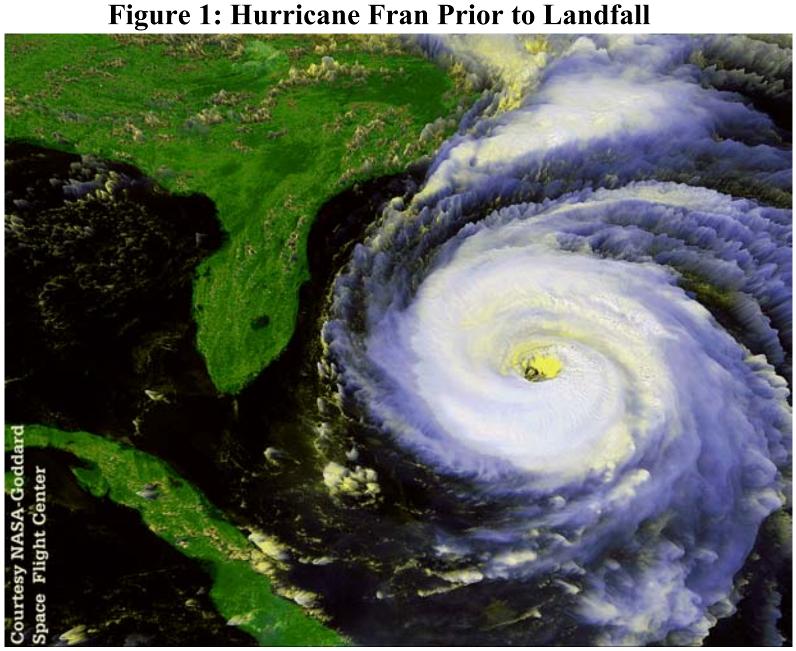
Following Fran:
Hurricane Loss Variation and Hedge Performance

By Bruce B. Thomas and Dr. Xin Cao

Hurricane Fran made landfall east of Cape Fear, North Carolina, at about 8 P.M September 5, 1996 (see Figure 1). Although its top winds quickly dropped from 120 to 100 miles per hour, Fran caused significant property damage in-land as far as Raleigh. Within days, this event was estimated as having caused approximately $1.6 billion dollars of insured losses. This estimate provided a sense of Fran's magnitude and helped put this event in context, but it left many questions unanswered.

More than eighteen months have elapsed and the majority of all the insurance claims relating to Fran have long since been settled, but the insurance industry still does not have a thorough understanding of Fran's impact on the landscape of insured properties. How were these losses distributed geographically and by line of insurance? Did different construction types within the same geographic area experience different damage rates? How much variation in loss experience was there among insurance companies?

Figure 1: Hurricane Fran Prior to Landfall



The GCCI

To help answer these questions, IndexCo, LLC and the Insurance Services Office, Inc.[1] have collected tens of millions of homeowner premium and loss records to calculate the

[1] The authors would like to thank Fred Lloyd and Gena Shangold of the Insurance Services Office for their assistance in gathering the loss data for this study.

Guy Carpenter Catastrophe Index (GCCI or Index)[2] for Hurricane Fran. The GCCI provides detailed information about the insured damage to homeowner properties caused by atmospheric perils such as hurricanes, tornadoes, and other storm activity, and serves as a standardized, objective, and transparent reference basis for financial contracts transferring catastrophe risk.

Constructing the Index for Hurricane Fran provided a wealth of descriptive information, which is useful for benchmarking insurance company loss experience against the industry and for tuning catastrophe models using large amounts of actual loss experience. A second objective was to analyze differences between individual companies' loss experience and the GCCI, which measures the average company's loss experience. By assuming that individual companies had hedged their Hurricane Fran losses using an Index-linked security, we hoped to gain a better understanding of the unexpected variation in hedge performance, i.e. *basis risk*.

Hedgers need to be able to identify and quantify sources of potential basis risk in Index-linked securities before these instruments can gain wide acceptance as vehicles for catastrophe risk transfer. This is the first time that this type of analysis can be performed using a large sample of companies' actual insurance and loss experience[3].

