10/05/18Z	110	3	ATL
1949	MISSING	(1949235N18300)	08/26/18Z	130	4	ATL
1949	MISSING	(1949264N16298)	09/22/12Z	65	1	ATL
1949	MISSING	(1949270N13271)	10/04/00Z	110	3	ATL
1950	BAKER	(1950232N16305)	08/31/00Z	75	1	ATL
1950	EASY	(1950244N19276)	09/05/06Z	105	3	ATL
1950	ITEM	(1950281N21269)	10/10/12Z	95	2	ATL
1950	KING	(1950286N16276)	10/17/00Z	100	3	ATL
1951	CHARLIE	(1951224N12314)	08/20/00Z	115	4	ATL
1952	ABLE	(1952231N15341)	08/31/00Z	90	2	ATL
1952	FOX	(1952295N12282)	10/24/18Z	130	4	ATL
1953	BARBARA	(1953223N23286)	08/13/18Z	95	2	ATL
1953	CAROL	(1953240N16340)	09/07/18Z	65	1	ATL
1953	FLORENCE	(1953267N17284)	09/26/12Z	80	1	ATL
1954	ALICE	(1954176N22266)	06/25/12Z	70	1	ATL
1954	CAROL	(1954238N24285)	08/31/12Z	85	2	ATL
1954	EDNA	(1954245N11304)	09/11/18Z	80	1	ATL
1954	HAZEL	(1954278N12301)	10/15/12Z	110	3	ATL
1955	CONNIE	(1955215N15324)	08/12/12Z	70	1	ATL
1955	DIANE	(1955219N17317)	08/17/06Z	75	1	ATL
1955	IONE	(1955253N15317)	09/19/06Z	90	2	ATL
1955	HILDA	(1955254N17299)	09/16/12Z	95	2	ATL
1955	JANET	(1955265N13306)	09/28/00Z	150	5	ATL

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1955	KATIE	(1955288N12282)	10/17/00Z	100	3	ATL
1956	ANNA	(1956208N21267)	07/26/18Z	65	1	ATL
1956	BETSY	(1956222N14313)	08/12/12Z	80	1	ATL
1956	FLOSSY	(1956265N17273)	09/24/06Z	75	1	ATL
1957	AUDREY	(1957176N22267)	06/27/12Z	125	4	ATL
1958	ELLA	(1958242N14303)	09/02/00Z	100	3	ATL
1958	HELENE	(1958264N19309)	09/29/12Z	65	1	ATL
1959	NONAME	(1959169N26273)	06/20/00Z	70	1	ATL
1959	CINDY	(1959187N30282)	07/09/00Z	65	1	ATL
1959	DEBRA	(1959204N27268)	07/25/00Z	70	1	ATL
1959	GRACIE	(1959264N20291)	09/29/18Z	105	3	ATL
1960	ABBY	(1960192N13304)	07/15/12Z	65	1	ATL
1960	DONNA	(1960243N10339)	09/10/06Z	115	4	ATL
1961	ANNA	(1961201N12300)	07/23/12Z	90	2	ATL
1961	CARLA	(1961247N13283)	09/11/18Z	125	4	ATL
1961	HATTIE	(1961301N12279)	10/31/12Z	120	4	ATL
1962	DAISY	(1962272N15311)	10/08/00Z	65	1	ATL
1963	CINDY	(1963260N27266)	09/17/12Z	65	1	ATL
1963	EDITH	(1963267N11308)	09/27/06Z	65	1	ATL
1963	FLORA	(1963270N08327)	10/04/00Z	125	4	ATL
1964	CLEO	(1964234N13316)	08/24/18Z	130	4	ATL
1964	DORA	(1964242N14342)	09/10/00Z	100	3	ATL
1964	HILDA	(1964273N21280)	10/04/00Z	95	2	ATL
1964	ISBELL	(1964283N13280)	10/14/18Z	110	3	ATL
1965	BETSY	(1965239N11310)	09/10/00Z	135	4	ATL
1966	ALMA	(1966155N13276)	06/08/06Z	85	2	ATL
1966	CELIA	(1966195N19301)	07/21/12Z	65	1	ATL
1966	INEZ	(1966265N10325)	09/29/18Z	100	3	ATL
1967	BEULAH	(1967249N14303)	09/20/06Z	140	5	ATL
1967	FERN	(1967275N20267)	10/04/06Z	65	1	ATL
1968	GLADYS	(1968288N14280)	10/19/00Z	70	1	ATL
1969	CAMILLE	(1969227N19278)	08/18/00Z	165	5	ATL
1969	FRANCELIA	(1969241N12298)	09/04/00Z	70	1	ATL
1969	GERDA	(1969249N25283)	09/10/00Z	95	2	ATL
1970	CELIA	(1970212N19278)	08/03/18Z	110	3	ATL
1970	ELLA	(1970252N15277)	09/12/06Z	105	3	ATL
1971	BETH	(1971223N27280)	08/16/12Z	65	1	ATL
1971	EDITH	(1971249N11302)	09/09/18Z	140	5	ATL
1971	GINGER	(1971249N26289)	09/30/18Z	65	1	ATL
1971	IRENE:OLIVIA	(1971255N11312)	09/19/06Z	65	1	ATL
1972	AGNES	(1972167N20271)	06/19/18Z	65	1	ATL

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1973	BRENDA	(1973230N21276)	08/21/06Z	80	1	ATL
1974	CARMEN	(1974241N17304)	09/02/06Z	130	4	ATL
1974	FIFI	(1974258N15295)	09/19/18Z	90	2	ATL
1975	BLANCHE	(1975205N26292)	07/28/06Z	70	1	ATL
1975	CAROLINE	(1975237N22290)	08/31/06Z	100	3	ATL
1975	ELOISE	(1975256N18306)	09/23/12Z	110	3	ATL
1976	BELLE	(1976219N26287)	08/10/00Z	80	1	ATL
1977	ANITA	(1977242N27272)	09/02/06Z	150	5	ATL
1977	BABE	(1977246N27274)	09/05/06Z	65	1	ATL
1977	EVELYN	(1977287N27297)	10/15/12Z	70	1	ATL
1978	GRETA	(1978257N11298)	09/18/00Z	110	3	ATL
1979	BOB	(1979191N22264)	07/11/12Z	65	1	ATL
1979	DAVID	(1979238N12324)	08/31/18Z	150	5	ATL
1979	FREDERIC	(1979241N11335)	09/13/00Z	115	4	ATL
1980	ALLEN	(1980214N11330)	08/10/00Z	110	3	ATL
1981	KATRINA	(1981307N17279)	11/06/00Z	65	1	ATL
1983	ALICIA	(1983228N27270)	08/18/06Z	100	3	ATL
1983	BARRY	(1983236N26284)	08/28/12Z	65	1	ATL
1984	DIANA	(1984253N29283)	09/13/06Z	80	1	ATL
1985	BOB	(1985202N26275)	07/25/00Z	65	1	ATL
1985	DANNY	(1985224N19279)	08/15/12Z	80	1	ATL
1985	ELENA	(1985240N20286)	09/02/12Z	100	3	ATL
1985	GLORIA	(1985260N13336)	09/27/00Z	90	2	ATL
1985	JUAN	(1985299N25270)	10/29/06Z	70	1	ATL
1985	KATE	(1985320N21296)	11/19/00Z	95	2	ATL
1986	BONNIE	(1986175N26273)	06/26/06Z	75	1	ATL
1986	CHARLEY	(1986226N30276)	08/17/12Z	65	1	ATL
1987	EMILY	(1987263N10309)	09/23/00Z	105	3	ATL
1987	FLOYD	(1987282N15277)	10/12/12Z	65	1	ATL
1988	DEBBY	(1988245N20269)	09/02/18Z	65	1	ATL
1988	FLORENCE	(1988251N23268)	09/10/00Z	70	1	ATL
1988	GILBERT	(1988253N12306)	09/14/12Z	145	5	ATL
1988	JOAN:MIRIAM	(1988285N09318)	10/22/06Z	125	4	ATL
1989	CHANTAL	(1989212N23270)	08/01/12Z	70	1	ATL
1989	HUGO	(1989254N13340)	09/21/18Z	120	4	ATL
1989	JERRY	(1989286N19268)	10/16/00Z	75	1	ATL
1990	BERTHA	(1990206N34285)	08/02/00Z	70	1	ATL
1990	DIANA	(1990216N13281)	08/07/18Z	85	2	ATL
1991	BOB	(1991228N26286)	08/19/18Z	85	2	ATL
1992	ANDREW	(1992230N11325)	08/24/06Z	130	5	ATL
1993	GERT	(1993258N11279)	09/20/18Z	85	2	ATL

