Using Financial Technology to Mitigate Extreme Events, Natural Disasters, and insurance regulation.

Abstract

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In this project, I explore how the recent advances in information and financial technology can be utilized to develop products to enhance insurance capacity and to transform the mitigation strategies developed by the private marketplace to reduce risk and insurance premiums caused by extreme events. The sheer number and severity of natural disasters and extreme events are increasing. For example, there were 28 weather and climate disasters with losses totaling over $1 billion in the USA in 2023, while by comparison between 1980 and 2023, the typical annual average for these events was 8.5. This size and scope of disaster number is the leading cause for the 12% increase in homeowners' insurance costs in 2023 in the United States. [Endnote 1, NOAA].

Globally, the number and cost of weather and climate disasters are increasing due to a combination of increased exposure, vulnerability, and the fast economic growth in exposed areas is increasing the frequency of some types of extreme events that lead to billion-dollar disasters. This is leading to a significant economic toll, and the estimated $2 trillion in losses from extreme weather events over the years highlights the substantial impact on the global economy [Endnote 2, ICC].

Two other disturbing factors are the concentration of losses and disparity between regions. While many adverse events occur, a relatively small number of extreme weather events are responsible for most economic losses. Additionally, the lower-income countries tend to experience a larger relative economic impact from extreme weather events compared to wealthier nations. Looking forward, as the intensity of extreme events accelerate and develops, what needs to be done is to ensure resilience and survival of the economies. Without insurance, extreme events could destroy the livelihood of individuals, economics of communities, and financial welfare of regions for decades. Insurance is vital for the resiliency of communities providing an impetus to build back better. Towards the end, after a serious examination of the existing institutional framework and infrastructure, I am proposing the development of new insurance models and products.

Multi-dimensional Problem:

Globally the insuring institutions face an underwriting capacity constraint. Additionally, there is a dichotomy and a serious disconnect between the development of mitigation strategies by the industry to address extreme events and its implementation by the stakeholders. While companies develop breakthrough innovations that can help us stem the effects of climate change and minimize losses, these innovations do not lead to any meaningful reduction in insurance premiums for natural disasters, flood mitigation, and other extreme events. Additionally, many do not participate in mitigation or buy adequate insurance for protection. Individuals need to be incentivized to engage in mitigation.

Professor Kunreuther (1996) defines and delineates the challenges of insurance for catastrophic risk as below:

The catastrophic risk due to an extreme event can be defined as one where many suffer a given level of harm due to a particular extreme event and losses increase. Nonetheless, over time, more individuals and firms are locating in harm's way while not taking appropriate protective measures against adverse events. This is due to the behavioral bias which leads to unwise decisions of not investing in adaptation or disaster mitigation measures until late.

However, mitigating against extreme events is an "all or none proposition" to minimize damages and cannot be executed in piece-meal. To ensure comprehensive protection all aspects of mitigation must be implemented. Additionally, the free-rider problem exists. In an interdependent world with no intervention by the public sector, it is economically rational for those at risk not to invest in protective measures. What is needed is combined cooperative efforts of the stakeholders and financial incentives to achieve total mitigation. Risk management strategies that involve private–public partnerships are crucial for addressing these issues and reducing future catastrophic losses and build resiliency. The difficulties in enforcing the mechanism for disaster mitigation include all financial alternatives including multiyear insurance contracts, well-enforced regulations, third-party inspections, and alternative risk transfer instruments.

To address these multi-dimensional problems of enhancing the underwriting capacity of insurance companies, incentivizing the implementation of mitigation strategies and overcoming the barriers to achieve total mitigation and to achieve expanded coverage of global nations against extreme events, I am examining the problems and proposing four diverse solutions.

A. Enhancing Underwriting Capacity: First, enhancing insurance company's capacity and survival using innovative products. The total amount of catastrophic insurance needed may exceed the current capacity of insurance company. Financial technologies and products can help transform the marketplace innovations to reduce risk and to break the vicious cycle for better risk management and loss minimization. To achieve this, I am proposing the issuance of **Coco Bonds** in the USA which have been gainfully employed by Banks in Europe. This is in addition to the other popular insurance products such as

CAT Bonds and Insurance Linked Securities. This could expand their capital and surplus of stock insurance companies by 1.5% enabling additional underwriting capacity.

B. **Develop Green Security to mitigate against Hurricanes**. Second, to ensure higher participation amongst the consumers and incentivize participation I propose a Green Security [SHIP **Safe Home Incentive Program security**]. This will expand insurance participation and enhance involvement limiting the number of uninsured individuals. I propose a building block approach in building this security, based on a portfolio theory of value chain incentives that can be a precursor to expand to other areas of insurance. It is based on the development in financial theory to promote Mitigation. This technological innovation integrates a delicate balance between market inventions and other stakeholders that enhances overall global wealth and achieves an optimal resource allocation for the economy at large. Suitable strategies for Insurance market regulation are needed for its realization and the challenges in implementation are explored.

C. **Overcome psychological obstacles to Insurance**. Third, addressing individual psychological barriers to Insurance. While Mitigation costs for extreme events are immediate, its benefits are seen as distant, unforeseen, unpredicted, and dispersed among heterogeneous stakeholders. Prior literature work in insurance area identify reluctance to buy insurance by consumers for a variety of reasons. Participation in National Flood Insurance and California Earthquake insurance are noteworthy examples. This lacuna and lack of action creates a critical implementation problem to minimize global losses. Thus, there is an urgent need to address this gap and find solutions to incentivize mitigation against extreme events. To achieve this I am exploring the mandatory purchase of limited disaster insurance, possibly parametric model of insurance akin to automobile insurance.

D. Fourth, I review the evolving newer insurance models and examine the steps to enhance Sovereign Macro Capacity of global nations by cooperative ventures and other newer subsidy models. Some of the newer and evolving models include,

- Global: Sovereign models by pooling of resources – Caribbean Catastrophe Insurance Facility, multi country risk pools
- National and Local governments – Meso insurance or Aggregator model; parametric insurance, social goals
- Community Based models: China's Employer based fire insurance; Kenya's Employer based renters insurance
- Parametric models [pre-determined amount] and evolving new models [Lemonade],
- Other parametric models : Raincoat, Jumpstart, Storm peace and Fast-track
- Collateralized Reinsurance and Limited Coverage "sidecars"

A. First Problem - Enhance Insurance Capital through COCO BONDS

Capital for Insurance Companies

A. M. Best manages a database of more than 1000 property- and casualty-insurance companies that have failed in the United States since 1969. Their analysis shows most common reasons for insolvency are **deficient loss reserves**, inadequate pricing, and rapid growth. For example, Best's Special Report (2023) details that from 2000 to 2022, 419 property and casualty (P&C) insurers in the United States became impaired, which included 354 insolvent liquidations. The primary causes of impairments were catastrophe losses. Fraud, investment losses, and climate changes increasing the cost of disasters faster than insurers can afford were other factors.

The capital for property and casualty insurance companies is a risk-based capital (RBC) ratio generally around 10% to 20%, though the exact percentage can vary depending on the company's risk profile and regulatory requirements. Companies with higher risk profile, exposure and assets need a larger capital cushion. The key metrics deciding on the capital are regulatory oversight institutions. The National Association of Insurance Commissioners [NAIC] set a minimum capital requirements to ensure the companies have sufficient capital to cover claims, and maintain the risk-based capital recommended by agencies and regulators. A low capital or undercapitalized institution will face regulatory intervention (Endnote 5, NAIC 2024)

For example, the capital requirements for Insurance companies in Florida are:

Property and Casualty Insurers – greater of $5 million or 10% of total liabilities (F.S. 624.407) Exception: financial guaranty insurance requires the total policyholder surplus to exceed $100 million (F.S. 627.973(1)(a); residential property insurer not holding a Certificate of Authority before July 1, 2011, $15 million (F.S. 624.408(1)(f)); domestic residential property insurer $15 million if not a wholly owned subsidiary of an insurer domiciled in another state (F.S. 624.407(1)(e)); domestic residential property insurer that is a wholly owned subsidiary of an insurer domiciled in another state $50 million (F.S. 624.407(1)(e)); domestic insurer that only transacts limited sinkhole coverage for personal lines residential property pursuant to F.S. 627.7151, $7.5 million; domestic mutual insurers are governed by F.S. 628; domestic reciprocal insurers are governed by F.S. 629
Mono-line insurer, Title, Surety, or Ocean Marine – greater of $2.5 million or 10% of insurer's total liabilities (F.S. 624.407)

Financial Guaranty Insurance Corporation – at least $50 million (F.S. 627.972(2))

Theoretically, the Capital for Insurance Company (Endnote 6) is Risk Based and the RBC ratio is as below: Risk Based Capital $BC\ Ratio = Total\ Adjusted\ Capital$ / $Risk\ Based\ Captical$. The capital and insurance company are based on its insurance and investment operations. And it is based on:

- C-1 Asset risk,

- C-2 Insurance risk,

- C-3 Interest rate risk and

- C-4 Business risk.

See (Dong Shin Seol, Qinxue Liu, Chuyi Ma, Kexin Liu, (2018) for a detailed discussion) for detailed analysis and description of the variables. The Required Risk Based Capital can then be obtained through the formula:

$$[C4+\sqrt{(C1+C3)^2\ +C2^{\ 2}\ )}]^3$$

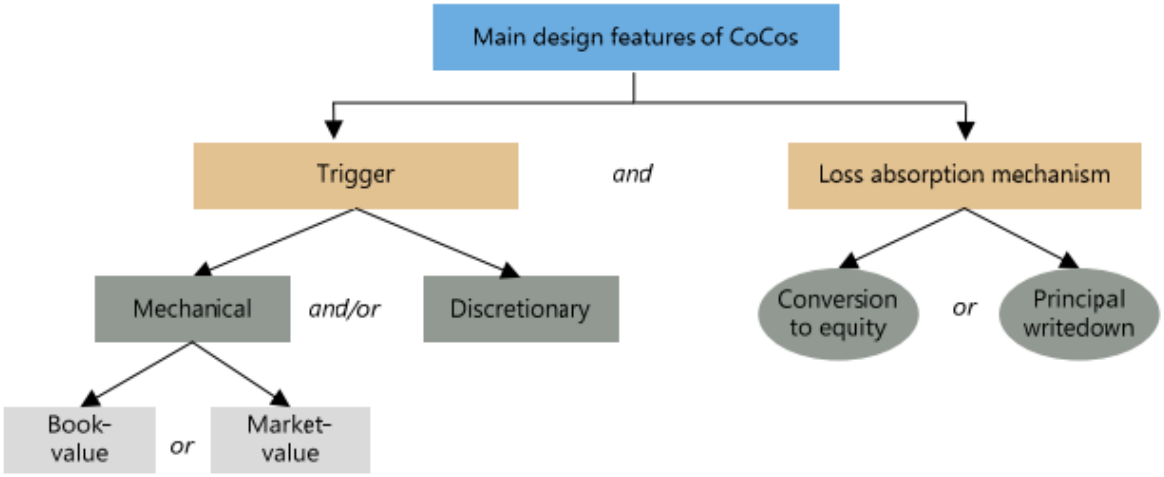
where C-1, C-2, C-3 and C-4 stands for the risk-based capital under that category.