General Methodology

The GCCI is a measure of the average insurance company's damage rate in a given area, i.e. an unweighted average of each sample company's paid losses divided by its insured value within a given ZIP code or collection of ZIP codes[4]. Although the procedures used to calculate the GCCI are described in detail in the Index Manual, two key differences between the methodology employed for this study and that used to calculate the GCCI in 1997 are worth noting.

First, exposure information was gathered by taking the average amounts of insurance in-force (homeowners coverage A) for each of 39 companies during September of 1996, rather than March 1996, in accordance with the normal Index calculation. Second, this study used all losses relating to Fran paid through December 31, 1997, rather than showing accumulated development on a quarterly basis. While not following the Index Methodology precisely, this information provides a good representation of the insurance in-force and the most developed paid loss information for Hurricane Fran.

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[2] The Guy Carpenter Catastrophe Index was published for the first time in August of 1997 by IndexCo, LLC, an affiliate of Guy Carpenter & Company, Inc.

[3] The authors would like to thank John A. Major for his invaluable support and assistance in IndexCo's research efforts. Index Hedge Performance, by John A Major, © 1997, University of Chicago Press, can be found at www.indexco.com.

[4] The Index divides paid homeowner losses with cause of loss codes as "wind," "hail," or "freeze by Coverage A insured values. For a complete description of the Index calculation, please reference the Guy Carpenter Index Manual at www.indexco.com.

Framing Fran
Having calculated the GCCI, we can finally describe Hurricane Fran's impact in detail. By multiplying the GCCI value for a given area by an estimate of total home value in that area, we can estimate the insurance industry's loss for any ZIP code, collection of ZIP codes, states or regions (reference Table 1). One can get an understanding how catastrophic Fran was in North Carolina by putting its $618 million of insured homeowner losses in the context of the $664 million of insurance premiums[5] that were collected during 1996. In addition to losing most of their annual homeowner premiums as a result of this one event, the industry incurred another $735 million of losses in 1996[6] relating to fire, liability, and other homeowner claims.

Table 1: Hurricane Fran Insured Losses

Region	Aggregate Home Value[7] (In Millions)	Hurricane Fran GCCI	Hurricane Fran Insured Losses (In Millions)
28443	$ 177	.044185	$ 7.8
284xx	6,101	.019412	118.4
North Carolina	131,872	.004689	618.4
Southeast	822,441	.000796	654.9
United States[8]	$ 5,938,083	.000112	$ 664.4

While these numbers help describe insured homeowner losses from Fran in a geographical and historical context, the GCCI also details loss experience at a ZIP code level. Figure 2 depicts Hurricane Fran's GCCI values at a ZIP code level.