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1995	ERIN	(1995212N22287)	08/02/00Z	75	1	ATL
1995	LUIS	(1995240N11337)	09/11/06Z	80	1	ATL
1995	OPAL	(1995271N19273)	10/04/18Z	110	3	ATL
1995	ROXANNE	(1995281N14278)	10/11/00Z	100	3	ATL
1996	BERTHA	(1996187N10326)	07/12/18Z	90	2	ATL
1996	CESAR	(1996207N12297)	07/28/00Z	70	1	ATL
1996	DOLLY	(1996232N17280)	08/20/18Z	65	1	ATL
1996	FRAN	(1996237N14339)	09/06/00Z	100	3	ATL
1996	HORTENSE	(1996248N15319)	09/10/00Z	70	1	ATL
1996	LILI	(1996289N13280)	10/18/06Z	75	1	ATL
1997	DANNY	(1997198N27267)	07/18/06Z	65	1	ATL
1998	BONNIE	(1998232N15312)	08/27/00Z	95	2	ATL
1998	EARL	(1998244N22267)	09/03/06Z	70	1	ATL
1998	GEORGES	(1998259N10335)	09/22/12Z	105	3	ATL
1998	MITCH	(1998295N12284)	10/29/06Z	75	1	ATL
1999	BRET	(1999231N20266)	08/22/18Z	120	4	ATL
1999	FLOYD	(1999251N15314)	09/16/06Z	90	2	ATL
1999	IRENE	(1999286N16278)	10/15/18Z	65	1	ATL
2000	KEITH	(2000273N16277)	10/05/12Z	75	1	ATL
2000	MICHAEL	(2000290N30289)	10/19/18Z	85	2	ATL
2001	IRIS	(2001278N12302)	10/09/00Z	125	4	ATL
2001	MICHELLE	(2001303N13276)	11/04/18Z	120	4	ATL
2002	GUSTAV	(2002252N29289)	09/12/00Z	80	1	ATL
2002	ISIDORE	(2002258N10300)	09/22/18Z	110	3	ATL
2002	LILI	(2002265N10315)	10/01/12Z	90	2	ATL
2003	CLAUDETTE	(2003188N11307)	07/15/12Z	75	1	ATL
2003	ERIKA	(2003227N26277)	08/16/12Z	65	1	ATL
2003	ISABEL	(2003249N14329)	09/18/12Z	90	2	ATL
2003	JUAN	(2003268N28298)	09/29/00Z	85	2	ATL
2004	CATARINA	(2004080S27311)	03/28/00Z	80	1	ATL
2004	CHARLEY	(2004223N11301)	08/13/18Z	125	4	ATL
2004	FRANCES	(2004238N11325)	09/05/00Z	95	2	ATL
2004	GASTON	(2004241N32282)	08/29/12Z	65	1	ATL
2004	IVAN	(2004247N10332)	09/16/06Z	105	3	ATL
2004	JEANNE	(2004258N16300)	09/26/00Z	105	3	ATL
2005	CINDY	(2005185N18273)	07/06/00Z	65	1	ATL
2005	DENNIS	(2005186N12299)	07/08/18Z	120	4	ATL
2005	EMILY	(2005192N11318)	07/18/06Z	115	4	ATL
2005	KATRINA	(2005236N23285)	08/29/06Z	125	4	ATL
2005	RITA	(2005261N21290)	09/24/06Z	100	3	ATL
2005	STAN	(2005275N19274)	10/04/12Z	70	1	ATL

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
2005	WILMA	(2005289N18282)	10/22/03Z	120	4	ATL
2005	BETA	(2005300N10279)	10/30/12Z	90	2	ATL
2007	DEAN	(2007225N12331)	08/21/06Z	150	5	ATL
2007	FELIX	(2007244N12303)	09/04/12Z	140	5	ATL
2007	HUMBERTO	(2007255N27265)	09/13/06Z	80	1	ATL
2007	LORENZO	(2007269N22265)	09/28/00Z	70	1	ATL
2008	DOLLY	(2008203N18276)	07/23/18Z	75	1	ATL
2008	GUSTAV	(2008238N14293)	08/30/18Z	125	4	ATL
2008	IKE	(2008245N17323)	09/07/18Z	105	3	ATL
2008	KYLE	(2008269N22290)	09/29/00Z	65	1	ATL
2008	PALOMA	(2008311N14278)	11/09/00Z	90	2	ATL
2009	BILL	(2009227N12328)	08/24/00Z	65	1	ATL
2009	IDA	(2009308N11279)	11/05/06Z	65	1	ATL
2010	ALEX	(2010176N16278)	07/01/06Z	75	1	ATL
2010	EARL	(2010236N12341)	09/04/18Z	65	1	ATL
2010	KARL	(2010257N16282)	09/17/12Z	110	3	ATL
2010	RICHARD	(2010293N17277)	10/25/00Z	85	2	ATL
1971	AGATHA	(1971142N12267)	05/24/18Z	75	1	EP
1971	BRIDGET	(1971166N12270)	06/17/12Z	75	1	EP
1971	LILY	(1971240N13266)	08/31/12Z	75	1	EP
1971	PRISCILLA	(1971280N11270)	10/12/06Z	70	1	EP
1973	IRAH	(1973265N13258)	09/25/18Z	70	1	EP
1974	DOLORES	(1974166N13263)	06/16/12Z	70	1	EP
1974	ORLENE	(1974264N16263)	09/23/18Z	75	1	EP
1975	OLIVIA	(1975295N14252)	10/25/06Z	100	3	EP
1976	LIZA	(1976270N13253)	10/01/12Z	110	3	EP
1976	MADELINE	(1976273N10270)	10/08/06Z	125	4	EP
1977	DOREEN	(1977225N18254)	08/15/18Z	65	1	EP
1979	ANDRES	(1979152N11265)	06/04/12Z	65	1	EP
1981	NORMA	(1981282N15256)	10/12/06Z	90	2	EP
1982	PAUL	(1982262N12270)	09/29/18Z	95	2	EP
1983	TICO	(1983285N09260)	10/19/12Z	110	3	EP
1984	ODILE	(1984262N14259)	09/22/12Z	85	2	EP
1985	WALDO	(1985280N15254)	10/09/06Z	90	2	EP
1986	NEWTON	(1986262N12266)	09/23/18Z	65	1	EP
1986	PAINE	(1986271N12267)	10/02/12Z	80	1	EP
1986	ROSLYN	(1986289N10267)	10/22/06Z	65	1	EP
1987	EUGENE	(1987203N11263)	07/25/06Z	85	2	EP
1989	COSME	(1989169N13265)	06/22/00Z	75	1	EP
1989	KIKO	(1989238N22253)	08/27/00Z	105	3	EP
1992	LESTER	(1992233N16254)	08/23/06Z	65	1	EP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1992	INIKI	(1992249N12229)	09/12/00Z	115	4	EP
1992	VIRGIL	(1992275N14260)	10/04/00Z	95	2	EP
1992	WINIFRED	(1992281N11263)	10/09/18Z	95	2	EP
1993	CALVIN	(1993186N13262)	07/07/12Z	95	2	EP
1993	LIDIA	(1993252N11265)	09/13/06Z	85	2	EP
1994	ROSA	(1994282N17247)	10/14/06Z	90	2	EP
1995	ISMAEL	(1995256N15253)	09/15/00Z	70	1	EP
1996	ALMA	(1996172N13261)	06/23/18Z	90	2	EP
1996	BORIS	(1996179N13266)	06/29/18Z	80	1	EP
1996	FAUSTO	(1996254N14258)	09/13/18Z	75	1	EP
1996	HERNAN	(1996274N13261)	10/03/06Z	65	1	EP
1997	NORA	(1997259N13258)	09/25/06Z	75	1	EP
1997	PAULINE	(1997279N12263)	10/08/18Z	115	4	EP
1997	RICK	(1997311N09258)	11/10/00Z	75	1	EP
1998	ISIS	(1998242N14252)	09/03/00Z	65	1	EP
2002	KENNA	(2002295N11261)	10/25/12Z	130	4	EP
2003	IGNACIO	(2003235N21253)	08/25/12Z	75	1	EP
2003	MARTY	(2003262N17254)	09/22/06Z	85	2	EP
2006	JOHN	(2006240N12265)	09/02/00Z	95	2	EP
2006	LANE	(2006257N16259)	09/16/18Z	110	3	EP
2007	HENRIETTE	(2007242N13264)	09/04/18Z	70	1	EP
2008	NORBERT	(2008278N14261)	10/11/12Z	95	2	EP
2009	JIMENA	(2009239N12270)	09/02/12Z	90	2	EP
1970	12B	(1970291N14085)	10/23/00Z	65	1	NIO
1970	15B	(1970312N12086)	11/12/12Z	65	1	NIO
1971	11B	(1971271N20089)	09/29/00Z	65	1	NIO
1971	14B:15B	(1971300N12091)	10/30/00Z	65	1	NIO
1971	18B	(1971308N11092)	11/06/00Z	65	1	NIO
1972	16B	(1972336N10089)	12/06/00Z	65	1	NIO
1974	06B	(1974225N22089)	08/15/06Z	65	1	NIO
1974	12B	(1974327N11088)	11/28/00Z	70	1	NIO
1975	03B	(1975125N13096)	05/07/12Z	65	1	NIO
1975	16A	(1975292N16073)	10/22/06Z	80	1	NIO
1976	10B	(1976308N13088)	11/05/00Z	65	1	NIO
1976	12B	(1976320N11087)	11/16/12Z	65	1	NIO
1977	06B	(1977318N06093)	11/19/12Z	105	3	NIO
1978	04B	(1978323N08092)	11/23/18Z	70	1	NIO
1979	01B	(1979126N07090)	05/12/06Z	80	1	NIO
1979	03B:HOPE	(1979205N10148)	08/07/18Z	65	1	NIO
1982	MISSING	(1982120N11083)	05/04/12Z	100	3	NIO
1982	MISSING	(1982309N11064)	11/08/06Z	85	2	NIO