Expanding Capital Base and enhancing underwriting capabilities

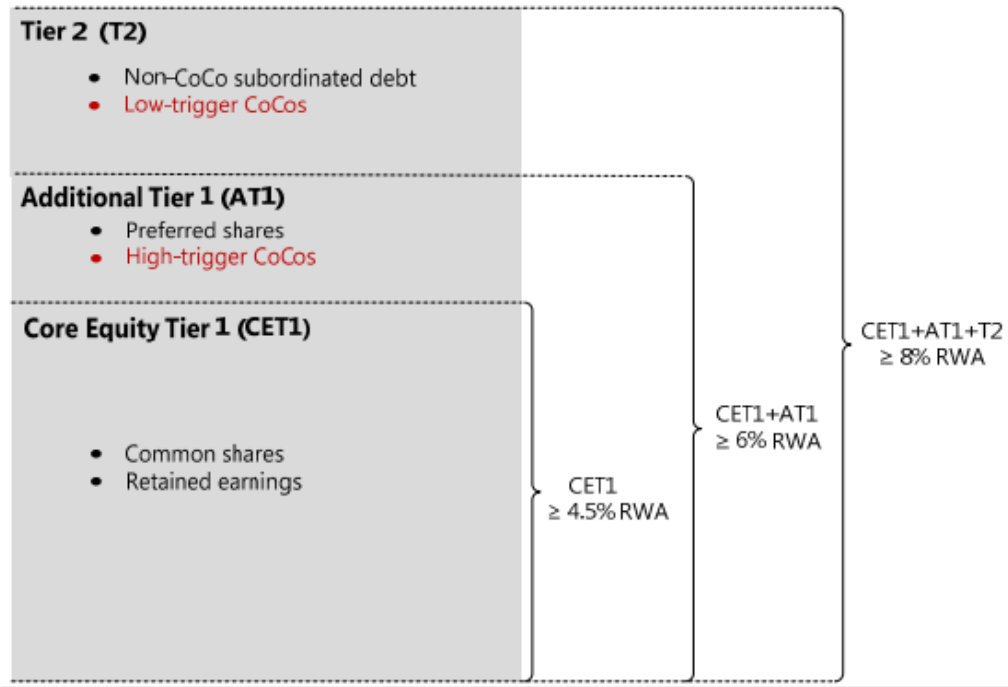
Through the issuance of Contingent Collateral Bonds (CoCos) underwriting capacity and capital of insurance companies can be increased. The Contingent Convertible Bonds (CoCos) are debt securities that convert into equity upon a predefined trigger event. CoCos was created after the 2007-2008 global financial crisis for banks, and widely used by European banks and insurance companies. These are hybrid securities that absorb losses and reduce the need for bailouts and insolvency should an extreme event occur. These securities provide an extra layer of protection against adverse events. This is currently used mainly by non-U.S. banks and help meet the additional tier 1 and tier 2 regulatory capital requirements. Over 85% of the CoCos market consists of European issuers. Insurance companies use CoCos for capital purposes or to address other regulatory concerns in Europe.

An important aspect is that Coco Bonds increase capital when it is needed most. These are also known as AT1 (Alternate Tier1) bonds and are high-yield, high-risk hybrid debt securities designed to help financial institutions absorb capital losses. These convert automatically from debt into equity when specific unfavorable capital conditions arise such as a disaster payout affecting the capital of the institution and enhance the balance sheet of the institution. At a particular preset trigger or strike price the bond converts to stock. Cocos were introduced after the 2007–2008 financial crisis to support undercapitalized banks and reduce taxpayer-funded bailouts. Used primarily in the banking industry, CoCos help satisfy regulatory capital requirements and absorb losses without requiring repayment, interest payments, or conversion when the institution is struggling. As an incentive to the investor in Coco bonds, they are paid significantly higher interest payments compared to traditional bonds, reflecting the higher risk involved. The Coco Bond Structure and trigger mechanism are detailed by Bank for International Settlements (Stefan Avdjiev et al. (2013)) and depicted in **graphs 1 and 2 below**.

Structure of CoCos Graph 1



CoCos' position in Basel III capital requirements[1] Graph 2



See Stefan Avdjiev et al. (2013) for detailed discussion.

Traditional CAT Bonds versus Proposed CoCo Bonds

The traditional Catastrophe bonds (CAT) provide financial assistance to insurance companies after a natural disaster and are generally non-investment grade corporate bonds with floating interest rates. The payout to the insurance company is triggered by a specific extreme event and provides a financial safety net for insurers.

The proposed Contingent Convertible bonds [CoCos] are convertible bonds that convert to equity if certain conditions are met. The main purpose is for institutions to meet regulatory capital requirements. It is a hybrid security that combines the properties of debt and equity. The trigger is a specific event when the financial metric of the issuing company falls short, and it helps the institution to absorb losses and meet regulatory capital requirements.

ADVANTAGES OF COCO BONDS

Reyes Pariente (2016) calculates that in Europe the issuance of Additional Tier 1 Capital per applicable regulations allow adding an additional 1.5% of additional capital of Banks to the mandatory requirements. Given the leverage multiplier effect, this can extend the underwriting capacity for Bonds. Also, for Insurance companies this could help them remain solvent during extreme events and avoid regulatory scrutiny.

Proposed empirical Study: I plan to collect data on the possible use of Coco bonds by US property and casualty insurance companies and determine the potential expansion of the underwriting capacity of these companies with the conditional capital.

PART B

Using the Value Chain for Risk Management: A Design for Financial Innovation

In this section, I explore the Development of a Green Instrument – SHIP Security – which can be used for Hurricane Mitigation.

There is abundant literature in insurance as to why individuals do not mitigate against extreme events. There is a dichotomy between theory and practice in implementing Mitigation against catastrophic risk. While all theories prescribe individuals to initiate loss prevention measures and enforce Mitigation practices to protect against natural hazards such as hurricanes and earthquakes (as Mitigation generates unique global optimal gain for all stakeholders) in practice individuals do not initiate Mitigation. Why? Mitigation costs are immediate, while its benefits are distant, unforeseen, unpredicted ·and dispersed among the heterogeneous stakeholders. Cummings (2011) and Wagner (2020) propose the most forceful arguments. They identify and dissect the psychological barriers. Governments and regulators face the vexing problem: How do we bridge the knowledge gap, and modify individual behavior? Advance in information technology in combination with financial theory enable an innovative solution to this intricate paradox. Using value-chain developments of information theory, and financial innovation we design a new security to address this obstacle. The value chain reaches across the varied stakeholder spectrum and synthesizes and synchronizes the benefits creating financial synergy. This financial synergy, when unbundled and restructured as a synthetic security achieves the desired cash flow configuration to make costless Mitigation feasible.

The need for Mitigation cannot be overemphasized to reduce overall global cost. The threat and costs from natural disasters have been increasing over time. The increasing number of extreme events and the severity underscore this problem. In 1990's Earthquakes in Kobe, Japan cost over $100 billion while the 1994 California Earthquake cost more than $12 billion in insured losses and cleanup costs. In the prior decades Hurricanes Hugo, Andrew and Floyd caused property damage exceeding $8 billion, $30 billion, and $6 billion in South Carolina, Florida, and North Carolina. Pielke and Landsea (1999) estimate that the average annual U.S. hurricane damage exceeds $5 billion during the decade of the 1990s, while Risk Management Solution's simulation study (1995) estimates a recurrence of 1906 earthquake in California would cost in excess of $105 billion in restoration and recovery costs in 1990s. **Tables I and II** identify some of the most expensive costs of extreme events.

Tables I and II about here

While timing and occurrence of earthquakes are essentially unpredictable using the current state of technology, long term meteorological trends appear to signal a rise in the frequency of major hurricanes. This poses a potentially serious threat to the economic well-being of vulnerable coastal states. Compounding this problem is the fact that half the American population lives within a 50-mile radius of the coast and the value of properties at risk run into trillions of dollars. The trend has underscored the need for the homeowners, institutions, and the government to be prepared for the high-severity catastrophes, which result in huge losses.

The long-term feasible solution to the problem is to institute the use of loss prevention measures and enforce mitigation on the part of homeowners. Hence, there is a need to develop incentives to encourage mitigation. However, there is a wide divergence, and a great disconnect between positive theory and normative practice. While the Governments' (Federal, State, and Local), Emergency managers, Insurance Companies, Bankers, Builders, Planners and Policy Makers enthusiastically promote Mitigation and support measures to reduce the impact and cost of damages, as a practical matter individual households have exhibited little interest and have not engaged in Mitigation or retrofit practices to protect against Natural disasters and extreme events. The reason for this puzzling behavior, as several academic work documents [Kunreuther (1996, 2002)], [Wagner (2000)], is due to the absence of financial impetus on the part of the homeowner. A cost minimizing individual property owner when faced with high severity, but low frequency catastrophes, would not engage in structural improvements or Mitigation as the benefits of Mitigation are unforeseen, unpredictable, and distant.

In this paper I have developed a framework to address this problem. We explore how the convergence of stakeholders' interest, financial networks, economic synergism, relationship-based technology, and recent advances in information technology (value chain approach) can be adapted for exceptional risk management. The specific problem I address is the growing threat of Hurricanes, and how one can use the value chain approach to design a new financial product to address this puzzle. The **'Building Block'** approach, which is a portfolio approach of value chain incentives, could be the harbinger for the development of an economic-theory-aided security to promote Mitigation.