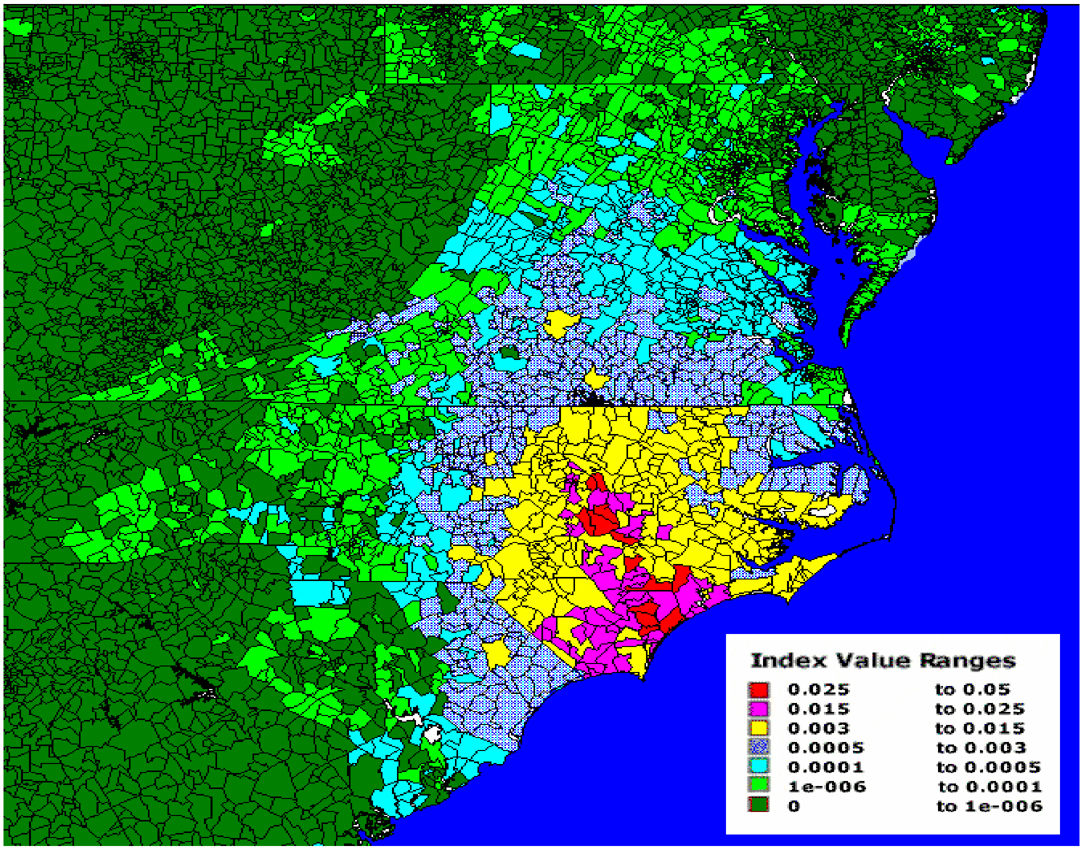
5 Total premiums written for homeowner multiperil policies in North Carolina.

6 Industry premium and loss information was gathered from Best DataBase Services P/C State/Line Report.

7 Aggregate "specified owner-occupied" housing value as supplied by Claritas, Inc.

8 District of Columbia and all United States except Texas.

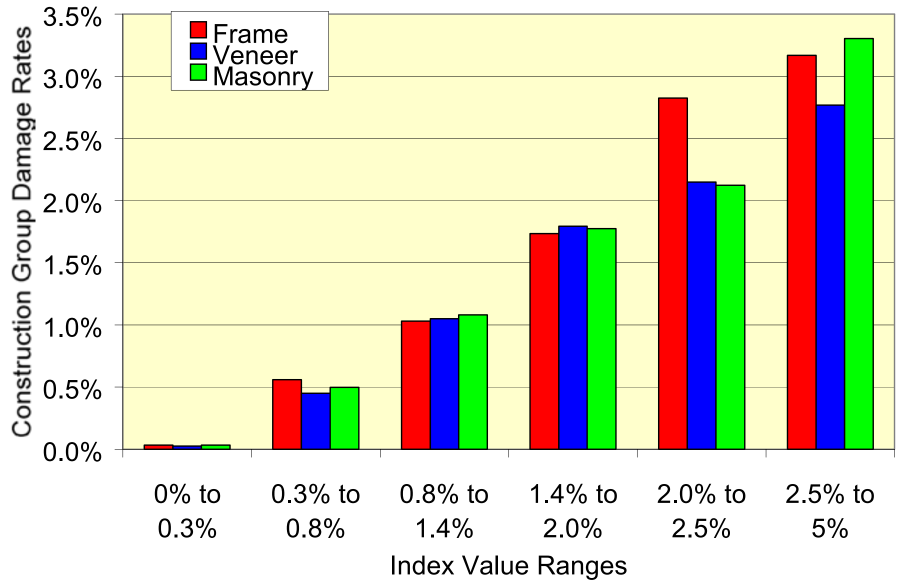
Figure 2. ZIP Code Level Hurricane Fran Damage



This map is striking because it shows that Fran's damage was highly concentrated geographically and yet it was also relatively discontinuous. This would imply that Fran's wind field was not as smooth as generally depicted by most catastrophe models and that adjacent ZIP codes can have significantly different loss experience.