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1984	MISSING	(1984314N09088)	11/14/00Z	80	1	NIO
1984	MISSING	(1984332N08086)	12/01/06Z	75	1	NIO
1988	MISSING	(1988327N06100)	11/29/06Z	105	3	NIO
1990	MISSING	(1990124N09088)	05/09/12Z	100	3	NIO
1991	MISSING	(1991113N10091)	04/29/18Z	135	4	NIO
1992	MISSING	(1992136N10090)	05/19/00Z	65	1	NIO
1992	MISSING	(1992311N06107)	11/13/06Z	70	1	NIO
1993	MISSING	(1993331N07108)	12/04/00Z	70	1	NIO
1994	MISSING	(1994117N07096)	05/02/12Z	110	3	NIO
1995	MISSING	(1995310N09096)	11/09/00Z	70	1	NIO
1995	MISSING	(1995323N05097)	11/25/06Z	85	2	NIO
1996	MISSING	(1996167N16072)	06/18/18Z	65	1	NIO
1996	MISSING	(1996306N15097)	11/06/12Z	115	4	NIO
1997	MISSING	(1997133N03092)	05/19/12Z	115	4	NIO
1997	MISSING	(1997263N14084)	09/26/18Z	65	1	NIO
1998	MISSING	(1998133N04086)	05/20/00Z	70	1	NIO
1998	MISSING	(1998152N11075)	06/09/00Z	105	3	NIO
1998	MISSING	(1998317N11087)	11/15/06Z	75	1	NIO
1999	MISSING	(1999135N12073)	05/20/06Z	110	3	NIO
1999	MISSING	(1999288N15093)	10/17/12Z	120	4	NIO
1999	MISSING	(1999298N12099)	10/29/00Z	140	5	NIO
2000	MISSING	(2000331N09091)	11/29/06Z	65	1	NIO
2000	MISSING	(2000358N08086)	12/26/12Z	65	1	NIO
2004	MISSING	(2004136N15090)	05/19/06Z	65	1	NIO
2006	MALA	(2006114N08090)	04/29/06Z	90	2	NIO
2007	AKASH	(2007133N15091)	05/14/18Z	65	1	NIO
2007	SIDR	(2007314N10093)	11/15/12Z	130	4	NIO
2008	NARGIS	(2008117N11090)	05/02/06Z	115	4	NIO
2009	AILA	(2009143N17089)	05/25/06Z	65	1	NIO
2010	PHET	(2010151N14065)	06/04/00Z	90	2	NIO
1970	05P:ADA	(1970003S16165)	01/17/18Z	85	2	SH
1970	14S:JANE	(1970040S16083)	02/23/00Z	70	1	SH
1970	INGRID	(1970041S16123)	02/16/00Z	75	1	SH
1971	09S:FELICIE	(1971017S11059)	01/19/18Z	65	1	SH
1971	12S:SHEILA	(1971029S14121)	02/03/00Z	125	4	SH
1971	19S:JOELLE	(1971046S18040)	02/17/00Z	65	1	SH
1971	21P:FIONA	(1971048S16141)	02/19/06Z	85	2	SH
1971	06S:SALLY	(1971337S07125)	12/09/12Z	100	3	SH
1971	09P:ALTHEA	(1971354S11159)	12/24/00Z	95	2	SH
1972	17S:EUGENIE	(1972039S13068)	02/14/12Z	70	1	SH
1972	21S:VICKY	(1972055S11122)	03/03/06Z	70	1	SH

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1972	23S:HERMIONE	(1972060S15075)	03/06/06Z	65	1	SH
1973	13S:KERRY	(1973019S15120)	01/21/18Z	85	2	SH
1973	17P:ADELINE	(1973027S15139)	01/29/00Z	75	1	SH
1973	06S:INES	(1973321S11135)	11/21/06Z	75	1	SH
1974	07S:TRACY	(1974356S09132)	12/24/18Z	110	3	SH
1975	21S:TRIXIE	(1975046S17124)	02/19/00Z	130	4	SH
1975	28S:BEVERLEY	(1975081S12116)	03/30/18Z	80	1	SH
1975	04S:JOAN	(1975334S11128)	12/07/18Z	135	4	SH
1976	09S:DANAE:TERRY	(1976010S12085)	01/21/18Z	75	1	SH
1976	10P:DAVID	(1976011S13177)	01/19/12Z	85	2	SH
1976	16S:WALLY	(1976054S16125)	02/26/12Z	65	1	SH
1976	04P:TED	(1976351S13140)	12/19/00Z	100	3	SH
1977	17S:HERVEA	(1977041S10076)	02/20/06Z	70	1	SH
1977	23S:LEO	(1977083S15125)	03/26/12Z	85	2	SH
1978	16S:VERN	(1978027S16115)	02/01/00Z	80	1	SH
1978	02S:ANGELE	(1978347S20041)	12/18/18Z	90	2	SH
1979	16P:ROSA	1979043S11161	02/26/00Z	80	1	SH
1980	07S:AMY	1980005S14120	01/10/00Z	135	4	SH
1980	11S:DEAN	1980027S11129	02/01/00Z	120	4	SH
1980	15S:ENID	1980043S16131	02/17/00Z	120	4	SH
1982	JUSTINE	1982075S12055	03/18/12Z	70	1	SH
1982	DOMINIC	1982095S11138	04/07/12Z	100	3	SH
1983	JANE	1983002S11112	01/09/06Z	90	2	SH
1983	QUENTON	1983330S11113	11/29/12Z	70	1	SH
1983	ANDRY	1983339S10065	12/12/06Z	100	3	SH
1984	CHLOE	1984057S14124	02/29/18Z	75	1	SH
1984	KATHY	1984077S12149	03/22/18Z	125	4	SH
1984	KAMISY	1984094S10080	04/09/00Z	100	3	SH
1985	SANDY	(1985078S14138)	03/24/18Z	70	1	SH
1986	WINIFRED	(1986027S13145)	02/01/06Z	90	2	SH
1986	HONORININA	(1986067S11080)	03/15/06Z	85	2	SH
1987	JASON	(1987036S12140)	02/11/00Z	65	1	SH
1988	CALIDERA:CALIDER O	(1988012S11061)	01/15/00Z	65	1	SH
1988	FILAO	(1988055S10051)	03/01/18Z	85	2	SH
1988	ILONA	(1988347S12128)	12/17/12Z	85	2	SH
1989	CALASANJY	(1989006S15044)	01/14/12Z	75	1	SH
1989	AIVU	(1989089S11158)	04/04/00Z	100	3	SH
1989	ORSON	(1989108S11128)	04/22/18Z	125	4	SH
1990	ALIBERA	(1989349S08065)	01/01/12Z	75	1	SH
1992	IAN	(1992055S12119)	03/02/18Z	100	3	SH

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1994	DAISY	(1994007S16056)	01/13/12Z	95	2	SH
1994	GERALDA	(1994026S11078)	02/02/12Z	105	3	SH
1994	LITANNE	(1994064S13099)	03/15/12Z	115	4	SH
1994	NADIA	(1994076S14078)	03/23/00Z	95	2	SH
1994	ANNETTE	(1994344S09112)	12/18/06Z	110	3	SH
1995	BOBBY	(1995049S11133)	02/24/12Z	110	3	SH
1995	CHLOE	(1995089S09131)	04/08/00Z	110	3	SH
1996	GERTIE	(1995348S16135)	12/20/06Z	65	1	SH
1996	BONITA	(1996001S08075)	01/10/18Z	115	4	SH
1996	BARRY	(1996002S15133)	01/05/12Z	80	1	SH
1996	EDWIGE	(1996049S10068)	02/26/18Z	95	2	SH
1996	KIRSTY	(1996066S17129)	03/11/18Z	100	3	SH
1996	OLIVIA	(1996095S09133)	04/10/06Z	125	4	SH
1997	RACHEL	(1996365S15137)	01/07/06Z	75	1	SH
1997	GRETELLE	(1997018S11059)	01/24/06Z	115	4	SH
1997	LISETTE	(1997056S16041)	03/02/00Z	75	1	SH
1998	THELMA	(1998335S12138)	12/10/18Z	120	4	SH
1999	VANCE	(1999074S13132)	03/22/00Z	125	4	SH
1999	GWENDA	(1999092S11131)	04/07/12Z	100	3	SH
1999	JOHN	(1999343S11123)	12/14/18Z	130	4	SH
2000	ELINE:LEON:LEONE_ ELINE	(2000032S11115)	02/22/06Z	115	4	SH
2000	STEVE	(2000056S17153)	03/06/12Z	65	1	SH
2000	HUDAH	(2000083S17102)	04/02/18Z	115	4	SH
2000	ROSITA	(2000105S10127)	04/19/12Z	105	3	SH
2001	SAM	(2000333S11140)	12/08/12Z	105	3	SH
2002	CHRIS	(2002033S13121)	02/05/18Z	125	4	SH
2002	HARY	(2002063S11066)	03/10/06Z	140	5	SH
2002	KESINY	(2002122S07063)	05/09/12Z	65	1	SH
2003	JAPHET	(2003056S21042)	03/02/12Z	90	2	SH
2003	MANOU	(2003122S11065)	05/09/06Z	75	1	SH
2003	DEBBIE	(2003350S10140)	12/20/12Z	65	1	SH
2004	ELITA	(2004025S16044)	02/03/00Z	65	1	SH
2004	MONTY	(2004056S18125)	03/01/00Z	105	3	SH
2004	GAFILO	(2004061S12072)	03/07/00Z	130	4	SH
2004	FAY	(2004072S11146)	03/27/00Z	110	3	SH
2005	ERNEST	(2005017S09061)	01/23/06Z	90	2	SH
2005	INGRID	(2005063S11140)	03/15/12Z	125	4	SH
2006	LARRY	(2006074S13158)	03/19/18Z	115	4	SH
2006	GLENDA	(2006081S14129)	03/30/12Z	90	2	SH
2006	MONICA	(2006106S10153)	04/24/06Z	155	5	SH

