“The Cognition of Catastrophe: Preliminary Examination of an Industry in Transition”

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THE COGNITION OF CATASTROPHE:
PRELIMINARY EXAMINATION OF AN INDUSTRY IN TRANSITION

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Abstract

A set of interviews explored major changes in insurance firms as a result of high levels of exposure to potential losses due to natural catastrophes. Common themes in innovations, decision mechanisms, policies and strategies are described. Two research programs exploring these are outlined.

INTRODUCTION

Property/casualty insurers have recently come to realize that their exposure to severe catastrophe losses is much greater than previously anticipated. The realization originated with a series of natural catastrophes that generated insured losses exceeding anything experienced in industry history. Prior to 1989, the industry had never lost over $1 billion from any single disaster. Since 1989, 10 domestic disasters have exceeded $1 billion in losses (Best Week 1996). Hurricane Andrew alone caused $15 billion in insured damage. The Northridge Earthquake caused losses over $12 billion. It is estimated that industry losses from a single event could reach $50 to $100 billion (Cummins, Lewis and Phillips, 1996). Over the past seven years, the industry has averaged over $10 billion per year in catastrophe losses, compared with an annual average of $2 billion over the seven years prior to 1989 (Standard and Poors 1997).

This change in magnitude of potential catastrophe losses represents a sudden, dramatic environmental shift for the insurance industry. This paper explores how the industry is making sense of and responding to this shift and describes some relevant theory, hypotheses and potential directions for research. The paper is based on a series of interviews with industry representatives that explored changes in how insurers are approaching catastrophe-risk management, including: information gathering and analysis, portfolio management, underwriting policies, competitive assessments and regulatory issues.

Method

Eight semi-structured interviews were held on the topic of how Hurricane Andrew, Hurricane Iniki and the Northridge Earthquake affected firms’ understandings of catastrophic risks and firms’ decision-making mechanisms. Interviewees were managers with major responsibility for property/liability catastrophic losses from primary insurers, reinsurers, rating agencies, and regulatory bodies.
The interviews were designed to yield general perspectives on industry trends so that theory and hypotheses could be developed. The sample of respondents was drawn so as to elicit a broad understanding of opinions within the industry. A small set (N=12) of regulators, primary insurers, and reinsurers were interviewed. Interviewees were not randomly selected. Thus, again, the results reported here are initial observations and themes from limited data. They have been set out as a first step toward more systematic research. No claims for the predominance or generalizability of these themes can be made, though the information was sufficient to suggest the theories and research questions described in the second half of this paper.

The interviews explored immediate effects (i.e., immediate responses to particular events) and secondary effects (i.e., changes implemented with an eye toward future catastrophes) of Hurricane Andrew, Hurricane Iniki and the Northridge Earthquake. They examined issues within firms, between firms, and between firms and regulators. They also explored, in some cases, differences between firms that were driven into insolvency by these events and firms that remained solvent.

**MAJOR THEMES**

*Theme 1: Stability and “Safety First” motivate the changes*

The insurance industry has always faced the possibility that a series of large catastrophic losses could pose solvency risks to large numbers of firms. However, for large firms, the probability of insolvency due to such catastrophes was considered extremely unlikely. History supported this conclusion. Losses from single catastrophes and conjunctions of catastrophes were low enough that such exposures were not specifically and systematically monitored by most firms. One company had been calculating PMLs for 20 years. Several others indicated that they had begun to estimate PMLs after suffering large losses from Hurricane Hugo. Hurricane Andrew apparently led others to do so.

Two types of concerns stemming from the recent increases in catastrophe losses are leading firms to attempt closer management of their catastrophe exposures. First, there is anxiety that catastrophes can seriously disrupt earnings and margins, at least for a short time. Sudden downturns in financial performance are undesirable, particularly in publicly-traded firms that are subject to financial-market scrutiny (Greenwald and Stiglitz 1990; Mayers and Smith 1990). Second, since single catastrophes can yield such large losses, there is a higher probability that catastrophes can financially ruin insurers. The interviews indicated that large insurers do not want to live with any foreseeable risk of ruin.