1. Analyzing the Vicious Cycle of Mitigation:

   - Institutional barriers to Mitigation results in piece-meal approach; inadequate reduction in premiums to be effective.
   - Individual barriers to Mitigation: *Psychological-Inertia
     *Moral Hazard and Financial Indolence
     *Manna Mentality and Free Rider problem
     Limit participation in mitigation or insurance.
   - Prior Literature work (Kunreuther [4] and other survey works detail this phenomenon.)

   Further analyzing the mitigation approaches in other product segments of Insurance I observe that these are:

1. Isolated, Sequestered, Small-scale Piece-meal incentive approach to Mitigation.
2. For example, in Auto Insurance mitigation through seatbelts, airbags, alarms, accidents which are isolated and small.
3. In residential homes, protection against thefts and Fire: Alarms and Sprinklers are small.
4. In life insurance premiums reductions for non-smokers, gender, age, occupation differ.
5. Generally, the impact on mitigation through Insurance alone is negligible.

1. Current Status of Hurricane Mitigation: Incentives and Disincentives

   The incentives and disincentives inherent in the State of Florida insurance market are critically reviewed. Several issues such as the rate hikes: from post Hurricane Andrew to 2024, and the Institutional and Legislative developments the Government's Strategic Commitment for price stabilization, and the Imposition of Penalties and Constraints are reviewed.

2. Overcoming Winner's Curse: Value Chain Approach

   The Mitigating Homeowners face a winner's curse. In the current institutional framework, they incur a substantial up-front cost to mitigate; If the extreme event or catastrophe does not occur, they lose. And if a catastrophe does occur, their loss is minimized, but the non-mitigating homeowners are not penalized. Individuals need to overcome the free riders, moral hazard, cash flow constraints. Two problems to overcome are the asymmetric information problem and the contingent claim threat to institutions and Government.

   What is needed is an innovative product with a collateral function of correcting critical incentive distortions? The new product should use the existing stakeholders, channels, and using synergy-enabled strategic value gains for synthesizing and

distributing for the mitigating homeowners. This has become possible now due to the advent of the internet which leads to declines in transactions costs, timely, low-cost information dissemination and leveling the information field.

3. A Value-Chain approach by all Stakeholders

    - Participation of all stakeholders: Identification of the Stakeholders (See Appendix 1): Co-opetition from stakeholders instead of competition.
    - Florida team's Incentives and Discussion of the 10 Incentives (See Appendix 2)

    There were three inherent challenges in converting the ad hoc' recommendations of the Homeowner Incentive Team committee into a prescription for action, and legislative policy. The first major challenge is that the recommendations of the team trade association's representatives were disconnected, piece-meal and unstructured and non-integrated with the other recommendations. While they are important incentives, as a separate entity they would have an insignificant impact on an individual's incentive to initiate Mitigation. They had to be woven into a complete "Mitigation" package to be meaningful for legislative impact. There have been attempts in the previous Florida legislative sessions to introduce mitigation benefits for individual incentives. (For example, the Florida Senate [1999] Bill 0122 for tax-exemption for shutter discounts installation, and 0124 [29-327-99] to current day high-impact resistant door and windows and premier roofs which attempt to give exemption to homeowners from taxation for general Mitigation improvements. But the legislative groups, and consumers felt a comprehensive, overall package was preferable to such separate ones.

    Secondly, while the varied stakeholder associations and organizations through their representatives have made recommendations, we have to ensure that individual corporations and entities are willing to develop the incentive package and integrate them in their operation and pass on the mitigation benefits. Thirdly, we needed strong research support into the cost/benefit analysis of the impact of the incentives for ensuring legislative support.

4. Financial Innovation: Design of "Safeguarded Home Incentive Plan" SHIP Instrument

    This design of security encompasses a complex series of events that need to be orchestrated. The cost savings projections of this paper imply that the convergence of stake holders' interest and new information technologies for securities design and development are simply more efficient in achieving Mitigation than the historical practices.

In a rare feat, SHIP security embodies a technological innovation that develops a delicate balance between public and private interests that enhances overall global wealth and achieves optimal resource allocation decisions for the economy at large.

To meet the challenge of developing a comprehensive package, we employ a value chain approach. The value chain approach, very popular in the "Information Systems" literature, enables us to aggregate contemporaneously and structure all the incentives into a complete Mitigation package and offer it as a "one-stop-shop" for the ultimate consumer. In a sense, it is like the 'design of a new security'. By buying this security, the individual can get all the benefits of Mitigation and the package with the enhancements, and underwriting is designed in such a fashion that it makes it a compelling purchase.

Some assumptions in the design of this "**SHIP** instrument."

1. First, we refrain from calling it a Mitigation Package. Psychological research has shown that the word 'Mitigation' has a negative connotation in consumer's mind, such as Litigation. Hence, we call this package, "**Safeguarded Home Incentive Package [SHIP**] instrument."
2. Given that on average, counties in Florida initiate only 2% new construction, it would take 50 years for all the new houses to be protected against the perils, this SHIP is offered both the new houses as well as existing retrofits.

VALUE CHAIN DIAGRAMS DETAILED
See Appendix 3.

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5. Efficacy of the SHIP Configuration:

Several state governments such as the Governments of North and South Carolinas, Florida and Texas have been concerned about this problem. The state of Florida for example set us up a study group Homeowner's Incentive Team (HIT) under the supervision of the Department of Community Affairs to address the issue of Mitigating against Hurricane risks and to develop a set of mitigation incentives for the Florida Homeowners. In prior years, the representatives of the following associations and organizations listed in Appendix 1 were invited to participate in the development of a comprehensive set of benefits for homeowners that will induce them to build or retrofit their homes that will be safer and more resistant to damage from hurricanes. The incentive proposals outlined in Appendix 2 have been developed by this group of stakeholders and were recommended for implementation as the impediments are overcome.

The State of Florida can design a new “Safeguarded Homes Incentive Package” such that Mitigation is offered at a ZERO cost to the individual homeowners. By proper configuration, design of the SHIP instrument, and with underwriting by the State and Enhancements by other agencies, the individual homeowner who mitigates and achieves the “SEAL OF APPROVAL” for mitigation, would do so at zero cost. This is accomplished by unbundling the value through the chain.

Hence by designing the instrument in such a fashion as to be of "zero-cost' to the individual the State can accomplish a very rare feat of breaking the psychological and financial barrier and motivating the individual homeowner to mitigate and retrofit. To evaluate the probability of success in overcoming impediments and implementing the SHIP design, four major assumptions have been made. These assumptions are critical to success, and the lack of anyone would lower the outlook on all the proposed incentives:

a. The State government strongly supports the concept of incentives to induce homeowners to strengthen their homes against hurricanes and will take the lead in whatever measures are necessary to implement the incentives, including a vigorous, sustaining public education, and advertising program.
b. Definition of the specific details of features and products that constitute a strengthened or mitigated home will be established and endorsed by the State in concurrence with other stakeholders. The definition will include minimum acceptable standards and some form of product approval.
c. A dependable system of certification that mitigation features have been installed or incorporated in mitigated homes will be established by the State, and inspectors will receive the necessary education and training to perform reliable inspections for the certification program.

Some of the incentive proposals require legislative action. These are Home Loan Interest Rate Reduction, and Sales tax exemption. Property Tax Exemption which also requires a Constitutional Amendment.

2% Solution. All the incentive proposals have applicability to both new construction and retrofit of existing homes. Ease of application is not equal, however, and depending upon the breadth of inclusion of mitigating features and construction techniques that are to be covered by the incentives, some of the proposals may be more easily applied to retrofit projects. One must be careful in restricting the incentives to retrofit projects only, because of the likelihood of deliberate delays in installing features in new homes that could be performed after the initial construction is complete to benefit from the incentives offered. Also, many construction features, such as roof structure connections, end wall bracing, and secondary roofing water barriers, are best and more cheaply installed during construction of the building.

6. Monte Carlo Simulation to Evaluate the Effectiveness of SHIP
   General Information: To establish the parameters for the effectiveness of SHIP security, we do a simulation using the following guidelines and values. The results of simulation are continuing for varied values and reported separately.

MODEL PARAMETERS AND RANGES

Value of Home:	$100,000 to $1,000,000
Average Life of Mitigated / Retrofitted Home:	30 Years
Total and Complete Mitigation/ Retrofit Cost:	7% to 10% of home value
State Sales Tax Exemption:	6% of Mitigation/Retrofit Materials
Builders/Contractors Mitigation/ Retrofit Incentive:	5% of Mitigation/ Retrofit Materials
Insurance Companies Mitigation/ Retrofit Deductions:	20% of Insurance Premium
Bank Rate Buy Down for Mitigation/Retrofits:	1% subsidized Financing, at 8% market rate
County Tax Rate on Mitigation/Retrofit structure:	2% of Retrofit and Mitigation structure

For example, for a typical home in South Florida, the following parameters are used.

ILLUSTRATION 1.

Value of Home: $100,000
Average Life of Mitigated/ Retrofitted Home: 30 Years
Total and Complete Mitigation/ Retrofit Cost: 7% of Home value.
State Sales Tax Exemption: 6% of Mitigation/Retrofit Materials
Builders/Contractors Mitigation/ Retrofit Incentive: 5% of Mitigation/ Retrofit Materials
Insurance Companies Mitigation/ Retrofit Deductions: 20% of Insurance Premium
Bank Rate Buy Down for Mitigation/Retrofits: 1% subsidized Financing, at 8% market rate County Tax Rate on Mitigation/Retrofit structure: 2% of Retrofit and Mitigation structure.