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
2006	BONDO	(2006350S07071)	12/25/12Z	70	1	SH
2007	CLOVIS	(2006364S12058)	01/03/06Z	65	1	SH
2007	FAVIO	(2007043S11071)	02/22/06Z	100	3	SH
2007	GEORGE	(2007058S12135)	03/08/12Z	110	3	SH
2007	INDLALA	(2007066S12066)	03/15/00Z	110	3	SH
2007	JAYA	(2007085S11085)	04/03/06Z	80	1	SH
2008	FAME	(2008023S10050)	01/27/06Z	85	2	SH
2008	IVAN	(2008037S10055)	02/17/06Z	105	3	SH
2008	JOKWE	(2008062S10064)	03/08/12Z	100	3	SH
2009	FANELE	(2009017S20043)	01/21/00Z	100	3	SH
2009	JADE	(2009093S12062)	04/06/00Z	65	1	SH
2009	LAURENCE	(2009346S12131)	12/21/06Z	130	4	SH
2010	ULUI	(2010070S15168)	03/20/12Z	75	1	SH
2010	PAUL	(2010086S12136)	03/29/12Z	70	1	SH
1950	JANE	(1950241N23140)	09/02/18Z	95	2	WP
1950	OSSIA	(1950269N05153)	10/02/06Z	70	1	WP
1950	18W:FRAN	(1950360N10141)	12/29/12Z	80	1	WP
1951	IRIS	(1951119N06145)	05/04/12Z	130	4	WP
1951	05W:KATE	(1951177N12136)	07/01/12Z	90	2	WP
1951	06W:LOUISE	(1951206N11145)	07/29/18Z	110	3	WP
1951	NORA	(1951239N11144)	09/02/12Z	90	2	WP
1951	PAT	(1951263N08137)	09/26/06Z	75	1	WP
1951	RUTH	(1951281N11147)	10/14/06Z	75	1	WP
1951	15W:WANDA	(1951321N09143)	11/20/06Z	90	2	WP
1951	16W:AMY	(1951337N09150)	12/09/06Z	95	2	WP
1952	03W:EMMA	(1952180N05144)	07/02/00Z	110	3	WP
1952	06W:HARRIET	(1952206N09134)	07/29/12Z	100	3	WP
1952	09W:LOIS	(1952236N10135)	08/28/00Z	75	1	WP
1952	10W:MARY	(1952242N08137)	08/31/18Z	65	1	WP
1952	11W:NONA	(1952245N09139)	09/04/06Z	65	1	WP
1952	18W:TRIX	(1952287N09148)	10/21/12Z	100	3	WP
1952	20W:WILMA	(1952296N06152)	10/27/00Z	130	4	WP
1952	24W:DELLA	(1952326N07144)	11/24/18Z	90	2	WP
1952	27W:GLORIA	(1952352N07147)	12/21/06Z	70	1	WP
1953	03W:JUDY	(1953148N08150)	06/03/18Z	120	4	WP
1953	05W:KIT	(1953176N05150)	07/03/12Z	110	3	WP
1953	08W:NINA	(1953219N08155)	08/16/12Z	120	4	WP
1953	10W:OPHELIA	(1953222N17127)	08/14/00Z	100	3	WP
1953	11W:PHYLLIS	(1953227N09147)	08/20/12Z	75	1	WP
1953	12W:RITA	(1953235N10162)	09/01/12Z	125	4	WP
1953	SUSAN	(1953256N17128)	09/18/18Z	110	3	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1953	15W:TESS	(1953260N07153)	09/25/06Z	65	1	WP
1953	20W:BETTY	(1953299N09138)	10/31/18Z	115	4	WP
1953	21W:CORA	(1953313N06155)	11/16/12Z	85	2	WP
1954	04W:GRACE	(1954223N22138)	08/17/12Z	100	3	WP
1954	06W:IDA	(1954231N10159)	08/29/12Z	65	1	WP
1954	08W:09W:KATHY	(1954240N13151)	09/07/00Z	80	1	WP
1954	10W:JUNE	(1954247N19152)	09/13/00Z	100	3	WP
1954	12W:MARIE	(1954261N11150)	09/25/12Z	75	1	WP
1954	13W:NANCY	(1954273N16146)	10/07/18Z	85	2	WP
1954	16W:PAMELA	(1954300N10141)	11/06/00Z	85	2	WP
1954	17W:RUBY	(1954307N04148)	11/08/06Z	65	1	WP
1954	19W:TILDA	(1954326N12157)	11/29/06Z	90	2	WP
1955	01W:VIOLET	(1955001N08140)	01/04/12Z	70	1	WP
1955	14W:KATE	(1955259N10153)	09/23/00Z	130	4	WP
1955	15W:LOUISE	(1955263N13150)	09/29/06Z	70	1	WP
1956	03W:THELMA	(1956107N06147)	04/21/06Z	105	3	WP
1956	05W:VERA	(1956187N12126)	07/07/18Z	65	1	WP
1956	06W:WANDA	(1956207N13145)	08/01/18Z	130	4	WP
1956	BABS	(1956223N16126)	08/16/18Z	80	1	WP
1956	10W:CHARLOTTE	(1956238N14143)	09/01/00Z	90	2	WP
1956	11W:DINAH	(1956242N16132)	09/03/00Z	85	2	WP
1956	12W:EMMA	(1956245N24140)	09/10/12Z	75	1	WP
1956	13W:FREDA	(1956257N18131)	09/16/00Z	80	1	WP
1956	14W:GILDA	(1956261N12129)	09/22/06Z	110	3	WP
1956	17W:JEAN	(1956288N11132)	10/20/18Z	130	4	WP
1956	19W:KAREN_LUCILLE :KAREN_LUCILLE	(1956314N08153)	11/15/06Z	80	1	WP
1956	POLLY	(1956342N14128)	12/08/18Z	80	1	WP
1957	05W:VIRGINIA	(1957168N05156)	06/25/06Z	100	3	WP
1957	06W:WENDY	(1957192N07141)	07/14/12Z	90	2	WP
1957	09W:BESS	(1957238N14153)	09/06/06Z	80	1	WP
1957	11W:CARMEN	(1957249N18125)	09/15/00Z	75	1	WP
1957	14W:GLORIA	(1957261N12135)	09/20/12Z	90	2	WP
1957	16W:IRMA	(1957281N15118)	10/12/00Z	70	1	WP
1957	19W:KIT	(1957309N11161)	11/11/18Z	120	4	WP
1958	07W:WINNIE	(1958192N16135)	07/15/12Z	150	5	WP
1958	09W:ALICE	(1958194N05146)	07/22/18Z	65	1	WP
1958	13W:GRACE	(1958240N08146)	09/04/00Z	115	4	WP
1958	14W:HELEN	(1958251N10142)	09/18/00Z	80	1	WP
1958	15W:IDA	(1958263N13148)	09/26/12Z	70	1	WP
1959	BILLIE	(1959190N08145)	07/15/18Z	70	1	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1959	ELLEN	(1959211N21148)	08/07/18Z	70	1	WP
1959	GEORGIA	(1959222N15153)	08/13/18Z	90	2	WP
1959	JOAN:JOAN-1	(1959236N12139)	08/29/12Z	160	5	WP
1959	LOUISE	(1959241N12148)	09/03/06Z	120	4	WP
1959	SARAH	(1959254N14148)	09/17/00Z	100	3	WP
1959	VERA	(1959263N11160)	09/26/06Z	140	5	WP
1959	FREDA	(1959317N09137)	11/16/18Z	105	3	WP
1959	GILDA	(1959346N06147)	12/18/00Z	140	5	WP
1959	HARRIET	(1959356N05152)	12/30/18Z	125	4	WP
1960	MARY	(1960154N17116)	06/08/12Z	80	1	WP
1960	OLIVE	(1960173N08137)	06/25/18Z	110	3	WP
1960	POLLY	(1960199N17129)	07/28/06Z	65	1	WP
1960	SHIRLEY	(1960210N13134)	07/31/12Z	120	4	WP
1960	TRIS:TRIX	(1960215N11138)	08/08/00Z	85	2	WP
1960	VIRGINIA	(1960220N18140)	08/10/18Z	70	1	WP
1960	WENDY	(1960223N23136)	08/12/06Z	70	1	WP
1960	DELLA:ELAINE	(1960230N13155)	08/29/00Z	80	1	WP
1960	KIT	(1960273N10142)	10/06/00Z	90	2	WP
1960	LOLA	(1960282N21132)	10/13/06Z	70	1	WP
1961	ALICE:ARICE	(1961135N12121)	05/19/00Z	70	1	WP
1961	BETTY	(1961141N09135)	05/26/12Z	100	3	WP
1961	ELSIE	(1961188N10147)	07/13/18Z	70	1	WP
1961	LORNA	(1961231N12134)	08/24/18Z	100	3	WP
1961	OLGA	(1961247N15127)	09/09/12Z	70	1	WP
1961	PAMELA	(1961248N18155)	09/11/18Z	125	4	WP
1961	NANCY	(1961250N07173)	09/16/00Z	90	2	WP
1961	SALLY:TD0922	(1961265N11156)	09/28/18Z	65	1	WP
1961	TILDA	(1961269N11161)	10/03/18Z	100	3	WP
1962	KATE	(1962198N15124)	07/22/12Z	70	1	WP
1962	OPAL:OPEL	(1962211N09153)	08/05/12Z	145	5	WP
1962	THELMA	(1962232N17149)	08/25/18Z	75	1	WP
1962	AMY	(1962241N14150)	09/05/00Z	130	4	WP
1962	DINAH	(1962268N12144)	10/03/12Z	75	1	WP
1962	LUCY	(1962327N05144)	11/27/00Z	65	1	WP
1963	SHIRLEY	(1963163N13135)	06/19/18Z	65	1	WP
1963	WENDY:WENDY-2	(1963190N15149)	07/16/00Z	90	2	WP
1963	AGNES:AGNESS	(1963196N10146)	07/20/06Z	75	1	WP
1963	BESS	(1963207N13151)	08/09/00Z	95	2	WP
1963	CARMEN	(1963219N09146)	08/13/18Z	100	3	WP
1963	FAYE	(1963240N09157)	09/07/06Z	85	2	WP
1963	GLORIA	(1963247N18145)	09/11/18Z	75	1	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1964	WINNIE	(1964177N09142)	07/01/18Z	100	3	WP
1964	ELSIE	(1964196N17144)	07/17/18Z	75	1	WP
1964	HELEN	(1964209N17150)	08/02/06Z	80	1	WP
1964	IDA	(1964215N07150)	08/06/18Z	135	4	WP
1964	KATHY	(1964224N25161)	08/23/00Z	70	1	WP
1964	RUBY	(1964245N20132)	09/05/06Z	120	4	WP
1964	SALLY	(1964247N09159)	09/10/06Z	90	2	WP
1964	TILDA	(1964256N17141)	09/22/06Z	80	1	WP
1964	VIOLET	(1964257N13118)	09/14/18Z	65	1	WP
1964	WILDA	(1964261N12149)	09/24/06Z	100	3	WP
1964	CLARA	(1964276N07142)	10/05/00Z	80	1	WP
1964	DOT	(1964278N07156)	10/12/18Z	90	2	WP
1964	IRIS	(1964305N12128)	11/04/00Z	65	1	WP
1964	JOAN	(1964309N11132)	11/08/12Z	70	1	WP
1964	KATE	(1964316N14117)	11/16/06Z	65	1	WP
1964	LOUISE:MARGE	(1964319N08141)	11/19/00Z	140	5	WP
1964	OPAL	(1964344N06153)	12/14/12Z	100	3	WP
1965	AMY	(1965140N09134)	05/27/00Z	65	1	WP
1965	BABE	(1965150N18109)	06/04/06Z	65	1	WP
1965	DINAH	(1965161N09151)	06/18/12Z	120	4	WP
1965	FREDA	(1965187N08144)	07/13/06Z	130	4	WP
1965	HARRIET	(1965200N10152)	07/25/18Z	100	3	WP
1965	IVY:JEAN	(1965205N07163)	08/05/18Z	130	4	WP
1965	MARY	(1965226N20139)	08/18/12Z	100	3	WP
1965	LUCY	(1965227N12173)	08/22/06Z	110	3	WP
1965	ROSE	(1965242N15139)	09/02/12Z	100	3	WP
1965	SHIRLEY	(1965244N09145)	09/09/18Z	130	4	WP
1965	TRIX	(1965251N11143)	09/17/12Z	85	2	WP
1966	IRMA	(1966130N06139)	05/15/12Z	100	3	WP
1966	MAMIE	(1966195N18135)	07/17/12Z	65	1	WP
1966	ORA	(1966204N16116)	07/25/18Z	85	2	WP
1966	TESS	(1966222N25140)	08/16/18Z	90	2	WP
1966	ALICE	(1966236N14144)	09/03/06Z	130	4	WP
1966	CORA	(1966241N17147)	09/06/18Z	140	5	WP
1966	ELSIE	(1966252N17112)	09/16/00Z	115	4	WP
1966	IDA	(1966261N13158)	09/24/12Z	100	3	WP
1966	PAMELA	(1966358N07139)	12/26/12Z	90	2	WP