Two patterns for monitoring and managing catastrophe exposures were reported. An older pattern was a heuristic that a firm should not hold more than some certain percent of their business in a catastrophe-prone line in a catastrophe-prone state. The presumption was that surplus plus reinsurance should be sufficient to cover losses so long as exposures were limited by means of this rough rule of thumb. A more recent pattern is for firms to seek not to hold a total PML greater than some multiplier of their surplus. That multiplier was reported to be between 4 and 7 times surplus among the firms we spoke with. Having chosen an unacceptable loss level,
the firms then choose a $p$ for such an event that the firm would be unwilling to accept; e.g., a firm might decide it would not accept any potentially ruinous bankruptcy risk for a 100-year event. If the PML for any 100-year event exceeds their multiplier, they would seek to reduce that PML. Firms using this portfolio management technique rely on probabilistic, simulation models — such as those provided by vendors — for estimates of PML.

Summary: Firms rely on safety-first type heuristics for assessing and managing their catastrophe exposures.

The levels of loss used to identify unacceptable risks were not universal. Some firms indicated that they worried only about risks that could essentially bankrupt them. Others indicated they would not accept levels of risk if the adverse event could noticeably affect the stability of their earnings, a more restrictive criterion than bankruptcy. Several large firms expressed the opinion that some small firms may not limit their exposure at all, and that this may give the small firms some competitive advantage.

Summary: The desire to (1) avoid disruptions in financial performance and (2) eliminate foreseeable risk of ruin motivate firms’ scrutiny of catastrophic risks. Some firms may not be concerned with either of these issues.

**Theme 2: Switch from history base to future base**

Calculability of expected losses is an important criterion for insurability. For most insured risks, calculations are based on loss histories. Long, stable loss histories, with no expectation that basic conditions have changed, yield high confidence levels for probabilistic estimates of future losses. At this time, for catastrophic risks, historic estimates are acknowledged to be poor estimators. Prospective models are the best available technology for estimating exposures.

The interviews indicated that recent catastrophes have led to a number of changes in expected catastrophe damages and associated costs. First of all, recent disasters have led to higher levels of post-disaster repair costs because the prices for repair materials and labor have risen more dramatically than was the case in the past. In part, this may reflect the fact that several recent disasters have been more serious and so created more serious shortages of materials and labor.

Second, recent events have revealed that assumptions about building codes and their enforcement and effectiveness are not accurate. Buildings are proving more vulnerable to damage than expected as a result (Insurance Institute for Property Loss Reduction 1995).

Third, in most catastrophe-prone states firms face exposure not only from policies they have written but also from state pools that will cover losses from firms that are bankrupted. The Florida Residential Property and Casualty Joint Underwriting Association and the California Earthquake Authority, for example, will, if necessary, distribute losses among solvent insurers proportional to their market shares if a major event bankrupts other insurers. Firms must consider this contingent liability when they estimate PMLs.
Fourth, scientific understanding of natural phenomena has progressed dramatically in recent years, again often as a result of studying recent catastrophes. In several arenas, scientists now recognize vulnerabilities that the industry was not previously aware of.

**Summary:** Loss histories will not yield accurate predictions of natural catastrophe losses because conditions have changed.

Catastrophe modeling has emerged as a major new technology for assessing catastrophic exposures. These computer-based, stochastic models project losses for hypothetical natural disasters of varying probability, given particular portfolios of insurance policies. The models rely on specific information about the location of the property, its construction, use and contents. Firms and vendors indicate that companies have not previously kept this level of information in their databases.

**Summary:** Adoption of catastrophe models necessitates changes in information gathering and record keeping.

The models themselves rely on highly detailed information about the probabilities and behaviors of catastrophic events and on the response of various property types to those stresses. This information is continuously being developed by scientific and engineering communities. Recent catastrophes have led to new understanding of the probabilities and behaviors of potential future earthquakes and hurricanes (U.S. Geological Survey 1996; Durham et al. 1995) which will in turn lead to improvements in the models.

**Summary:** Better scientific understanding of the nature of catastrophe risks and their effects allow more accurate catastrophe modeling.

The output of the models are estimates of losses for catastrophic events with various probabilities of occurrence. Variance in these estimates is an important part of the output (Dong et al. 1996). Interviewees indicated that insurance managers are not yet accustomed to working with hypothetical models and with variances. Firms will need to become more comfortable with probabilistic, simulation-based estimates of exposures, which are far less “hard” figures than are actual historic losses. An analogous but more difficult challenge is to determine how such data will be used by regulators. Regulators are also accustomed to working with historical loss data. They express discomfort with hypothetical models since the computer models necessarily include assumptions that can be made differently by different scientists, firms, or political bodies. Regulators are sensitive to the manipulability of those assumptions. Standardization is desired as a means to reduce manipulability of models.