IndexCo also used its database to determine how damage rates for different construction classes changed with increasing levels of loss (Figure 3). While higher wind speeds increased overall loss experience for each construction type, Veneer (brick, stone, or masonry veneer) tended to have somewhat less damage than other construction types across all levels of Hurricane Fran loss experience. Equally interesting is the fact that Masonry homes had the worst loss experience in the areas with the highest damage rates.

Figure 3. Hurricane Fran Damage Rates by Construction Group in North Carolina



Given that this data is from one event only, it is not clear that these differences are statistically significant and one must be careful about generalizing these findings. However, this real world data offers a great opportunity for the industry to validate its current catastrophe models.

Single Company Hedge Analysis

A second part of our work involved analyzing individual company loss variation within North Carolina and its impact on hedge performance. IndexCo had access to individual company information that made-up over 90% of the insurance in-force used to calculate the Fran Index for North Carolina. To determine variation in hedge performance, we assumed that each sample company knew in advance that a Hurricane Fran-type event would happen and had used the Index as the reference basis for a hedge.

Leaving aside issues of availability and cost, we assumed that each sample company had hedged its Fran losses by buying a financial contract that paid an amount equal to the Index Value times its amount of insurance in-force. We considered two different types of hedges. A state hedge was calculated by multiplying a company's amount of insurance in-force in North Carolina by the Fran Index value for North Carolina (see Table 2). A Zip code hedge was determined by multiplying Fran ZIP level Index values times each company's amount of insurance in-force within each ZIP code and summing the products.

Table 2: Company Hedge Basis Risk

		State Hedge		Zip Code Hedge	
Market Share	**Number of Companies**	**Average Basis**	**Standard Deviation**	**Average Basis**	**Standard Deviation**
< 1%	7	136.9%	160.4%	13.8%	12.1%
1% - 3%	5	5.2%	42.4%	-.2%	17.0%
3% - 5%	4	-5.5%	16.7%	-6.4%	10.9%

Table 2 explanation. Basis is the difference between each company's loss and the hedge recovery that they received. Standard deviation is a measurement of variation around the average basis.

This analysis revealed significant variation between a given company or portfolio of loss and the Index for North Carolina. However, a ZIP code hedge would have performed much better for most of the sample companies.

One can think of the difference between the state hedge and the ZIP hedge as a "market penetration variance," given that this variation represents the extent of the mismatch between individual company market penetration and the Index market penetration. As one might expect, this variation was largely a function of company size. The smallest companies in our sample, those with less than one percent market share, had market penetration variances exceeding 100% of the losses they were trying to hedge. However, this variation decreased substantially as company market share increased.

Although this analysis demonstrates that a ZIP level hedge considerably reduces basis risk, the fact that we only have one observation for each of the sample companies reduces the usefulness of these statistics. Thus, we used the Bootstrap resampling method to get a statistically sound evaluation of the efficacy of these two types of hedges.

By random sampling with replacement each company's ZIP level losses 346 times, we created a new distribution of ZIP code loss experience and we determined statewide loss experience by summing these ZIP losses. By repeating this process 500 times for each company, we confirmed that a ZIP code hedge would have performed considerably better than the state hedge for Hurricane Fran. Using this Bootstrap analysis also enabled us to generate correlation coefficients between each company's sample hedge recoveries and its actual loss experience.

Table 3 shows that all of the sample companies were highly correlated with the ZIP level Index. Although the average correlation between company losses and the ZIP hedge was 92%, most of the companies had correlation coefficients in the middle to high ninety percent range. On the other hand, the average correlation between individual company loss experience and a state hedge was only 40%.

Table 3: Correlation of Company Losses to Hedge Recoveries

Company	ZIP Code Hedge	State Hedge
A	99%	69%
B	98%	38%
C	97%	53%
D	97%	48%
E	97%	19%
F	96%	37%
G	96%	79%
H	95%	48%
I	95%	22%
J	92%	41%
K	92%	10%
L	90%	42%
M	90%	15%
N	88%	44%
O	87%	24%
P	62%	52%
Average	**92%**	**40%**

This analysis shows that it is much more efficient to transfer catastrophe risk using a ZIP code hedge than a state hedge. By hedging at a ZIP code level, companies can effectively reduce their market penetration variance to zero, leaving only a relatively small damage rate variance with the Index.