1967	SALLY	(1967059N02145)	03/03/00Z	65	1	WP
1967	VIOLET	(1967091N04151)	04/08/00Z	100	3	WP
1967	ANITA	(1967175N10142)	06/30/00Z	65	1	WP
1967	CLARA	(1967183N20155)	07/11/06Z	80	1	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1967	DOT	(1967200N16136)	08/21/06Z	65	1	WP
1967	CARLA	(1967283N11150)	10/16/18Z	110	3	WP
1967	EMMA	(1967303N07150)	11/03/12Z	110	3	WP
1967	FREDA	(1967310N11129)	11/08/06Z	65	1	WP
1967	GILDA	(1967311N09160)	11/18/00Z	75	1	WP
1968	DELLA	(1968256N16148)	09/24/12Z	65	1	WP
1968	ELAINE	(1968266N06142)	09/28/06Z	110	3	WP
1968	MAMIE	(1968314N08138)	11/20/06Z	65	1	WP
1968	ORA	(1968325N05168)	11/29/06Z	65	1	WP
1969	SUSAN	(1969105N06148)	04/23/12Z	85	2	WP
1969	VIOLA	(1969201N04151)	07/28/00Z	100	3	WP
1969	BETTY	(1969216N09143)	08/08/12Z	65	1	WP
1969	ELSIE	(1969259N15165)	09/26/12Z	95	2	WP
1970	OLGA	(1970178N07153)	07/05/06Z	65	1	WP
1970	WILDA	(1970219N18140)	08/14/12Z	95	2	WP
1970	ANITA	(1970227N17148)	08/21/00Z	100	3	WP
1970	BILLIE	(1970233N15138)	08/30/06Z	75	1	WP
1970	GEORGIA	(1970250N15140)	09/11/00Z	140	5	WP
1970	JOAN	(1970282N08147)	10/13/00Z	150	5	WP
1970	KATE	(1970286N06143)	10/18/12Z	110	3	WP
1970	PATSY	(1970318N13157)	11/18/18Z	135	4	WP
1971	DINAH	(1971141N07156)	05/25/18Z	90	2	WP
1971	FREDA	(1971160N10135)	06/15/06Z	65	1	WP
1971	GILDA	(1971173N09136)	06/27/12Z	90	2	WP
1971	HARRIET	(1971181N09138)	07/06/18Z	80	1	WP
1971	JEAN	(1971190N09141)	07/14/00Z	85	2	WP
1971	NADINE	(1971200N11144)	07/25/12Z	120	4	WP
1971	OLIVE	(1971205N10153)	08/04/18Z	75	1	WP
1971	ROSE	(1971218N08161)	08/13/12Z	110	3	WP
1971	TRIX	(1971231N24151)	08/29/12Z	85	2	WP
1971	AGNES	(1971251N18127)	09/18/06Z	75	1	WP
1971	BESS	(1971258N20158)	09/22/12Z	110	3	WP
1971	DELLA	(1971267N12130)	09/29/06Z	65	1	WP
1971	HESTER	(1971291N11134)	10/23/00Z	90	2	WP
1972	KIT	(1972004N10142)	01/07/12Z	90	2	WP
1972	ORA	(1972174N11137)	06/24/06Z	70	1	WP
1972	RITA	(1972187N10150)	07/26/06Z	65	1	WP
1972	TESS	(1972189N11171)	07/23/06Z	65	1	WP
1972	BETTY	(1972221N11151)	08/17/06Z	75	1	WP
1972	CORA	(1972234N17128)	08/27/18Z	65	1	WP
1972	ELSIE	(1972244N12123)	09/04/00Z	70	1	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1972	FLOSSIE	(1972251N12137)	09/15/12Z	70	1	WP
1972	HELEN	(1972254N14145)	09/16/06Z	100	3	WP
1972	LORNA	(1972271N15125)	10/02/18Z	65	1	WP
1972	PAMELA	(1972307N18144)	11/08/00Z	100	3	WP
1972	THERESE	(1972335N06142)	12/09/18Z	100	3	WP
1973	ANITA	(1973184N11110)	07/08/12Z	70	1	WP
1973	DOT	(1973193N13111)	07/17/00Z	65	1	WP
1973	MARGE	(1973253N14129)	09/13/18Z	80	1	WP
1973	NORA	(1973274N10137)	10/07/18Z	100	3	WP
1973	RUTH	(1973284N12144)	10/15/12Z	85	2	WP
1974	DINAH	(1974156N06144)	06/10/00Z	70	1	WP
1974	IVY	(1974197N11147)	07/20/00Z	90	2	WP
1974	POLLY	(1974236N18154)	09/01/06Z	80	1	WP
1974	BESS	(1974280N11143)	10/10/18Z	65	1	WP
1974	CARMEN	(1974286N11138)	10/16/06Z	70	1	WP
1974	DELLA	(1974291N10150)	10/26/00Z	80	1	WP
1974	ELAINE	(1974296N14148)	10/29/12Z	65	1	WP
1974	GLORIA	(1974306N07142)	11/06/18Z	120	4	WP
1974	IRMA	(1974324N08146)	11/28/00Z	90	2	WP
1975	LOLA	(1975019N09140)	01/24/06Z	65	1	WP
1975	NINA	(1975211N19137)	08/03/00Z	105	3	WP
1975	RITA:TD0809	(1975221N18116)	08/22/12Z	80	1	WP
1975	PHYLLIS	(1975223N14138)	08/17/00Z	80	1	WP
1975	ALICE	(1975258N12132)	09/17/18Z	75	1	WP
1975	BETTY	(1975259N10141)	09/22/06Z	95	2	WP
1975	18W:FLOSSIE	(1975288N13138)	10/23/00Z	65	1	WP
1976	OLGA	(1976131N12142)	05/20/18Z	85	2	WP
1976	RUBY	(1976172N11141)	06/25/00Z	80	1	WP
1976	BILLIE	(1976213N08160)	08/09/12Z	90	2	WP
1976	FRAN	(1976246N09157)	09/12/12Z	65	1	WP
1976	IRIS	(1976257N15113)	09/19/18Z	65	1	WP
1977	SARAH	(1977194N07142)	07/20/06Z	75	1	WP
1977	THELMA	(1977200N10138)	07/25/00Z	80	1	WP
1977	VERA	(1977206N24137)	07/31/06Z	110	3	WP
1977	KIM	(1977308N07156)	11/13/18Z	110	3	WP
1978	ELAINE	(1978230N09136)	08/27/12Z	65	1	WP
1978	LOLA	(1978264N08147)	10/01/06Z	65	1	WP
1978	RITA	(1978288N10185)	10/26/12Z	125	4	WP
1979	CECIL	(1979098N02144)	04/15/12Z	80	1	WP
1979	03B:HOPE	(1979205N10148)	08/02/00Z	105	3	WP
1979	IRVING	(1979219N15138)	08/17/00Z	70	1	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1979	OWEN	(1979262N15149)	09/30/06Z	65	1	WP
1979	TIP	(1979275N05159)	10/19/00Z	70	1	WP
1979	VERA:VERA-1	(1979300N04166)	11/06/06Z	90	2	WP
1980	JOE	(1980197N07154)	07/20/12Z	105	3	WP
1980	KIM	(1980201N08155)	07/25/00Z	100	3	WP
1980	NORRIS	(1980236N15144)	08/27/12Z	90	2	WP
1980	16W:ORCHID	(1980246N05151)	09/10/18Z	85	2	WP
1980	RUTH	(1980254N14112)	09/15/18Z	65	1	WP
1980	PERCY	(1980257N17133)	09/18/00Z	115	4	WP
1980	BELLY:BETTY	(1980296N05165)	11/04/12Z	120	4	WP
1981	JUNE	(1981166N11135)	06/20/06Z	75	1	WP
1981	OGDEN	(1981207N22150)	07/30/12Z	65	1	WP
1981	THAD	(1981227N18129)	08/22/18Z	70	1	WP
1981	CLARA	(1981256N10150)	09/21/18Z	70	1	WP
1981	GAY	(1981286N10150)	10/22/12Z	70	1	WP
1981	HAZEN	(1981317N14153)	11/19/06Z	70	1	WP
1981	IRMA	(1981319N07163)	11/24/06Z	85	2	WP
1981	LEE	(1981355N07149)	12/25/06Z	95	2	WP
1982	NELSON	(1982077N04161)	03/25/12Z	105	3	WP
1982	BESS	(1982202N11165)	08/01/12Z	70	1	WP
1982	ANDY:ANDY-1	(1982202N12148)	07/28/18Z	105	3	WP
1982	FAYE	(1982227N09140)	08/24/18Z	75	1	WP
1982	ELLIS	(1982229N09154)	08/26/18Z	65	1	WP
1982	HOPE	(1982246N16119)	09/14/18Z	65	1	WP
1982	JUDY	(1982247N11147)	09/12/06Z	70	1	WP
1982	KEN	(1982257N17140)	09/24/12Z	70	1	WP
1982	NANCY	(1982283N16148)	10/14/06Z	115	4	WP
1982	PAMELA	(1982325N08176)	12/07/00Z	70	1	WP
1982	ROGER	(1982339N07139)	12/09/06Z	65	1	WP
1983	VERA	(1983186N04153)	07/14/06Z	80	1	WP
1983	WAYNE	(1983201N08144)	07/25/06Z	80	1	WP
1983	ELLEN	(1983239N10183)	09/08/18Z	70	1	WP
1983	FORREST	(1983259N08161)	09/25/00Z	120	4	WP
1983	JOE	(1983279N04140)	10/13/12Z	65	1	WP
1984	ALEX:ALEX-1	(1984180N16130)	07/03/06Z	75	1	WP
1984	ED	(1984207N29135)	07/31/00Z	70	1	WP
1984	IKE	(1984239N08146)	09/01/12Z	125	4	WP
1984	AGNES	(1984302N00149)	11/04/18Z	120	4	WP
1985	HAL	(1985162N05154)	06/24/00Z	80	1	WP
1985	IRMA	(1985168N05156)	06/30/18Z	65	1	WP
1985	JEFF	(1985199N08143)	07/30/12Z	75	1	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1985	KIT	(1985212N22148)	08/09/18Z	70	1	WP
1985	MAMIE:MIMIE	(1985226N23126)	08/18/00Z	70	1	WP
1985	NELSON	(1985227N16149)	08/23/06Z	70	1	WP
1985	PAT	(1985236N23125)	08/30/18Z	95	2	WP
1985	TESS	(1985240N08148)	09/03/00Z	65	1	WP
1985	ANDY	(1985268N16126)	09/29/12Z	70	1	WP
1985	CECIL	(1985281N02144)	10/15/18Z	100	3	WP
1985	DOT	(1985284N05159)	10/18/12Z	110	3	WP
1986	NANCY	(1986169N07152)	06/23/18Z	70	1	WP
1986	PEGGY	(1986179N11175)	07/08/18Z	100	3	WP
1986	WAYNE	(1986228N19120)	08/21/18Z	80	1	WP
1986	ABBY	(1986252N06153)	09/19/00Z	90	2	WP
1986	MARGE	(1986343N05176)	12/21/06Z	80	1	WP
1987	THELMA	(1987188N10151)	07/15/12Z	70	1	WP
1987	ALEX	(1987202N09144)	07/26/18Z	65	1	WP
1987	BETTY	(1987219N08134)	08/12/00Z	135	4	WP
1987	CARY	(1987219N08155)	08/18/00Z	70	1	WP
1987	KELLY	(1987282N12137)	10/16/12Z	80	1	WP
1987	NINA	(1987320N03171)	11/25/12Z	145	5	WP
1987	PHYLLIS	(1987343N05154)	12/15/18Z	90	2	WP
1988	ROY	(1988005N03174)	01/16/00Z	75	1	WP
1988	SUSAN	(1988150N19119)	06/01/18Z	75	1	WP
1988	WARREN	(1988193N09149)	07/19/06Z	65	1	WP
1988	PAT	(1988290N08145)	10/20/12Z	75	1	WP
1988	RUBY	(1988295N10138)	10/24/00Z	100	3	WP
1988	SKIP	(1988308N09140)	11/07/00Z	120	4	WP
1989	BRENDA	(1989134N07138)	05/20/12Z	70	1	WP
1989	CECIL	(1989142N11114)	05/24/18Z	70	1	WP
1989	DOT	(1989153N04144)	06/10/00Z	95	2	WP
1989	GORDON	(1989190N20160)	07/15/18Z	140	5	WP
1989	JUDY	(1989201N11145)	07/27/12Z	90	2	WP
1989	SARAH:SARAH-1	(1989246N16159)	09/12/06Z	65	1	WP
1989	WAYNE	(1989259N20126)	09/19/00Z	65	1	WP
1989	ANGELA	(1989271N12142)	10/05/12Z	130	4	WP
1989	BRIAN	(1989272N18120)	10/02/12Z	80	1	WP
1989	DAN	(1989279N07151)	10/10/12Z	65	1	WP
1989	ELSIE	(1989286N14137)	10/19/00Z	140	5	WP
1989	GAY	(1989305N07105)	11/08/18Z	140	5	WP
1989	HUNT	(1989314N10152)	11/21/18Z	90	2	WP