**Summary:** A switch to catastrophe modeling demands that insurers and regulators become comfortable with estimates based on assumptions and variances. Standardization of modeling is expected as one measure to facilitate acceptance.

In addition, insurers’ confidence in current estimates of catastrophe exposures is not terribly high. They expect that, following future catastrophes, legal and other forces will drive costs
(e.g., damages, repair costs, underwriting pool assessments, etc.) even higher than models currently assume. All the firms interviewed expressed a pessimistic bias in the face of this ambiguity. Several firms indicated that they therefore adjust forecasts from vendors when they use them internally; they increase expected losses. They do not make adjustments to the probabilities offered in the models.

**Theme 3: Shift to PML-based underwriting**

Interviewees reported that, before catastrophes became a major concern, firms managed their catastrophe exposures at a gross level by constraining the percent of their premium derived from catastrophe-prone states. They would use rules of thumb about not writing more than x% of their business in these states.

When it became apparent that catastrophe exposures were much higher than expected, a number of firms began to seek to reduce those exposures. As discussed previously, most adopted policies that said they would like to reduce their Probable Maximum Loss (PML) for catastrophe losses to some threshold level. The levels mentioned during the interviews were on the order of 4 to 7 times surplus.

A common concern among the interviewees was that regulatory constraints make it difficult for them to reduce their catastrophe exposures. Regulations limited the percent of policies they could decline to renew or cancel. Organizational inertia has also apparently made it more difficult for firms to reach their exposure goals. They find it difficult to constrain their sales forces, for example, and are reluctant to abandon growing markets to competitors.

**Summary:** Firms would like to manage PMLs by limiting them. Regulatory constraints, organizational inertia, and competitive pressures are among the forces that have kept many from reaching their PML goals.

Although the firms all use the same term – PML – as the conceptual entity they seek to monitor with regard to their catastrophe exposures, there is actually a great deal of variability in the specific components of risk different firms reflect in their PML figures. Not all firms include the same types of losses in their estimates of PML. For example, some firms include business interruption, fire following, and anticipated state pool assessments, while others do not. The level of risk at which PML is scrutinized also varies. Some firms focus on 100-year events; others on 250-year PMLs. Finally, firms do not necessarily monitor catastrophe exposures in all arenas where they participate. For example, the firms we studied do not monitor PML in Hawaii because it is a small market, accounting for low premium percentages for large insurers, even though it has high wind catastrophe potential (e.g., Hawaii’s Hurricane Iniki in 1992 was the third largest hurricane in history in terms of insured losses, after Andrew and Hugo). Other “catastrophe blind spots” are harder to understand. One firm is not monitoring NJ wind exposures, though they are monitoring NY wind and have significant business in both these states with extensive coastal property exposure (Insurance Institute for Property Loss Reduction 1995).
The A.M. Best company has begun to include catastrophe exposures as part of their ratings of insurers. Their initial efforts to study exposures have been hampered by the lack of standardization. Standard and Poors has announced that they will also assess catastrophe exposures when rating insurers (Brooks and Levin 1997). State regulators are greatly concerned to see that insurers remain solvent following catastrophes and expect to more systematically assess their exposures as well. Thus, pressures from several directions should lead to standardization of PML estimation.

Summary: There is at this time no standardization of firms’ calculations of catastrophe exposures, though pressures for standardization are mounting.

Theme 4: Additional Methods for Managing Catastrophe Exposures

Several firms described the idea of catastrophe swaps as potentially valuable as a means for better balancing their catastrophe exposures. However, all felt the infrastructure for catastrophe swaps is not yet adequate to entice them to participate. In particular, they feared that (1) they would have inadequate information to assess the risks they swapped into their portfolios and so would be vulnerable to adverse selection; and (2) secrecy might not be adequate so that their participation might become known and read as a signal in the marketplace that the firm is worried about its portfolio.

Other new types of financial instruments, such as Act of God bonds and Catastrophe Futures, are available for managing exposure and shocks to capital. Again, most firms are not yet interested in participating because they feel the institutional infrastructure for these tools is not yet adequate. Managers with responsibility for catastrophe portfolios indicated that the time investment required to do due diligence before participating is currently excessive and that their confidence in the infrastructure is low.