Under these conditions:

1.	Mitigation Cost	= $7,000
2.	State Exemption from Sales Tax	= -$420
3.	Builders/Contractors Discount	= -$350
4.	Amount Financed by Banks	= $6,230
5.	Present Value of Subsidized Bank Financing (7% mortgage versus 8% for	= - $581

30 years valued at 8%:)

6. Insurance Premium Subsidy Present Value (Insurance cost assumed to be 1% of home value; Insurance deductions assumed to be 20%, Benefit Occurring for 30 years; rate increases not included Discounted at 8%.) = - $2,252
7. Present value of County Tax Exemption (County tax exemption, valued for 30 years, tax rate increases not included, Discounted at 8%) (Opportunity Benefit: 2% of 7,000 for 30 years) = - $1,576
8. Federal Tax Exemption for Retrofits/ Mitigation (One time subsidy, valued for 30% tax-payee Similar to Solar Energy Credit) = - $2,100

= - $279.00

NET COST TO THE HOMEOWNER:

This example is an illustration that for a homeowner with the above set of values and variables, Mitigation can be implemented immediately, at no cost to the homeowners. The Paper continues with a comprehensive analysis of the varied parameters and its influence on the overall decision. Other aspects of this green instrument is identified below.

7. Origination and Marketing of 'SHIP'

Who would offer this product? The Financial institution that originates home mortgages. Why? This product's design and offering is highly information-intensive and hence the effective individual synthetic customization of the security, and its institutional adaptation uniquely is suited for an organization with 'institutional memory', continuous access to financial networks, synchronal strategic alliances, and continuing relationship with homeowners, and which can enforce efficient, and perpetual, and cost-less monitoring. (Eccles and Crane). Financial Institutions, in addition to maintaining organized infrastructure such as low-cost direct communication, memory, and data processing capacity have established trust and confidentiality central to the free flow of information which is a major impetus and its efficacious association with homeowners provide them with a steady stream of information which can greatly aid in the shaping, design and transformation of synthetic products and services. The longstanding relationship between the bank and the homeowners can help in bundling SHIP with the existing mortgage loan rather than treating each as an independent, autonomous transaction and achieve economies of scale. Delegating this responsibility to the mortgage originating institution reduces duplication of effort and provides greater pricing flexibility for the institution.

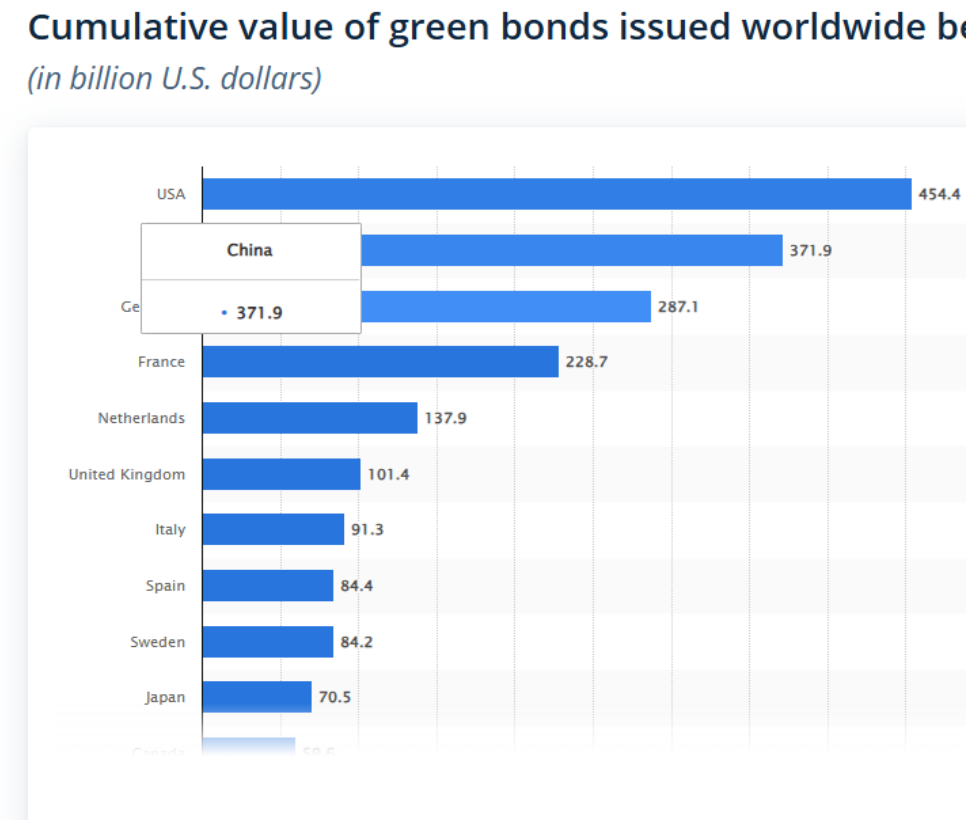
8. Potential Challenges:
Some specific issues in the design of this SHIP Security which are beyond the scope of this paper and hence not addressed include designing to satisfy the regulatory

(SEC) demands for full and complete disclosure of information; the due diligence effort required for registration of the offering and modalities and methods for marketing and promotion of this (Seminars, Road presentations). The design of new securities immensely benefits from day-to-day client interaction and experimentation and typically have high development costs. When such a security issue is contemplated, then ideally an investment banking firm can help with such developments.

Growing Popularity of GREEN SECURITIES

Several initiatives have been launched globally to redirect assets toward green investments. For example, historically, by signing the Montreal Carbon Pledge, more than 120 investors with assets under management worth more than USD 10 trillion had committed to supporting the development of the green bond market and to measuring and publishing the carbon footprint of their investments (Zerbib, 2019).

Between 2014 and 2023, the United States was the leading country in terms of issuance of green bonds, with 454 billion U.S. dollars. China was second in the ranking, followed by Germany. While France ranked fourth number and supranational green bonds value was the fifth highest. The graph below details the participation of various countries.



PART C

Overcoming Individual Psychological Barriers

Natural catastrophes are becoming more common and more expensive, but human and financial losses can be greatly reduced through incentives to purchase insurance and install protective measures. Extensive work in this area has been done by Wharton Professor Kunreuther et al. (2009, 2011), and Katherine R. Wagner (2020) Stanford University.

Kunreuther (2009) summarizes the behavioral challenges in buying Disaster Insurance:

- People don't realize or assess the risk correctly.
- Don't understand Insurance.
- Not motivated to buy a product they may never use.
- Unwilling or unable to invest upfront cost.
- Free-Rider Problem

Wagner (2020) while examining why reforming natural disaster insurance markets so hard concludes:

- While policies related to natural disaster insurance are evolving, reform is not straightforward. There is a gap.
- Homeowners may not buy natural disaster insurance if their perception of risk does not match reality, and insurers may be reluctant to sell insurance if they cannot also insure themselves in capital markets.
- A single natural disaster could bankrupt insurance companies and devastate homeowners without insurance.
- New policies should reflect the challenges that these infrequent, spatially correlated, and catastrophic disasters create.

Behavioral Obstacles in Implementing Mitigation? *Personality Characteristics*

An analysis of the behavioral psychology and personality characteristics of individuals mitigating shows while 80% of the vulnerable population is in favor of disaster mitigation against extreme events:

- 10% of the population will carry out Mitigation regardless of the circumstances.
- 80% of the population will Mitigate given certain conditions and incentives.
- 10% of the population will Not Mitigate under any circumstances.

Overcoming Psychological barriers to Mitigation.

Two Schools of Thought have evolved in Insurance risk mitigation which can be classified as Positive Versus Normative Behavior:
Governments and Institutions strongly advocate Mitigation to reduce loss of life and property. The basic goal of mitigation is to reduce the cost of coastal hazards and natural disasters to minimize the hardships to population, regions, and governments (Federal, State, and Local). While the governments have been primarily assuming the risk of uninsured loss and recovery from catastrophic events, this burden is dramatically going to escalate in the future. Recent developments by many insurance companies to curtail benefits and coverage for the insured, as well as de-aggregation of cross product and cross regional subsidies and coverage (Endnote 4) increase the exposure of other entities. A multi-prong approach of risk reduction, risk transference, risk elimination with active, and willing participation of all the stake holders is a requisite to minimize the risk of natural disasters. Better forecasting models, and enhanced awareness may increase the speed of response and minimize hurricane losses. Risk transference mechanisms such as relocating high risk infrastructure or avoiding future construction in vulnerable locations will lead to minimizing damages. While the total elimination of hurricane risk is optimal, with the state of current technology we cannot accomplish this. Hence the focus is on Risk Mitigation.

However, the individual households do not mitigate. Why? First, it is an expensive proposition imposing on the individual a significant cash flow burden. Secondly the anticipated benefits are predicated upon a major catastrophe with a low probability occurring at an unforeseen time in future. This creates a 'moral hazard' situation for the homeowner. If Mitigation or retrofit is undertaken, substantial financial cost is immediately incurred necessitating a cash out flow. The benefits or advantage occur only if the property is significantly damaged or destroyed by Hurricanes, the probability of which is low. The property owner who spends significantly, therefore, is worse off than neighbors who did not do Mitigation or retrofit if the property experiences no Hurricanes. Also, the current institutional system has an indifferent approach to Mitigation. Potential assistance from Federal agencies such as FEMA and other aid agencies adds to the 'free rider problem' and promotes a climate of disincentive to mitigate. Prior studies, demonstrates that Mitigation or

purchase of insurance may not prove to be financially sound proposition for the individual if they anticipate a bail out by other entities. Additional compounding issues include the rapid urbanization and coastal counties development as well as the non-conformity or deemphasizing of building codes due to rapid development.

Erwann Michel-Kerjan et al. (2011) document the Free Rider Problem and discuss its implications in depth.

For example, the study provide details of federal aid as percentage of total disaster losses which potentially could disincentive mitigation efforts and purchase of insurance against disasters.