Other Sources of Basis Risk

Despite the use of a ZIP code hedge, there will be some variation between individual company loss experience and the Index. This variation results from:

1. Company differences in construction class, average deductible, and year-of-construction, i.e. an "underwriting factor."
2. Company differences in risk selection or claim payment practices that cannot be explained using the Index data, i.e. a "company factor."
3. Process risk, which is the unpredictable or random component of loss variation.

IndexCo was able to reduce basis risk for individual companies somewhat by taking into account differences in construction class and average deductible between a given company's portfolio of exposures and the Index. Since we did not find large systematic exposure differences between companies or large damage rate variances between construction classes, this result is reasonable.

Similarly, we found some relatively small systematic differences in loss experience among companies from variables exogenous to the Index data that might result from differences in risk selection or claim practices. However, taking these company factors into account was only marginally helpful in diminishing ZIP level hedge basis risk. Although we continue to analyze these effects, we currently believe that most of the basis risk in the ZIP code level hedge of Hurricane Fran resulted from random variation or process risk.

Figure 4. Process Risk Decreases with Higher Damage Rates and More Insured Homes

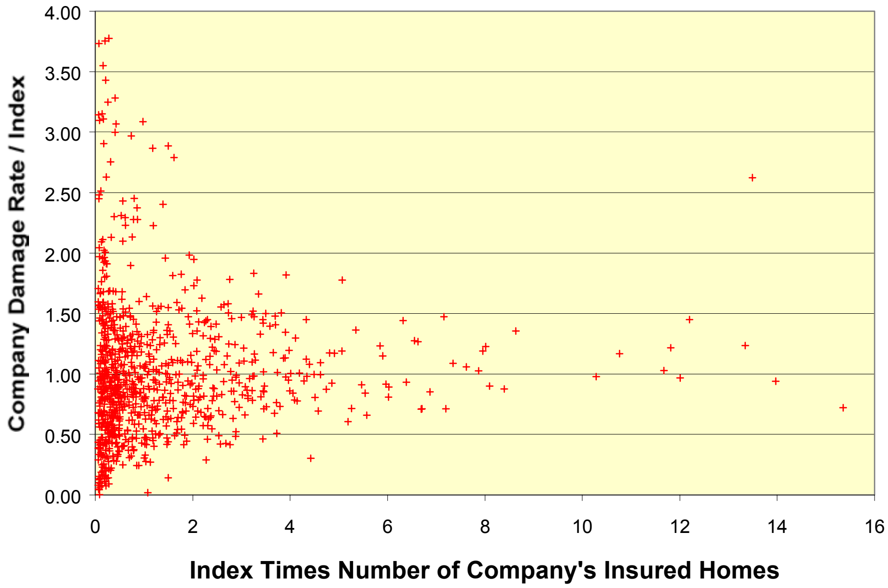


Figure 4 explanation. The vertical axis represents the relationship between each company's damage rate and the Index at a ZIP code level (1.00 represents a perfect relationship). The horizontal axis represents the number of homes an insurer has in a ZIP code multiplied times the Index value (200 homes times a 5.0% Index value would equal a 10 on this scale).

As Figure 4 shows, variation between a company's damage rate and the Index tends to decrease as the company's insured houses and the overall damage rate for a ZIP code increased. The obvious conclusion is that hedgers will experience significantly less process risk in areas where they have many exposures and for very large events. This trend indicates that process risk might be much less for events that are much larger than Hurricane Fran, where insured damage is more significant and more widespread.

Conclusion

Hedging catastrophe risk with a monoline, ZIP code level Index can eliminate much of the basis risk that would otherwise be in Index-linked securities. Despite Hurricane Fran's relatively small size, insurers' loss experience was highly correlated with the Guy Carpenter Catastrophe Index. Furthermore, our work suggests that basis risk will diminish substantially as catastrophic damage increases. This makes the Index an ideal tool for insurers and reinsurers who want to manage high layers of catastrophe risk by buying, selling, and swapping Index-linked securities.

Authors' Note: This article was published in the August 1998 edition of Best's Review as "Deconstructing Fran."