Summary: Firms are interested in and watching developments with regard to new financial instruments for capitalizing and hedging catastrophe risk underwriting, but most firms are not yet willing to participate in them due, reportedly, to institutional inadequacies.
Exposures can be managed by reducing loss levels as well as by managing portfolios. Improved mitigation is a topic that interested some firms but most have not developed extensive plans for acting in this arena, beyond lending support to industry lobbying positions and efforts. Firms generally were skeptical that much could be accomplished with regard to mitigation. Several interviewees contended that rates are already inadequate in catastrophe-prone states and that his would make it impossible for their firm to offer significant discounts as incentives to mitigation. In this context, they feared that public pressure for insurers to offer mitigation discounts could cause the industry to be perceived as greedy and irresponsible because they would not rebate money to safer policyholders.

Summary: There is at this time not much industry interest in extensive programs for improving mitigation. The most extensive efforts that receive support are industry-wide, common-good efforts.

Finally, there are concerns that some firms have decided to live with catastrophe risks or to ignore them rather than manage them. Some firms may be too small to constrain sales in favor of better PML ratios; some firms may have insufficient technical prowess to recognize and manage catastrophe risks; some firms may be making a conscious competitive choice to grow in arenas where others are retrenching, though their solvency risks may be quite high. Whatever the causes, if there is a segment of firms undertaking excessive catastrophe risks, if regulation is not adequate to identify and constrain them, the well being of their policy holders is at risk. The solvency of all other insurers is also at risk insofar as state catastrophe pools will distribute the claims liabilities of firms that go insolvent to firms that are still in business.

Summary: There may be segments of the industry that are bearing excessive catastrophe risks.
DIRECTIONS FOR RESEARCH

Two types of study are planned to examine the research questions arising from the interviews. One will be an analysis of a database of estimated catastrophe exposures for insurance firms. The other will be a questionnaire exploring their catastrophe estimation techniques and related decision rules.

Research Topic 1: Industry Catastrophic Risk Tastes

“Safety First” and Stability

“Safety first” models address decisions about risks that include a risk of ruin. Standard economic models that include the possibility of a disaster no differently from risks with less extreme possible downsides. Safety-first (S-F) principles assert that actors pursue maximum profits only after satisfying certain constraints with regard to the probability of a catastrophic outcome. Thus, risks that include the possibility of a disaster are treated very differently from risks that do not.

The interviews suggested that insurance firms are relying on S-F type constraints based on probable maximum losses (PMLs) to monitor and manage their catastrophe exposures. Three types of constraints that are important in S-F models were found to be important to the insurance firms interviewed:

Trait 1: S-F Adoption
When expected income is below the levels needed to ensure survival, all decisions are survival decisions. An actor is not in a position to trade profits for safety, because they have no surplus expected resources to trade.

Trait 2: S-F Tradeoffs
Actors that are operating above survival levels of income will trade expected returns for reduced risk of ruin.

Trait 3: S-F Variations
The level of loss that is considered disastrous is subjectively defined. Thu7s, when an actor’s solvency is well assured, variability in performance may seem disastrous to them, whereas variability would seem a luxury to a struggling firm that can envision bankruptcy as a credible threat.
Re: Trait 1: S-F Adoption

S-F models predict that willingness to take catastrophic risks will vary with firms’ overall performance. Firms whose success is less than assured to begin with will not be in a position to constrain their profit pursuit in order to reduce catastrophe probabilities because they have not yet achieved assured profitability in the first place. Traditional S-F models have found adoption to be a function of income and assets.

H1: Firms with sales and asset levels so low that their solvency is not assured will not adopt a safety-first constraint and so will take on more catastrophic risk than larger firms.

Consistent with S-F models, a preliminary study by A.M. Best ([Dunleavy et al. 1996]) indicated that small insurance firms hold far more catastrophe exposure than larger firms. Table 1 below summarizes estimated gross PML leverage data from that study, which was based on a strategic sample of major property underwriters in catastrophe-prone states. The study’s authors caution that these are preliminary results from a nonrandom sample.