Federal aid as Disaster % of total damage	
Hurricane Ike (2008)	69%
Hurricane Katrina (2005)	50%
Hurricane Hugo (1989)	23%
Hurricane Diane (1955)	6%

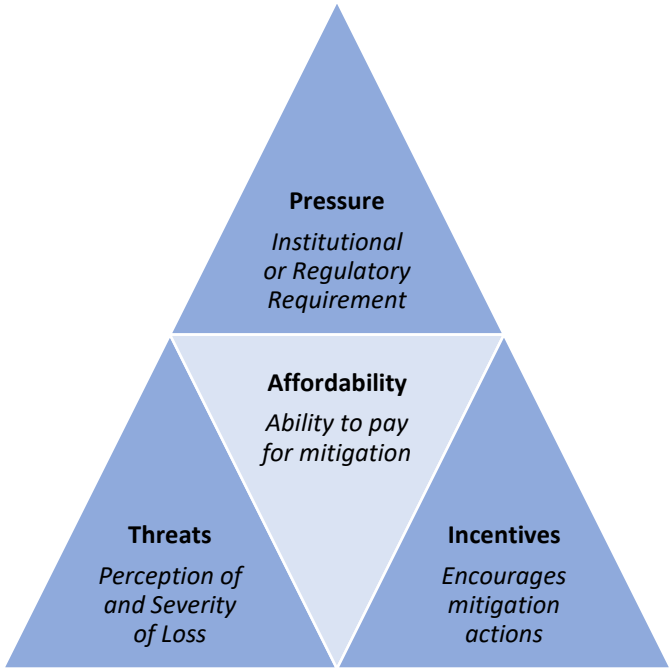
Additionally related question for the insurance companies, is whether the Insurance companies survive a 100-year, $200 billion storm? The pragmatic recognition is that if individuals do not institute Mitigation measures and insurance cost escalates after disaster, the societal risk increase over time and this problem in a macro sense has remained largely unaddressed and ignored.

Successful and Ineffective Mitigation Practices

Mitigation when not mandated may be ineffective and not successful.

Four-Factor Model: Motivation alone is insufficient; incentives are necessary to encourage action.

Example: In the USA, car insurance serves as a model where mandatory requirements, combined with incentives like premium discounts for safe driving, successfully promote risk mitigation.



PART D

Enhancing Global Macro Capacity – Sovereign Pool and Employer Based Insurance

The question of whether insurance companies globally can pay the losses has attracted considerable interest in literature. Cummins, Doherty, and Lo (JBF, 2002)'s work presents a theoretical and empirical analysis of the US property-liability insurance to finance catastrophic property losses in the $100 billion dollar range. Estimating the capacity using insurer financial statement data, they find that the industry could adequately fund a $100 billion event in early 2000's. However, they conclude that such an event would cause numerous insolvencies and severely destabilize insurance markets.

Since then, there has been numerous extreme events in the last two decades. The U.S. has sustained 403 weather and climate disasters since 1980 where overall damages/costs reached or exceeded $1 billion (including CPI adjustment to 2024). The total cost of these 403 events exceeds $2.915 trillion in 2023 dollars. The U.S. losses from billion-dollar disasters over the last seven years (2015-2022) alone are more than $1 trillion and have further skewed the total distribution of extreme weather costs. From 1980-2000, about 75% of all disaster-related costs were due to billion-dollar disasters, and by 2010, the percentage had risen to about 80%. By 2022, it has risen to 85% of all disaster-related costs, or $2.475 trillion out of $2.850 trillion. (Endnote 7)

What is the funding and underwriting capacity? In 2022, the assets of insurance companies globally amounted to approximately 35.7 trillion U.S. dollars - a decrease of almost five trillion U.S. dollars from the previous year. (Endnote 8).

Insurance is big business, and it's one of the most powerful industries shaping action on climate change. The global insurance sector premiums topped $5 trillion in 2021, according to Research and Markets, which is comparable to the entire annual US federal budget. The most relevant form of climate-related insurance is property and casualty, which covers homes, cars, and personal belongings. For example, in 2020, this segment collected $1.6 trillion in premiums, or payments from the policyholders who buy insurance. (Endnote 9).

Figures 3, 4, 5, 6 and 7 detail the actual costs of extreme events for the two major regions of the world – USA and Europe.

Sovereign Risk Pools

Globally to expand underwriting capacity many low-income nations are exploring sovereign risk pools. A sovereign risk pool is an insurance instrument that covers multiple countries. Member countries share risks by paying premiums to the same 'pool' and receive payouts after disasters. Sovereign risk pools work according to the same principle as catastrophe bonds: by spreading the risks farther, they become more manageable. In this case, the risks each country faces are too significant for an individual country to manage. But when the countries share resources, they can

cover their losses. Through the risk pool, members can obtain higher quality insurance for a lower cost due to cross-subsidy. Diversifying risks lowers premiums and allows for shared operational costs, while scaling up gives members access to the international reinsurance market. There are three main sovereign risk pools: the African Risk Capacity in West Africa, Pacific Catastrophe Risk Assessment and Financing Initiative, and the Caribbean Catastrophe Risk Insurance Facility. Risk pools can also be implemented at the subnational level also. Sovereign risk pools require significant political commitment from member countries and must be expertly designed to be financially sustainable, but when implemented effectively, they can be mutually beneficial for all members. (Endnote 11, Beatrix Scolari and Maria Pfister (2018)),

Expanding Global Reinsurance Capacity

Historically, Reinsurance has played a crucial role globally for protecting against extreme events. Although estimates vary, a substantial gap exists between the existing reinsurance coverage and a catastrophic loss exceeding the $15–20 billion range. For example, Swiss Re (1998) estimated that reinsurers would pay 39% of a once-in-a-century catastrophe loss in the United States, such as a $56 billion hurricane or a $65 billion earthquake in California. The Swiss Re study estimated there was a worldwide total of $53 billion in catastrophe excess-of-loss reinsurance in place in 1997. Cummins and Weiss (2000) document that the reinsurance industry could have funded $60 billion of a $100 billion above-expected loss.

According to 2014 data, the total reinsurance capital is about $575 billion ($660 billion, 2021), including $62 billion in ILS capacity other than traditional reinsurance. Alternative capacity (ILS) includes collateral reinsurance, sidecar, industry loss warranty (ILW), and CAT bonds. As complements to reinsurance, they represented about 10% of the global catastrophe reinsurance capital in 2014 (250-year occurrence). Dionne et al. (2022) think there is sufficient capacity because annual average long-run catastrophe losses are around $150 billion, but there have been significant recent exceptions: in 2011 ($375 billion), 2017 ($340 billion), and 2021 ($343 billion). They show that the US insurance industry's capacity to pay catastrophe losses is higher in 2020 than it was in 1997. Insurers could pay 98% of a $200 billion loss in 2020, compared to 81% in 1997.

The Reinsurers have experienced poor profitability in their Florida programs in recent years, because of a combination of high catastrophe losses and claims litigation costs significantly above the US average. A number of reinsurers have reduced their exposure to the Florida market over the past few years, by writing less coverage, increasing the minimum dollar amount of damages that primary insurance must cover before reinsurance will apply, and increasing their own retro coverage.

State-run Citizens Property Insurance Corporation — created by the Florida legislature in 2002 — is the insurer of last resort for property owners who cannot find coverage in the private insurance market. Citizens is among the largest property insurers in the state, averaging an 11% market share of Florida homeowners' premiums since the nonprofit's inception. (Moody's Endnote 10).

Similar situation is fast developing in California due to fire hazard in 2025 questioning the viability of the State's Insurance of the last resort company.

New Enhanced Evolving Models of Insurance.

Enhancing Sovereign Macro Capacity of global nation by cooperative ventures and other new insurance models are identified below. A detailed discussion of these models and their limitations are outlined in Carolyn Kousky (2022). I outline the different models and currently exploring how these models and their applications could expand global underwriting capacity.

- Global: Sovereign models by pooling of resources – Caribbean Catastrophe Insurance Facility, multi country risk pools
- National and Local governments – Meso insurance or Aggregator model; parametric insurance, social goals
- Community Based models: China's Employer based fire insurance, Kenya's Employer based renters insurance
- Parametric models [pre-determined amount] and evolving new models [Lemonade],
- Other parametric models : Raincoat, Jumpstart, Storm peace and Fast-track
- Collateralized Reinsurance and Limited Coverage "side-cars"

Conclusions

The current projections are that with the increased frequency and severity of extreme events the current insurance and reinsurance capacity may be inadequate to cover the losses and provide support to communities to recover and rebuild. It is of utmost urgency to identify financial solutions to avoid the problem of non-insurance or limited insurance. Towards this end, I explore four possible solutions to enhance the capacity of insurance companies, re-insurance companies. First, I propose issuance of CoCo bonds. To address the problem of increasing enrollment coverage of uninsured consumers, I explore how we can incentivize the individual and institutions to expand coverage by developing a green security – the SHIP [Safe Home Incentive Program] security and do a cost benefit analysis of this instrument. To overcome the psychological impediments of insuring against extreme events, I will explore whether a mandatory requirement such as automobile insurance would be beneficial. I also explore the evolving new macro models of global nations and local governments. Overall, I conclude that these financial solutions and innovations would help in reducing overall risk and break the vicious cycle for better risk management and loss minimization.

Some relevant background literature

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ENDNOTES

Endnote 1 In 2023, Insured losses in the U.S from natural catastrophes amounted to roughly $80 billion. What makes 2023 an outlier is that most losses resulted from severe convective storms rather than a few isolated large-scale events like hurricanes. Overall, there were 28 catastrophic events in the U.S. that generated at least $1 billion in insured losses in 2023. This is considerably higher than the historical annual average of 8.5 events from 1980-2023. The annual average for the most recent five years is also notably higher at 20.4 events.

Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2024). Accessed from: https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73

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Endnote 10 https://www.moodys.com/web/en/us/about/insights/data-stories/reinsurers-mitigate-lower-profits.html

Endnote 11 See for a detailed discussion: Beatrix Scolari and Maria Pfister (2018), "Fact Sheet: Strengthening Financial Resilience to Climate Change – The Role of Insurance" Environmental and Energy Study Institute, August 31, 2018, Editor: Brian La Shier https://www.eesi.org/papers/view/fact-sheet-strengthening-financial-resilience-to-climate-change

Table One

The top five worst hurricanes in US history

[Endnote 3, Victoria Heath, 2024].