1990	OFELIA	(1990166N06141)	06/23/00Z	90	2	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1990	PERCY	(1990171N11148)	06/27/00Z	95	2	WP
1990	WINONA	(1990216N29125)	08/10/00Z	65	1	WP
1990	YANCY	(1990221N07162)	08/19/00Z	90	2	WP
1990	ZOLA	(1990228N15141)	08/22/00Z	90	2	WP
1990	BECKY	(1990232N13141)	08/29/06Z	70	1	WP
1990	ABE	(1990235N10152)	08/31/00Z	85	2	WP
1990	DOT:DOT-1	(1990245N16149)	09/07/12Z	70	1	WP
1990	ED	(1990250N13157)	09/14/12Z	70	1	WP
1990	FLO	(1990251N06171)	09/19/06Z	90	2	WP
1990	GENE	(1990261N12141)	09/30/00Z	65	1	WP
1990	PAGE	(1990309N08167)	11/30/06Z	65	1	WP
1990	MIKE	(1990310N07152)	11/12/12Z	130	4	WP
1991	YUNYA	(1991163N11128)	06/15/00Z	65	1	WP
1991	ZEKE	(1991187N06139)	07/12/18Z	80	1	WP
1991	AMY	(1991194N11147)	07/19/06Z	105	3	WP
1991	BRENDAN	(1991196N06153)	07/22/00Z	65	1	WP
1991	CAITLIN	(1991200N05157)	07/29/06Z	75	1	WP
1991	FRED	(1991220N10133)	08/16/00Z	95	2	WP
1991	KINNA	(1991251N12138)	09/13/18Z	85	2	WP
1991	MIREILLE	(1991256N13171)	09/27/06Z	95	2	WP
1991	NAT	(1991257N16130)	09/22/18Z	105	3	WP
1991	RUTH	(1991289N06156)	10/27/06Z	105	3	WP
1992	CHUCK	(1992174N13126)	06/28/00Z	80	1	WP
1992	ELI	(1992188N07156)	07/10/18Z	65	1	WP
1992	GARY	(1992198N13135)	07/22/12Z	65	1	WP
1992	JANIS	(1992212N05154)	08/07/18Z	95	2	WP
1992	IRVING	(1992212N20135)	08/04/00Z	80	1	WP
1992	FARREST:FORREST	(1992314N08141)	11/21/06Z	95	2	WP
1993	KORYN	(1993164N04160)	06/25/18Z	110	3	WP
1993	LEWIS	(1993185N09137)	07/10/12Z	85	2	WP
1993	NATHAN	(1993199N10156)	07/24/12Z	70	1	WP
1993	PERCY	(1993207N19130)	07/29/12Z	65	1	WP
1993	ROBYN	(1993211N07161)	08/09/18Z	90	2	WP
1993	TASHA	(1993224N07153)	08/20/18Z	75	1	WP
1993	YANCY	(1993240N17142)	09/03/06Z	115	4	WP
1993	ABE	(1993250N17119)	09/13/18Z	100	3	WP
1993	DOT	(1993261N11131)	09/26/06Z	75	1	WP
1993	FLO	(1993271N14134)	10/04/00Z	70	1	WP
1993	IRA	(1993298N11154)	11/01/06Z	105	3	WP
1993	KYLE	(1993322N09137)	11/23/06Z	95	2	WP
1993	LOLA	(1993331N05172)	12/08/12Z	105	3	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1993	MANNY	(1993336N05164)	12/09/18Z	115	4	WP
1993	NELL	(1993353N05159)	12/26/00Z	70	1	WP
1994	OWEN	(1994088N09148)	04/03/18Z	75	1	WP
1994	TIM	(1994186N09139)	07/10/12Z	125	4	WP
1994	FRED	(1994224N20152)	08/21/12Z	90	2	WP
1994	GLADYS	(1994231N12157)	09/01/00Z	105	3	WP
1994	ORCHID	(1994259N12128)	09/29/06Z	95	2	WP
1994	SETH	(1994273N08176)	10/11/18Z	65	1	WP
1994	TERESA	(1994287N14156)	10/21/00Z	75	1	WP
1994	AXEL	(1994345N06165)	12/21/06Z	95	2	WP
1995	FAYE	(1995193N06156)	07/23/06Z	95	2	WP
1995	GARY	(1995208N17121)	07/31/00Z	65	1	WP
1995	HELEN	(1995215N12145)	08/12/00Z	70	1	WP
1995	LOIS	(1995233N16115)	08/28/00Z	65	1	WP
1995	KENT	(1995236N10134)	08/31/06Z	95	2	WP
1995	RYAN	(1995258N14115)	09/23/12Z	100	3	WP
1995	SIBYL	(1995264N06174)	09/29/12Z	65	1	WP
1995	TED	(1995277N07141)	10/13/06Z	65	1	WP
1995	YVETTE	(1995292N08150)	10/26/00Z	65	1	WP
1995	ANGELA	(1995293N05177)	11/02/18Z	140	5	WP
1995	ZACK	(1995294N05163)	10/31/18Z	105	3	WP
1996	EVE	(1996192N19152)	07/18/00Z	115	4	WP
1996	GLORIA	(1996201N07137)	07/26/06Z	90	2	WP
1996	FRANKIE	(1996202N17115)	07/23/18Z	90	2	WP
1996	HERB	(1996203N12152)	07/31/12Z	130	4	WP
1996	KIRK	(1996210N05156)	08/13/18Z	95	2	WP
1996	NIKI	(1996227N08156)	08/21/18Z	95	2	WP
1996	SALLY	(1996246N08148)	09/09/00Z	110	3	WP
1996	ABEL:BETH	(1996282N11162)	10/17/12Z	90	2	WP
1997	OPAL	(1997165N12139)	06/20/00Z	65	1	WP
1997	ROSIE	(1997196N08142)	07/26/06Z	70	1	WP
1997	VICTOR	(1997210N15120)	08/02/12Z	65	1	WP
1997	WINNIE:WINNIE-1	(1997217N06168)	08/18/12Z	75	1	WP
1997	AMBER	(1997232N14136)	08/28/18Z	95	2	WP
1997	ZITA	(1997232N17115)	08/22/00Z	65	1	WP
1997	OLIWA	(1997240N12193)	09/15/18Z	75	1	WP
1997	FRITZ	(1997261N13114)	09/25/00Z	75	1	WP
1997	IVAN	(1997283N07177)	10/19/18Z	120	4	WP
1997	LINDA	(1997298N06140)	11/03/12Z	65	1	WP
1998	OTTO	(1998213N14128)	08/04/00Z	100	3	WP
1998	STELLA	(1998253N17150)	09/15/18Z	65	1	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
1998	VICKI	(1998259N17118)	09/22/00Z	90	2	WP
1998	ZEB	(1998281N11151)	10/14/00Z	155	5	WP
1998	BABS	(1998285N12149)	10/21/18Z	120	4	WP
1998	FAITH	(1998342N06141)	12/10/12Z	65	1	WP
1999	MAGGIE	(1999151N09132)	06/06/12Z	80	1	WP
1999	OLGA	(1999208N06139)	08/03/06Z	70	1	WP
1999	SAM	(1999230N12129)	08/22/06Z	75	1	WP
1999	YORK	(1999253N17124)	09/16/06Z	70	1	WP
1999	BART	(1999260N20130)	09/23/18Z	100	3	WP
1999	DAN	(1999275N16135)	10/05/00Z	110	3	WP
2000	KAI-TAK	(2000185N15117)	07/09/00Z	65	1	WP
2000	JELAWAT	(2000214N22155)	08/10/12Z	65	1	WP
2000	BILIS	(2000230N08139)	08/22/12Z	140	5	WP
2000	PRAPIROON	(2000237N08138)	08/31/12Z	65	1	WP
2000	SAOMAI	(2000245N14157)	09/15/18Z	65	1	WP
2000	WUKONG	(2000248N17117)	09/09/00Z	95	2	WP
2000	XANGSANE	(2000299N08139)	10/27/12Z	70	1	WP
2000	BEBINCA	(2000305N06136)	11/02/12Z	85	2	WP
2001	CHEBI	(2001170N11138)	06/23/12Z	90	2	WP
2001	DURIAN	(2001180N15118)	07/01/18Z	75	1	WP
2001	UTOR	(2001181N08141)	07/06/00Z	65	1	WP
2001	YUTU	(2001204N19127)	07/25/18Z	75	1	WP
2001	TORAJI	(2001206N14134)	07/29/12Z	95	2	WP
2001	DANAS	(2001246N19156)	09/11/00Z	70	1	WP
2001	NARI	(2001248N23125)	09/16/12Z	85	2	WP
2001	LEKIMA	(2001264N21126)	09/26/12Z	65	1	WP
2001	LINGLING	(2001309N10130)	11/11/18Z	95	2	WP
2001	VAMEI	(2001361N01106)	12/27/06Z	65	1	WP
2002	RUSA	(2002234N14164)	08/31/06Z	70	1	WP
2002	SINLAKU	(2002240N16155)	09/07/06Z	70	1	WP
2002	HIGOS	(2002268N15163)	10/01/06Z	95	2	WP
2003	IMBUDO:LMBUDO	(2003196N04150)	07/22/00Z	115	4	WP
2003	ETAU	(2003212N09150)	08/08/12Z	90	2	WP
2003	MORAKOT	(2003212N12130)	08/03/12Z	65	1	WP
2003	KROVANH	(2003226N07156)	08/22/06Z	90	2	WP
2003	DUJUAN	(2003240N20139)	09/02/12Z	85	2	WP
2003	MAEMI	(2003247N10153)	09/12/12Z	95	2	WP
2003	MELOR	(2003302N11133)	10/31/18Z	65	1	WP
2003	NEPARTAK	(2003316N11141)	11/18/06Z	70	1	WP
2004	NIDA	(2004134N07132)	05/17/00Z	130	4	WP
2004	CHANTHU	(2004158N07142)	06/12/06Z	75	1	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
2004	MINDULE:MINDULLE	(2004174N14146)	07/01/12Z	65	1	WP
2004	RANANIM	(2004219N15137)	08/12/12Z	85	2	WP
2004	CHABA	(2004230N09172)	08/30/00Z	90	2	WP
2004	AERE	(2004231N09147)	08/25/06Z	85	2	WP
2004	SONGDA	(2004239N11171)	09/07/00Z	90	2	WP
2004	MEARI	(2004263N13153)	09/28/18Z	65	1	WP
2004	MA-ON	(2004275N14139)	10/09/06Z	105	3	WP
2004	MUIFA	(2004319N10134)	11/19/12Z	85	2	WP
2004	NANMADOL	(2004333N06154)	12/02/12Z	115	4	WP
2005	ROKE	(2005071N06152)	03/16/12Z	80	1	WP
2005	HAITANG	(2005192N22155)	07/18/06Z	95	2	WP
2005	MATSA	(2005211N09141)	08/05/18Z	65	1	WP
2005	SANVN:SANVU	(2005222N14131)	08/13/00Z	65	1	WP
2005	MAWAR	(2005230N20144)	08/25/12Z	90	2	WP
2005	TALIM	(2005237N14148)	08/31/12Z	110	3	WP
2005	NABI	(2005241N15155)	09/06/00Z	95	2	WP
2005	KHANUN	(2005248N08142)	09/11/06Z	105	3	WP
2005	DAMRCY:DAMREY	(2005262N13127)	09/25/18Z	80	1	WP
2005	LONGWANG	(2005268N19146)	10/01/18Z	115	4	WP
2006	CHANCHU	(2006128N09138)	05/11/12Z	75	1	WP
2006	PRAPIROON	(2006209N13130)	08/03/12Z	65	1	WP
2006	SAOMAI	(2006216N07151)	08/10/06Z	130	4	WP
2006	SHANSHAN	(2006252N13139)	09/17/06Z	75	1	WP
2006	XANGSANE	(2006268N12129)	09/27/06Z	115	4	WP
2006	CIMARON	(2006298N12143)	10/29/12Z	140	5	WP
2006	CHEBI	(2006311N16143)	11/10/18Z	125	4	WP
2006	DURIAN	(2006329N06150)	11/30/00Z	135	4	WP
2006	UTOR	(2006340N08142)	12/09/00Z	65	1	WP
2007	MAN-YI	(2007188N04148)	07/14/00Z	90	2	WP
2007	USAGI	(2007208N20155)	08/02/06Z	90	2	WP
2007	PABUK	(2007216N18138)	08/07/12Z	70	1	WP
2007	SEPAT	(2007223N19136)	08/17/18Z	105	3	WP
2007	FITOW	(2007240N17153)	09/06/12Z	75	1	WP
2007	NARI	(2007254N18140)	09/16/06Z	75	1	WP
2007	WIPHA	(2007257N16134)	09/18/18Z	105	3	WP
2007	LEKIMA	(2007272N17125)	10/03/12Z	70	1	WP
2007	KROSA	(2007274N18131)	10/06/12Z	115	4	WP
2007	MATMO:PEIPAH	(2007306N18133)	11/04/12Z	65	1	WP
2007	MITAG	(2007324N10140)	11/25/18Z	75	1	WP
2008	HALONG	(2008135N12116)	05/17/06Z	65	1	WP
2008	FENGSHEN	(2008169N08135)	06/21/06Z	100	3	WP