Table 1:
Gross PML Leverage

<table>
<thead>
<tr>
<th>Group Size ($million surplus)</th>
<th>Sample Size</th>
<th>Median PML/surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50</td>
<td>n=32</td>
<td>29%</td>
</tr>
<tr>
<td>50-250</td>
<td>n=17</td>
<td>79%</td>
</tr>
<tr>
<td>&gt;250</td>
<td>n=11</td>
<td>477%</td>
</tr>
</tbody>
</table>

Source: Dunleavy et al. 1996
Our interviews, combined with S-F models, suggest three types of reasons to expect S-F based stratification in PML exposures.

a. S-F models suggest that small firms cannot afford to restrict premiums in order to reduce catastrophe exposure. If this phenomenon is driven by inadequate income to sustain viability, we will expect to see that firms whose sales and asset levels are below some baseline level for ensuring solvency will have much higher PML leverages.

H1.a: Firms with very low levels of sales and assets will have very high PML exposures.

To assess H1.a, we will look at absolute sales and asset levels, premium/surplus ratios, ratings, and bankruptcy risk estimates compared with PML exposures for a random sample of insurance firms.

b. Regulators voiced the suspicion that small firms, compared to large, lack the technical capability and professionalism to monitor and make decisions about their catastrophe exposures. If this is the case, it is competencies rather than cash that might drive variation in catastrophe exposures. Size may interact insofar as small firms have less technical competence available.

H1.b: Firms with the lowest levels of professional and technical competence in the industry will have much higher levels of PML exposure.

To explore H1.b, we will examine degree of professionalism of ownership, top management team, and numbers of technical employees compared with PML exposures.

c. A hypothesis voiced by several large firms was that the failure to curtail catastrophe exposure is a competitive strategy for small firms, a strategy that presents a competitive disadvantage to firms that attempt to manage their catastrophe exposures more conservatively. This issue can be examined by exploring whether firms with higher levels of PML exposure have a competitive advantage.

H1.c: Firms with much higher levels of PML exposure will be experiencing higher rates of growth or profitability than competitors with lower levels of exposure.

To explore H1.c, we will examine growth rates and profitability of the sample of insurers. In particular, we will look to see whether advantage fell to firms with higher PMLs following the Andrew and Northridge disasters.
Re: Trait 2: S-F Tradeoffs

Next let us consider the question of how firms trade expected returns for reduced risk of ruin. Two types of rules have been proposed to describe this constraint (c.f., Encarnacion 1991; Stone 1973a and 1973b). The Cramer-Roy rule posits that decision makers seek to minimize the probability \( p \) of a disaster. The Tesler rule suggests that decision makers choose a critical level of \( p \) and a level of \( L \) that are to be considered unacceptable. They will reject risks that exceed these constraints; within the remaining set of risks, they maximize profits.

The interviews suggested that firms are indeed using S-F type logic in managing their exposures to catastrophe risks. They seek to reduce the probability that they could suffer a very large shock to capacity due to an event or series of events. In particular, the firms’ descriptions of how they use information from simulation models to monitor their catastrophe exposures is highly consistent with Tesler. They choose a \( p \) level (e.g., 100 year events or 250 year events) and an \( L \) level (e.g., bankrupting loss or stability disrupting loss) that are considered unacceptable. When they identify a risk that exceeds that PML at that \( p \) level, they seek to reduce that exposure.

H2: Firms that are operating above subsistence levels will adopt Tesler-form S-F constraints (i.e., catastrophic L level and \( p \) for that L) to monitor their portfolios of catastrophe risks.

To examine this, a questionnaire will explore firms’ PML-based underwriting heuristics. The data analysis study will explore patterns of PML related to proposed Tesler-form heuristics.

Re: Trait 3: S-F Variations

The level of loss that is considered catastrophic can vary in any S-F rule. Two types of loss scenarios were mentioned by interviewees as driving their attempts to manage PML. Generally, the largest firms sought to ensure that catastrophes not disrupt the stability of their financial performance. Small but fundamentally solvent firms primarily discussed avoiding bankrupting or crippling levels of PML. Thus, informally, it appears that the level of catastrophe to be avoided varies with firm performance. Informally, also, the Dunleavy et al. study found the level of catastrophe exposure held by medium-sized firms is much higher than the level held by very large firms, which suggests that size or size-related performance factors may indeed lead to different catastrophe-avoidance choices. These comments and findings support the Tesler-like S-F thesis that holds that the risk around which safety first constraints are built need not be a “true” disaster risk.

The basic S-F argument discussed previously suggested that firms that have not reliably secured profitable performance will not be in a position to trade profits for safety. The above extension suggests that firms that do not yet have stable earnings will not be able to make tradeoffs in order to protect stability. Thus, above subsistence levels we would expect to find two different types of behavior: bankruptcy-avoiding and shock-avoiding.
H3: Above subsistence levels, S-F constraints will vary with the level of financial security at which firms are operating.