Insurance Payout for Extreme Hurricanes

Hurricane	Year	Cost in Billion
Katrina	2005	$201.5
Harvey	2017	$160.5
Ian	2022	$121.6
Sandy	2012	$89.1
Irma	2017	$64.2

Table Two

Most Insurance Payout for Flood

Insurance Information Institute – 2024

https://www.iii.org/fact-statistic/facts-statistics-flood-insurance

Top 10 Most Significant Flood Events By National Flood Insurance Program Payouts (1)

Rank	Date	Event	Number of paid losses	Amount paid ($ millions) when occurred	Amount paid ($ millions) in 2023 dollars	Average paid loss in 2023 dollars
1	Aug. 2005	Hurricane Katrina	168,200	$16,330	$25,592	$152,152
2	Oct. 2012	Superstorm Sandy	132,800	8,967	11,931	89,842
3	Sep. 2017	Hurricane Harvey	77,100	9,015	11,302	146,589
4	Sep. 2022	Hurricane Ian	48,000	4,300	4,441	92,521
5	Sep. 2008	Hurricane Ike	46,900	2,711	3,814	81,322
6	Aug. 2016	Louisiana severe storms and flooding	27,600	2,522	3,223	116,775
7	Sep. 2004	Hurricane Ivan	31,000	1,671	2,709	87,387
8	May 2001	Tropical Storm Allison	62,200	1,110	1,919	30,852
9	Aug. 2011	Hurricane Irene	43,800	1,344	1,826	41,689
10	Apr. 2017	Hurricane Irma	22,300	1,094	1,365	61,211

(1) Includes events from 1978 to December 31, 2023 as of January 2024. Defined by the National Flood Insurance Program as an event that produces at least 1,500 paid losses. Ranked on Amount Paid in 2023 dollars.

Source: https://content.naic.org/sites/default/files/2023-annual-property-and-casualty-insurance-industries-analysis-report.pdf

Table Three

US Property and Casualty Insurance Financial Results over time

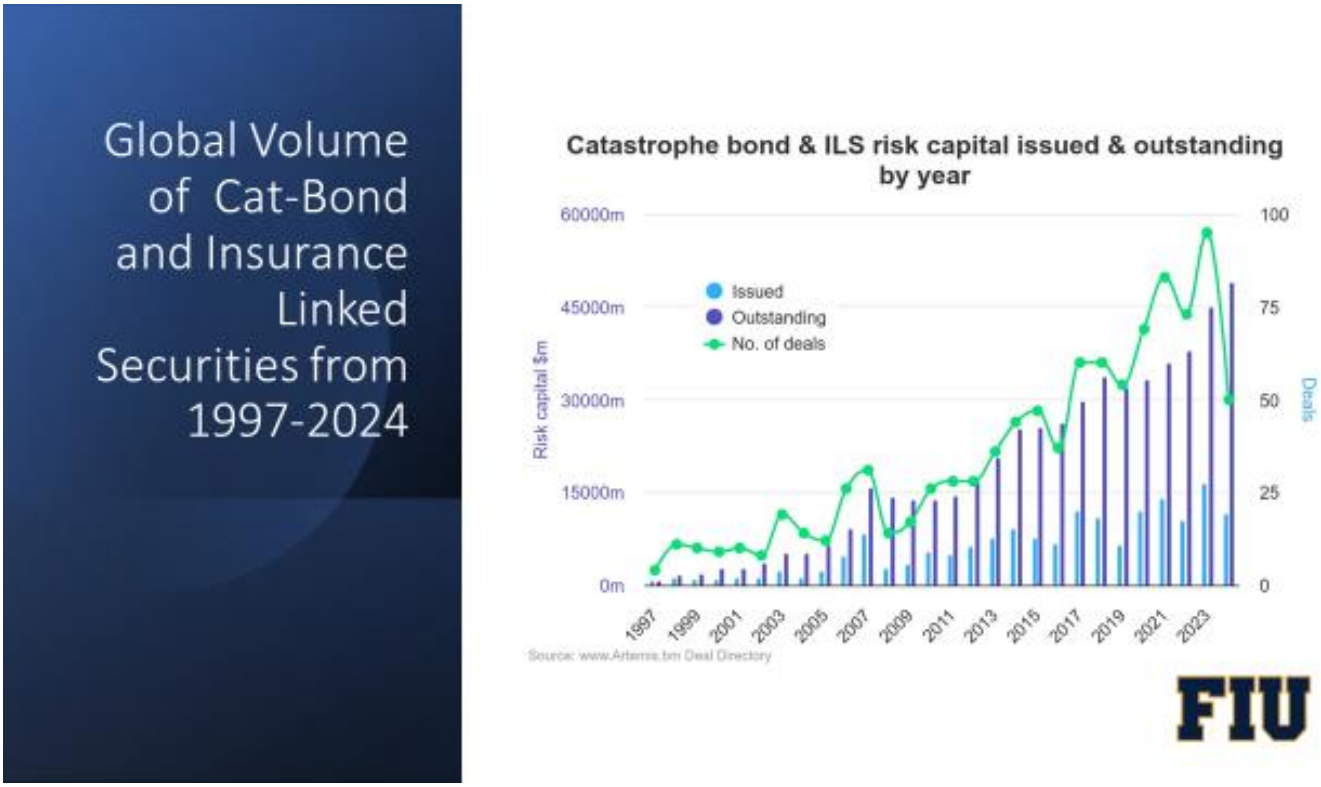
U.S. Property and Casualty Insurance Industry Results (in millions, except for percent)

For the year ended December 31,	YoY Chg	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014
Net Premiums Written	10.0%	859,850	781,750	719,927	658,910	642,980	621,786	561,952	537,926	524,006	506,657
Net Premiums Earned	9.4%	823,435	752,690	693,776	646,010	630,772	603,188	549,958	533,236	515,835	497,931
Net Losses Incurred	9.3%	546,228	499,631	432,600	383,305	378,581	366,258	353,954	323,195	296,749	284,934
Loss Expenses Incurred	7.7%	81,253	75,464	70,653	69,885	69,242	64,658	65,218	61,829	60,932	58,706
Underwriting Expenses	6.5%	213,792	200,677	189,526	179,963	173,054	168,228	151,672	148,692	145,753	139,846
Underwrting Gain (Loss)	25.5%	(18,443)	(24,746)	(111)	12,104	8,374	2,907	(22,459)	(1,700)	11,453	14,658
Net Loss Ratio	(0.2) pts	76.2%	76.4%	72.5%	70.2%	71.0%	71.4%	76.2%	72.2%	69.3%	69.0%
Expense Ratio	(0.8) pts	24.9%	25.7%	26.3%	27.3%	26.9%	27.1%	27.0%	27.6%	27.8%	27.6%
Combined Ratio	(1.0) pts	101.5%	102.5%	99.6%	98.7%	98.7%	99.1%	103.9%	100.5%	97.8%	97.3%
1yr Rsrv Devlp/PY PHS	0.5 pts	-	(0.5%)	(0.7%)	(0.8%)	(0.8%)	(1.6%)	(1.4%)	(0.7%)	(1.2%)	(1.4%)
Net Invmnt. Inc. Earned	0.9%	70,076	69,467	52,935	51,596	55,132	53,287	48,978	45,539	47,228	46,401
Net Realized Gains (Loss)	3,054.6%	50,404	1,598	18,204	11,064	11,259	10,885	19,833	8,747	10,285	12,006
Net Invmnt. Gain (Loss)	69.5%	120,479	71,064	71,139	62,660	66,391	64,172	68,812	54,286	57,513	58,407
Investment Yield	(0.03) pts	3.20%	3.23%	2.58%	2.75%	3.02%	3.06%	3.08%	3.01%	3.18%	3.17%
Total Other Income	(99.8%)	5	1,979	3,514	1,034	1,284	1,530	(4,687)	950	1,475	(2,908)
Net Income[1]	126.0%	87,567	38,745	60,453	59,198	62,233	57,565	38,717	42,860	56,884	56,439
Return on Revenue	4.6 pts	9.3%	4.7%	7.9%	8.4%	8.9%	8.6%	6.3%	7.3%	9.9%	10.1%
December 31,	YoY Chg	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014
Policyholders' Surplus[2]	6.2%	1,062,988	1,000,893	1,077,866	955,136	891,214	779,921	786,016	734,026	705,948	706,740
Return on Surplus	4.8 pts	8.5%	3.7%	5.9%	6.4%	7.4%	7.4%	5.1%	6.0%	8.1%	8.1%

1. Excludes investment income from affiliates. 2. Adjusted to eliminate stacking

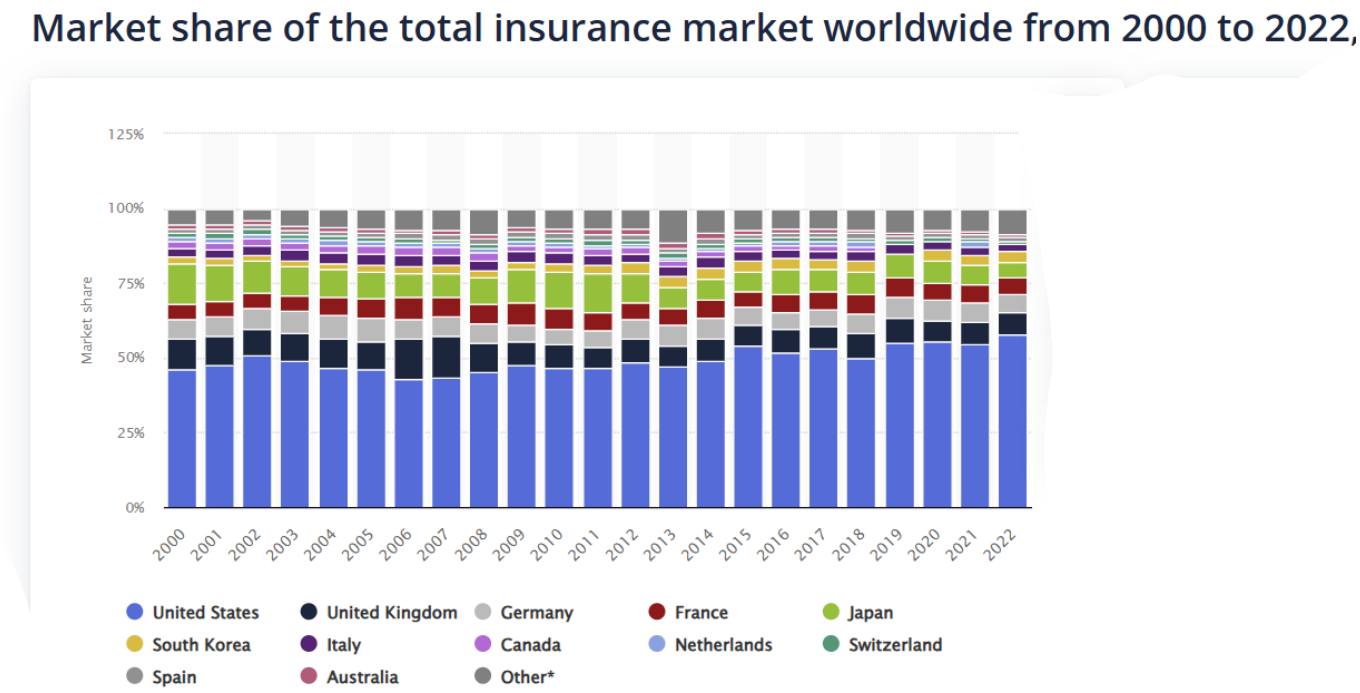
Source: https://content.naic.org/sites/default/files/2023-annual-property-and-casualty-insurance-industries-analysis-report.pdf

Figure ONE



Source: https://www.statista.com/statistics/1045207/market-share-of-insurance-worldwide-by-country/#:~:text=Market%20share%20of%20the%20total,worldwide%202000%2D2022%2C%20by%20country&text=Between%202000%20and%202022%2C%20the,entire%20insurance%20market%20in%202022.