Year	IBTrACS Name	IBTrACS ID	Date	Wind Speed	Cat.	Basin
2008	KALMAEGI	(2008193N20126)	07/17/12Z	90	2	WP
2008	FUNG-WONG	(2008206N22133)	07/27/18Z	95	2	WP
2008	SINLAKU	(2008252N16128)	09/13/12Z	100	3	WP
2008	HAGUPIT	(2008262N16142)	09/23/18Z	120	4	WP
2008	JANGMI	(2008268N12140)	09/28/06Z	115	4	WP
2009	CHAN-HOM	(2009123N10111)	05/07/06Z	90	2	WP
2009	MOLAVE	(2009196N14129)	07/18/12Z	65	1	WP
2009	MORAKOT	(2009215N20133)	08/07/12Z	80	1	WP
2009	KOPPU	(2009254N14130)	09/14/18Z	75	1	WP
2009	KETSANA	(2009268N14128)	09/29/06Z	90	2	WP
2009	PARMA	(2009271N09148)	10/03/00Z	90	2	WP
2009	MELOR	(2009272N07164)	10/07/18Z	65	1	WP
2009	MIRINAE	(2009299N12153)	10/30/12Z	85	2	WP
2010	CONSON	(2010191N12138)	07/16/06Z	80	1	WP
2010	CHANTHU	(2010198N15123)	07/22/00Z	80	1	WP
2010	FANAPI	(2010256N17137)	09/19/00Z	105	3	WP
2010	KOMPASU	(2010240N15142)	09/01/18Z	80	1	WP
2010	MEGI	(2010285N13145)	10/18/00Z	150	5	WP