H3.a Firms that have stable earnings and profitability will adopt stability-related constraints.

H3.b Firms that have not yet achieved stability but are secure about their survival will adopt a survival constraint.

To examine these hypotheses we will look at whether earnings stability predicts differences in PMLs during the database study. We will also explore firms’ underwriting heuristics on the questionnaire.

Risk-Return Issues

Classical microeconomic theory predicts that higher returns fall to firms that take higher risks. One behaviorally based model, called the risk-return paradox, predicts that firms take higher risks when they are performing badly. Lower returns are actually associated with higher risk (i.e., more variable financial performance); and higher returns with lower risk (Bowman; Fiegenbaum and Thomas).

The risk-return paradox has not yet been demonstrated in the arena of risks of ruin. The S-F model suggests that a risk-return paradox will be observed at a gross level insofar as firms with more stable performance should choose lower PMLs. This is addressed by H3.a and H3.b, described above.

In addition, the risk-return paradox suggests that within subgroups of firms (i.e., within the group using stability constraints and within the group using ruin constraints) higher profit will predict lower PMLs (see figure below).

H4: Within S-F classes, less variance in profitability will be associated with lower levels of PML.

H4 will be examined during the database study.
Structural Issues

Mutual firms are less accountable to market forces than are stock firms. In the small set of interviews conducted, only stock firms expressed concern about preserving stability of earnings. They made an explicit market argument in defense of this heuristic: fear that analysts will punish firms whose earnings vary. Thus, it will be worthwhile to check whether firms’ institutional structure affects their catastrophe exposures in the predicted direction.

H5: All else equal, stock firms will hold lower levels of PML than mutuals.

Research Topic 2: Adoption of Innovation

Risks with catastrophic qualities are widely considered uninsurable. In fact, Bickelhaupt’s General Insurance (1983) lists importance, accidental nature, calculability, definiteness of loss, and no excessively catastrophic loss as the conditions for insurability. Natural catastrophes with multi-billion dollar losses seem to violate two of these conditions: calculability (of p and L in advance) and not excessively catastrophic. On the other hand, as Bickelhaupt points out, few risks are “perfectly” insurable. Also, what is insurable may change over time. Flood damage was considered uninsurable for many years but is now handled in many places through a federal insurance program.

Primary insurers have tended historically to rely principally on pooling for risk management. They have not organized or evolved with an emphasis on dealing with low-probability, high-consequence risks. Three other types of market and regulatory mechanisms have evolved which have focused on handling handle these: (1) Government insurance programs, which are not subject to market forces as firms are; (2) Niche firms that specialized in otherwise uninsurable losses (such as Lloyds of London), which do not rely primarily on pooling; and (3) Reinsurers, who do rely on pooling but who limit their exposures more assiduously than do primaries so as to protect their solvency.

As a result of the recent dramatic increases in catastrophe losses and exposures, primary insurers find themselves, by default rather than by choice, in the low-probability-high consequence risk business. According to the interviews, some dramatic adjustments in how the firms do business have resulted. The adjustments explored during the interviews were of four types:

a. Switching risk assessment systems away from history-based to future-based forecasts
b. Switching underwriting and portfolio monitoring and management systems toward more monitoring and closer management based on PMLs
c. Switching capitalization systems toward new financial instruments (including Act-of-God and catastrophe bonds)
d. Switching information systems from gross control of claims to more detailed control

Organizational innovations can be thought of as falling into two categories: competence enhancing and competence destroying. Competence enhancing innovations build on and extend existing organizational understandings, routines and linkages; competence destroying innovations make existing understandings, routines and linkages obsolete and demand the adoption of new ones (Clark 1987). Adoption of competence-destroying innovations is by definition more disruptive.

Of the innovations described in the interviews, the first three described above (a-c) are arguably competence destroying innovations, radical innovations demanding significant changes. Only one (d) appears to be a competence-enhancing innovation, building on existing competencies. They all demand major adjustments to the way the insurers conceive of and make decisions about risk estimates and risk bearing.