Figure TWO



The total Market share of the total insurance market worldwide 2000-2022, by country. Between 2000 and 2022, the United States has consistently held the largest share of the insurance market globally. Alone, the U.S. made up almost 58 percent of the entire insurance market in 2022. Jan 17, 2025.

Figure THREE

Global Volume of Cat- Bond and Insurance Linked Securities from 1997-2024

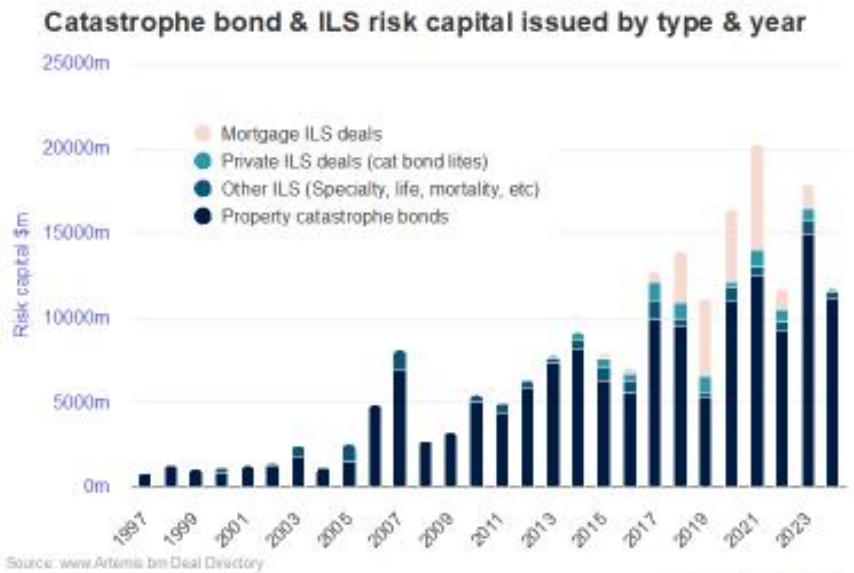


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Figure FOUR

CPI-Adjusted | Unadjusted

Billion-dollar events to affect the United States from 1980 to 2024 (CPI-Adjusted)

Disaster Type	Events	Events/ Year	Percent Frequency	Total Costs	Percent of Total Costs	Cost/ Event	Cost/ Year	Deaths	Deaths/ Year
Drought	32	0.7	7.9%	$367.5B CI	12.6%	$11.5B	$8.2B	4,658†	104†
Flooding	45	1.0	11.2%	$203.0B CI	7.0%	$4.5B	$4.5B	742	16
Freeze	9	0.2	2.2%	$37.4B CI	1.3%	$4.2B	$0.8B	162	4
Severe Storm	203	4.5	50.4%	$514.3B CI	17.6%	$2.5B	$11.4B	2,145	48
Tropical Cyclone	67	1.5	16.6%	$1,543.2B CI	52.9%	$23.0B	$34.3B	7,211	160
Wildfire	23	0.5	5.7%	$147.9B CI	5.1%	$6.4B	$3.3B	537	12
Winter Storm	24	0.5	6.0%	$104.2B CI	3.6%	$4.3B	$2.3B	1,463	33
All Disasters	**403**	**9.0**	**100.0%**	**$2,917.5B CI**	**100.0%**	**$7.2B**	**$64.8B**	**16,918**	**376**

†*Deaths associated with drought are the result of heat waves. (Not all droughts are accompanied by extreme heat waves.)*

Flooding events (river basin or urban flooding from excessive rainfall) are separate from inland flood damage caused by tropical cyclone events.

The confidence interval (CI) probabilities (75%, 90% and 95%) represent the uncertainty associated with the disaster cost estimates. Monte Carlo simulations were used to produce upper and lower bounds at these confidence levels (Smith and Matthews, 2015).

Figure FIVE

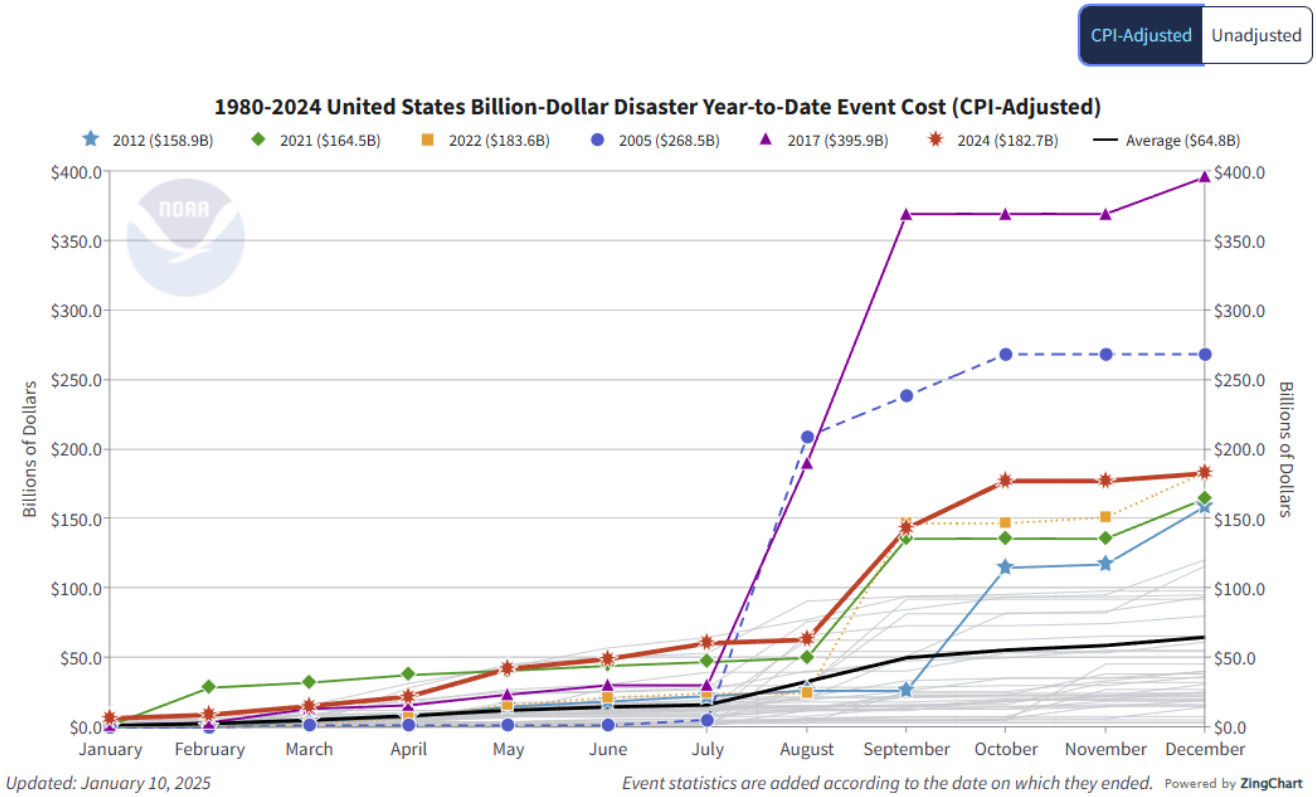
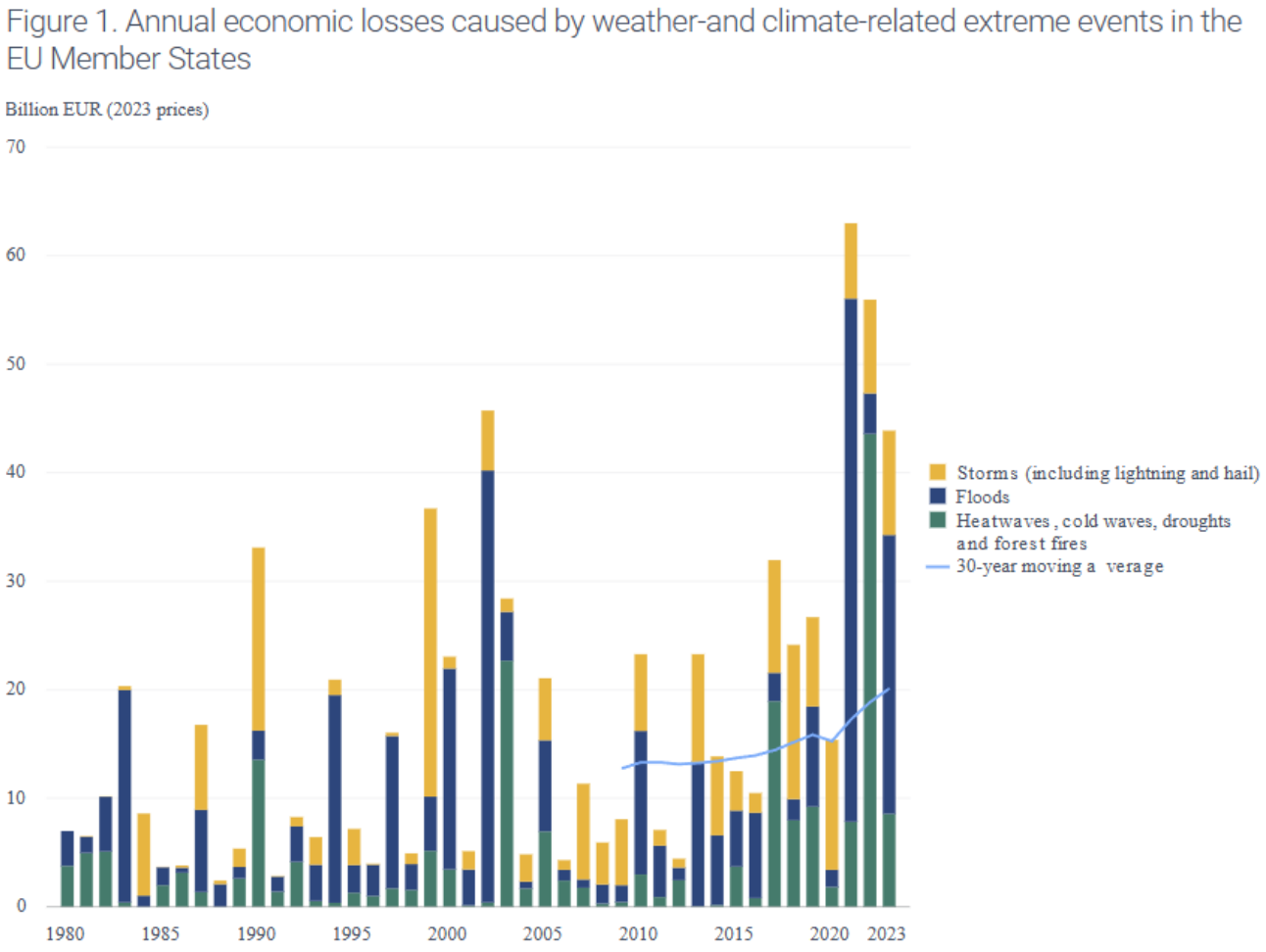