Appendix 2: Notes on Methodology for Assessing the Role of Catastrophe Models in Characterizing the Florida Hurricane Risk

Data for Citizens' Premiums, Policy Counts, and Market Share

All "Annual Report" or "Monthly Report" pertains to documents distributed by Citizens Property Insurance Corporation.

Year	Direct Written Premium Data from…	Policies-in-Force Data from…	Market Share by Written Premium Data from…
2002	2007 Annual Report	2007 Annual Report	2007 Annual Report
2003	December 2003 Monthly Report	2007 Annual Report	2007 Annual Report
2004	December 2004 Monthly Report	2007 Annual Report	2007 Annual Report
2005	December 2005 Monthly Report	2007 Annual Report	2007 Annual Report
2006	2007 Annual Report	2007 Annual Report	2007 Annual Report
2007	2007 Annual Report	2007 Annual Report	2007 Annual Report
2008	2008 Annual report	2008 Annual Report	Public Records Request to FLOIR, #131017-13
2009	2009 Annual report	2009 Annual Report	FLOIR QUASR search engine, 4th Quarter Filings, All Counties, All Coverages
2010	2010 Annual report	2010 Annual Report	FLOIR QUASR search engine, 4th Quarter Filings, All Counties, All Coverages
2011	December 2011 Monthly Report	December 2011 Monthly Report	FLOIR QUASR search engine, 4th Quarter Filings, All Counties, All Coverages

Information on Data Used to Assess Expert Agreement/Disagreement about Florida's Hurricane Risk

- **Standards 2001**
  - Form E
    - The modeler will provide estimates of loss for various probability levels using the hypothetical data set. The modeler will also provide the annual aggregate and occurrence mean, median and standard deviation for its PML distribution.
  - Approved Models
    - AIR Atlantic Tropical Cyclone Model V4.1.0, Program CLASIC/2 V3.0; February 2002
    - RMS RiskLink Version 4.2 SP1a; February 2002
- **Standards 2002**
  - Form E
    - Provide estimates of the insured loss for various probability levels using the hypothetical data set. Provide the following: a. The annual aggregate mean, median, standard deviation, and interquartile range for PML distribution; that is, the mean, median, standard deviation, and interquartile range of the annual aggregate insured losses. b. The occurrence mean, median, standard deviation, and interquartile range for PML distribution; that is, the mean, median, standard deviation, and interquartile range of the insured losses from individual events.
  - Approved Models
    - AIR Atlantic Tropical Cyclone Model V5.0.0, Program CLASIC/2 V5.5; February 2002
    - RMS RiskLink Version 4.3a ~~4.2SP1a~~; February 2003
- **Standards 2003**
  - Form S-11 Probable Maximum Loss (PML)
    - Provide estimates of the insured loss for various probability levels using the hypothetical data set provided in the file named "FormA2Input03.xls." Provide the total average annual loss for the PML distribution. If the methodology of your model does not allow you to produce a viable answer, please state so and why.
  - Approved Models
    - AIR Atlantic Tropical Cyclone Model V6.1, Program CLASIC/2 V6.0, May 2004
    - RMS RiskLink version 4.32a, April 2004
- **Standards 2004**
  - Form S-2 Probable Maximum Loss
    - Provide projections of the insured loss for various probability levels using the hypothetical data set provided in the file named "FormA2Input04.xls." Provide the total average annual loss for the PML

distribution. If the methodology of your model does not allow you to produce a viable answer, please state so and why.

- Approved Models
  - AIR Atlantic Tropical Cyclone Model V7.0, Program CLASIC/2 V6.6.1; February 25, 2005
  - RMS RiskLink version 4.5a, May 2005

- **Standards 2005**
  - Form S-2 Probable Maximum Loss
    - Provide projections of the insured loss for various probability levels using the hypothetical data set provided in the file named "FormA2Input05.xls." Provide the total average annual loss for the PML distribution. If the methodology of your model does not allow you to produce a viable answer, please state so and why.
  - Approved Models
    - AIR Atlantic Tropical Cyclone Model V8.0, Program CLASIC/2 V8; February 27, 2006
    - RMS RiskLink version 5.1a; May 2006
- **Standards 2006**
  - Form S-2 Probable Maximum Loss
    - Provide projections of the insured loss for various probability levels using the hypothetical data set provided in the file named "FormA1Input06.xls." Provide the total average annual loss for the PML distribution. If the methodology of your model does not allow you to produce a viable answer, please state so and why.
  - Approved Models
    - AIR Atlantic Tropical Cyclone Model V9.0, Program CLASIC/2 V9; February 26, 2007
    - RMS RiskLink version 6.0a; June 2007
    - Florida Public Hurricane Loss Model 2.6; June 12, 2007
- **Standards 2007**
  - Form S-2 An Example of a Probable Maximum Loss (PML) Based on a Limited Hypothetical Data Set
    - Provide projections of the insured loss for various probability levels using the hypothetical data set provided in the file named ―FormA1Input07.xls.‖ Provide the total average annual loss for the PML distribution. If the methodology of your model does not allow you to produce a viable answer, please state so and why.
  - Approved Models
    - AIR Atlantic Tropical Cyclone Model V10.0, Program CLASIC/2 V10; February 26, 2008
    - RMS RiskLink version 6.0b; March 2008
    - Florida Public Hurricane Loss Model 3.0; May 15, 2008
- **Standards 2008**
  - Form S-2: An Example of Loss Exceedance Estimates Based on a Limited Hypothetical Data Set

        - Provide projections of the insured loss for various probability levels using the hypothetical data set provided in the file named "FormA1Input08.xls" and using the 2007 Florida Hurricane Catastrophe Fund aggregate exposure data set provided in the file named "hlpm2007.exe." Provide the total average annual loss for the loss exceedance distribution using each data set. If the methodology of your model does not allow you to produce a viable answer, please state so and why.
    - Approved Models
        - AIR Atlantic Tropical Cyclone Model V11.0, CLASIC/2 V11; May 9, 2009
        - RMS RiskLink 8.0.1a; May 2009
        - Florida Public Hurricane Loss Model 3.1; May 22, 2009
- **Standards 2009**
    - Form S-2: Examples of Loss Exceedance Estimates
        - Provide projections of the insured loss for various probability levels using the hypothetical data set provided in the file named "FormA1Input09.xls" and using the 2007 Florida Hurricane Catastrophe Fund aggregate personal residential exposure data set provided in the file named "hlpm2007.exe" and using the 2007 Florida Hurricane Catastrophe Fund aggregate personal and commercial residential exposure data set provided in the file named "hlpm2007c.exe." Provide the total average annual loss for the loss exceedance distribution using each data set. If the methodology of your model does not allow you to produce a viable answer, please state so and why.
    - Approved Models
        - AIR Atlantic Tropical Cyclone Model V12.0.1, Program CLASIC/2 V12.0.4; November 3, 2010
        - Letter of Acceptability also accepts v13.0.4
        - RMS RiskLink 11.0SP2; September 2011
        - Florida Public Hurricane Loss Model 4.1; July 11, 2011

Appendix 3: Methodology for Figure 7 and Table 11

It is important the reader understands that information in Figure 7 and Table 11 is presented as a demonstration of necessary trade-offs rate decision-making. Not much more should be inferred.

Florida loss events, 1900- 2012, were identified using the ICAT Damage Estimator at www.icatdamageestimator.com. ICAT's database provides normalized economic losses by event using the methodology presented in (Pielke et al. 2008). I then halved these values to give an estimate of insured losses. Using this data, a historical pure premium was found by the sum of all loss events divided by the number of years in analysis (113 years).

The pure premium for the columns labeled FCHLPM, Wind, and Wind + Surge were found using a common commercial catastrophe model applied to the model's Florida all-lines industry portfolio. Model runs include loss amplification (i.e. demand surge). Due to Florida regulations, losses found using the FCHLPM approved model is based on a long term or "historic" catalog. Losses in the latter two analyses are based on a near term or "stochastic" catalog of events.

Once I established the pure premium from each model type, I used the normalized event losses to establish an index for each respective model type by dividing the loss by the pure premium. The numbers in Table 11 represent counts of when the index was greater or less then one. I considered values less than one as a false negative- the prediction was less than the observed. I considered values greater than one as a false positive- the prediction was greater than the observed. There were no instances when the value was exactly one.