There is apparently significant variability within the industry at this time in terms of adoption of these sorts of innovation. Dunleavy et al. (1996) report, based on their survey of insurers, that some firms argue that their catastrophe history does not indicate they need to worry about their exposures (i.e., continue to rely on history-based projections); others consider market size an adequate indicator of catastrophe exposure and have adopted very gross assessments of PML; still others have adopted sophisticated catastrophe-exposure models and are attempting to manage their catastrophe risks actively.

The matrix in Figure 1 outlines the possible patterns of innovation that may be found in the industry at this time given the nature of the changes described during the interviews. Firms may either take a conservative or radical position with regard to risk estimation innovations. If conservative, they would continue to rely primarily on loss histories; if radical, they would adopt forecasting methods. They might similarly take a conservative or radical approach to risk-bearing innovations. On the dimension of underwriting, this would range from restricting capital to constrain PML while continuing a pooling strategy to hedging through mechanisms like catastrophe swaps. With regard to capitalization, innovation might range from conservative adjustments to reinsurance contracts to radical adoption of new financial instruments.

\[ Figure \ 1: \ \text{Possible Patterns of Innovation} \]

<table>
<thead>
<tr>
<th>Risk Estimation</th>
<th>Risk Bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>conservative (pooling)</td>
<td>I</td>
</tr>
<tr>
<td>radical (emergent)</td>
<td>II</td>
</tr>
</tbody>
</table>

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Patterns of innovation in this industry can potentially reveal important factors about competitive dynamics. Economic literature links innovation to competitive advantage. The firm with the most to gain is expected to be the innovator (von Hippel 1988). In this context, the firm with the greatest capital exposed to PML would be the one with the most to gain through improved catastrophe-risk management. Management theory takes a different, evolutionary view of innovation. Management theory links innovation to path dependencies rather than incentives. The firm with the most propitious basket of resources and capabilities in advance of a shock will be in the position to first adopt innovations that fit them after the shock occurs. In other words, the firm that is “lucky” enough to have the right traits when an opportunity to evolve in a more advantageous direction will be the one who innovates earliest. These two schools of thought offer different predictions about how competitive dynamics will develop, who will win and lose in the new environment.

Questions about the forces driving innovation and new competitive dynamics in this industry can be answered by examining order of adoption of the relevant innovations.

\[ H6.a: \) (Economic) Earlier innovation will be associated with greater potential loss
\[ H6.b: \) (Evolutionary) Earlier innovation will be associated with greater “cognitive” readiness

Cognitive readiness can be measured by a number of factors: professionalization of firm (TMT, Ownership), size of technical staff, degree of involvement with risk-based capital and other future-based risk concepts, degree of completeness of claims database (what fields are included). Potential loss can be measured by PML/surplus.

A survey will explore these issues.

CONCLUSIONS

A set of interviews were conducted to identify major changes being undertaken in the insurance industry in response to a recent pattern of large losses from natural catastrophes. It is widely held that the pattern is not an anomaly; the expected costs for natural catastrophes has risen enormously. Primary insurers hold portfolios of policies with much greater catastrophe exposures than they had ever imagined.

Because catastrophe risks were not previously considered a major part of their business, primaries did not assess their catastrophe risks closely nor did they have special, sophisticated strategies for bearing those risks. The change in the environment has led at least some of them to do both. This is necessitating major innovations in organizational cognitions, capabilities, and linkages. We propose to examine patterns of innovation in this industry through a survey, in
order to get a better understanding of what drives innovation and how it affects competitive
dynamics.

The interviews suggest that a certain form of heuristic – a safety-first rule – guides the firms’
catastrophe risk choices. SF theory predicts that firms whose profitability is not yet assured will
not make SF tradeoffs. These should show the highest levels of catastrophe exposure. Once
firms have a level of performance such that profitability is basically ensured, they may begin to
trade profit for safety. Among this set of firms – those whose basic profitability is fairly likely
ensured -- the interviews suggest that again two patterns may be observed. For firms that have
achieved profitability but whose earnings are not particularly stable, tradeoffs will be made
between profit and ensuring continued survival. Firms that have a history of stable earnings, by
contrast, will probably adopt a more stringent safety constraint; they may trade profit for stability.
Thus, the merely profitable but not yet stable firms should exhibit a middle level of catastrophe
exposure; the highly stable, profitable firms should have the lowest levels. Relatively, the risk-
return paradox predicts that higher levels of profitability will be associated with lower levels of
catastrophe risk. We propose to examine these questions by means of a survey and analysis of a
database of catastrophe exposures.
REFERENCES