CPI-Adjusted
Unadjusted
1980-2024 United States Billion-Dollar Disaster Year-to-Date Event Cost (CPI-Adjusted)
2012 ($158.9B)
2021 ($164.5B)
2022 ($183.6B)
2005 ($268.5B)
2017 ($395.9B)
2024 ($182.7B)
Average ($64.8B)
$400.0
$350.0
$300.0
$250.0
$200.0
$150.0
$100.0
$50.0
$0.0
Billions of Dollars
January
February
March
April
May
June
July
August
September
October
November
December
Updated: January 10, 2025
Event statistics are added according to the date on which they ended.
Powered by ZingChart

Figure SIX

Weather- and climate-related extremes caused economic losses of assets estimated at EUR 738 billion during 1980 - 2023 in the European Union,



https://www.eea.europa.eu/en/analysis/indicators/economic-losses-from-climate-related#:~:text=Relatively%20few%20events%20are%20responsible,events%20cause%2028%25%20of%20losses.

Figure SEVEN

Figure 2. Economic losses and fatalities caused by weather - and climate - related extreme events (1980-2023) - per country

Country	Total losses (Million EURO)	Loss per sq.km (EURO)	Losses per capita (EURO)	Insured losses (Million EURO)	Insured losses (%)	Fatalities
Austria	14726	175564	1806	2786	19	771
Belgium	16988	553942	1612	6679	39	4693
Bulgaria	5168	46564	650	93	2	265
Croatia	4154	73402	943	101	2	910
Cyprus	441	47626	618	8	2	68
Czechia	18533	234974	1783	2168	12	716
Denmark	8751	203867	1618	5443	62	533
Estonia	332	7333	236	51	15	5
Finland	2380	7034	457	73	3	7
France	129897	203449	2092	46052	35	50461
Germany	180372	504438	2225	54759	30	104544
Greece	16350	124155	1548	849	5	4690
Hungary	10444	112291	1026	587	6	874
Ireland	3955	56542	965	541	14	68
Italy	133934	443373	2311	5916	4	21822
Latvia	1250	19348	544	71	6	88
Lithuania	2283	34976	690	58	3	103
Luxembourg	1262	486143	2694	627	50	170
Malta	51	162361	128	2	4	5
Netherlands	10970	293491	688	4297	39	3918
Poland	20630	66138	545	1379	7	2553
Portugal	16671	180755	1628	578	3	10339
Romania	19628	82335	916	199	1	1445
Slovakia	1956	39893	367	84	4	121
Slovenia	17484	862448	8693	271	2	321
Spain	95966	189662	2258	5243	5	32053
Sweden	3703	8276	406	957	26	44
EU-27	**738280**			**139872**		**241587**
Iceland	26	250	88	0	0	3
Liechtenstein	21	134250	653	10	48	0
Norway	4416	11486	950	3079	70	46
Switzerland	19893	481820	2685	7278	37	2309
Turkey	6896	8837	104	456	7	1855

https://www.eea.europa.eu/en/analysis/indicators/economic-losses-from-climate-related#:~:text=Relatively%20few%20events%20are%20responsible,events%20cause%2028%25%20of%20losses.

Appendix 1
Hurricane Mitigation Participating Organizations

The representatives of the following associations and organizations listed below were invited to participate in the development of a comprehensive set of benefits for homeowners that will induce them to build or retrofit their homes that will be safer and more resistant to damage from hurricanes:

1. Florida Association of AIA
2. Florida Bankers Association
3. Florida Association of Mortgage Brokers
4. Mortgage Bankers Association of Florida
5. Florida Association of Realtors
6. Florida Insurance Council
7. Florida Home Builders Association
8. Florida Building Material Association
9. Florida Electric Power Coordinating Group
10. Florida Municipal Electric Association
11. Florida Association of Property Appraisers
12. Florida Association of Counties
13. Florida League of Cities
14. Florida Chamber of Commerce
15. Florida Department of Insurance
16. Federal Emergency Management Agency
17. Fannie Mae
18. Institute for Business and Home Safety (IBHS)
19. Florida Housing Finance Corporation and
20. Department of Housing and Urban Development.

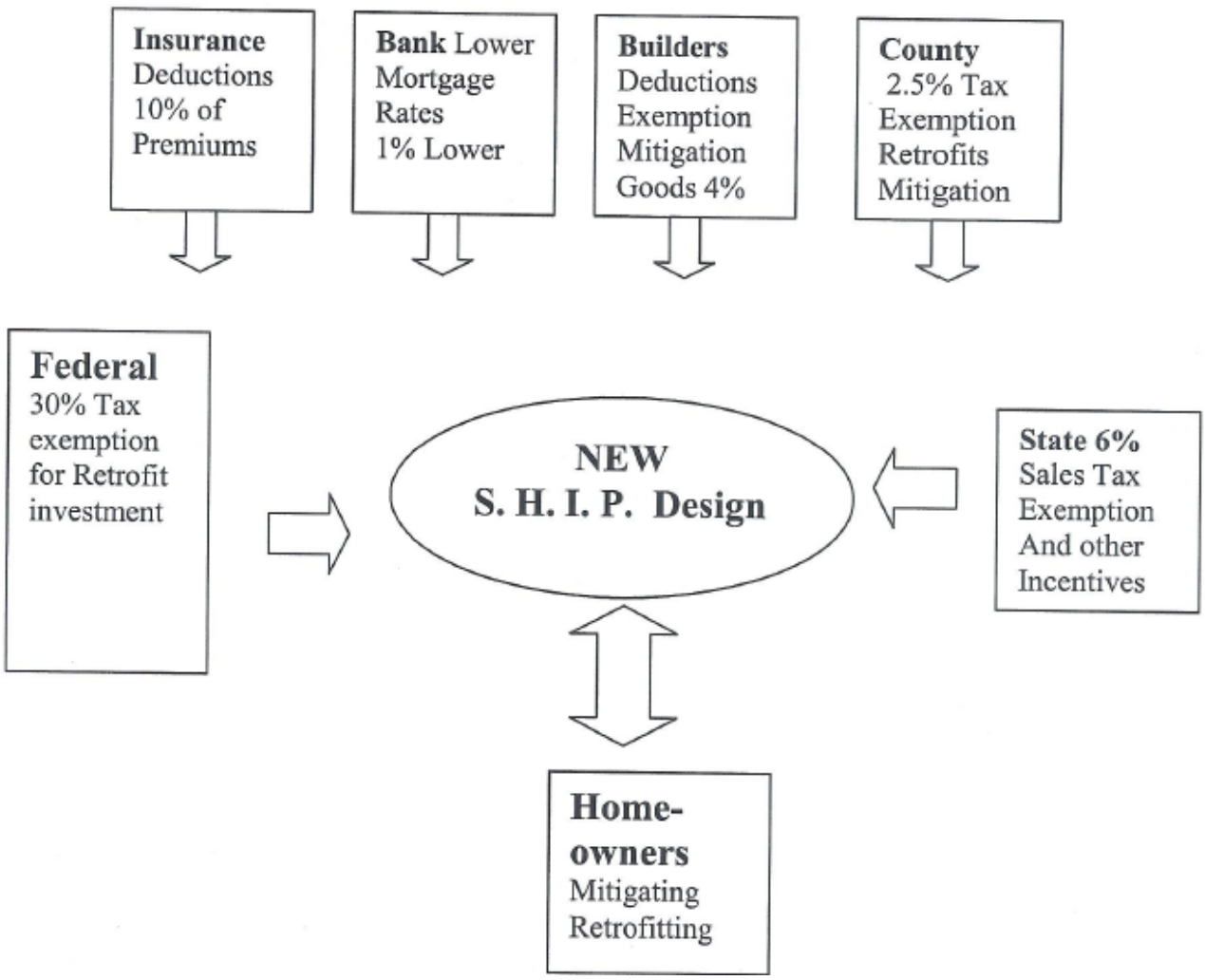
Appendix 2
Piece Meal Incentives for Hurricane Mitigation

The following incentive proposals have been developed by the Florida Department of Community Affair's Homeowner Incentive Team, and were recommended for implementation as the impediments are overcome:

1. Brokerage Fee Reduction
2. Building Material Discounts
3. Building Permit Fee Reduction
4. Employer Assistance to Employees
5. Home Loan Interest Rate Reduction
6. Insurance Reductions
    a. Premium rate reduction
    b. Deductible reduction
7. Property Tax Exemption
8. Sales Tax Exemption
9. Federal Income Tax Reduction

Appendix 3

Developing a GREEN Mitigation Product



VALUE CHAIN APPROACH TO SHIP