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**Article**

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NBER Reporter Online

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National Bureau of Economic Research (NBER), Cambridge, Mass.

*Suggested Citation:* Froot, Kenneth A. (1999) : Risk management and insurance, NBER Reporter Online, National Bureau of Economic Research (NBER), Cambridge, MA, Iss. Summer 1999, pp. 18-21

This Version is available at:
https://hdl.handle.net/10419/67033

# Risk Management and Insurance

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My research over the past several years has focused on two topics: corporate risk management, with a special emphasis on the insurance sector, and the portfolio flows of international investors. In this article, I first discuss the work on risk management, explaining why the insurance industry provides a wonderful set of experiments for testing some ideas about the subject. I then turn to my work on international portfolio flows.

Financial risk management is probably the central activity of financial intermediaries, including banks and insurance companies. Intermediaries take risks by investing their capital in illiquid and information-intensive financial activities. It is these imperfections in financial markets that allow intermediaries to make profits. But the imperfections are not merely a source of profit—they also create costs. That is, intermediaries must finance themselves by issuing claims that are at least partially illiquid and information-intensive. This suggests that exogenous shocks to intermediaries' financial capital should have implications for the pricing and availability of the instruments in which they invest.

How do financing imperfections influence financial policies, such as risk management, capital budgeting, and capital structure? For example, suppose that a financial firm becomes concerned about the feasibility or cost of raising equity capital, or that its costs of carrying a given amount of capital rise. The marginal value of the firm's internal funds will have increased. As a result, that firm will wish to reduce risks to its capital in order to conserve on internal funds.

The first thing the firm can do is to hedge out any and all "market risks" —for example, risks that can be hedged without friction in the capital markets. These hedges have zero net present value from the market's perspective, since they are done at fair prices. However, they create additional firm value because they allow the firm to use less capital and to raise needed capital less often.[1]

Having hedged all frictionless market risk, can the firm further reduce its risk? Yes, the firm can alter its capital budgeting policy by raising internal hurdle rates. At first blush, an increase in hurdle rates would seem to do little to conserve on internal funds. After all, industrial firms are more likely to reduce new investment than they are assets in place, so higher hurdle rates would not reduce risk quickly. In this regard, however, financial firms are special. Financial firms have larger and more liquid balance sheets. Higher hurdle rates would encourage a reduction in risk exposures.

However, it would not be optimal for a financial firm to raise all its hurdle rates by the same amount. Investments that co-vary positively with fluctuations in overall firm capital should receive higher hurdle rates. However, investments that co-vary negatively with internal capital should see their hurdle rates decline. In a recent paper, Jeremy C. Stein and I model these internal hurdle rates. We show that, in the presence of financing imperfections, optimal hurdle rates should include an additional factor driven by co-variance with internal capital. For internal pricing, the price of capital at risk is measured by a risk-aversion term that reflects the shadow value of internal funds, whereas the quantity of capital at risk is measured by a given investment's covariance with the rest of the firm's portfolio.[2]

If financial imperfections are present, then negative shocks to financial-firm capital should be associated with increases in hurdle rates and more aggressive hedging. Unfortunately, it is difficult to provide unambiguous empirical evidence that an intermediary's capital position matters for pricing. That is because classical hurdle rates are not directly observable, and changes in intermediary capital are often endogenous. Consider the often-cited correlation between bank capital and bank lending, for example. One could argue that such a correlation emerges because losses reduce capital, causing banks to raise hurdle rates and cut back on lending. But it is difficult to rule out the alternative interpretation: that a decline in lending opportunities causes the decline in lending and the increase in observed lending rates. Under this interpretation, there is no need for a change in bank hurdle rates.

To determine which of these explanations is correct, one would need to observe either hurdle rates or losses that are unrelated to changes in investment opportunities. These conditions come close to being met in one area of the insurance markets —catastrophe (cat) insurance. Insurers purchase catastrophe re-insurance against natural disasters (such as hurricane, earthquake, freezing weather conditions, and the like) to offset losses triggered by such events on the policies they write. Such events stress insurer capital, since the trigger claims against many policies at once. Re-insurance treaties are

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traded contracts that permit insurers to pay a premium to hedge out portions of the cat risk embedded in their policies.

Can the market for catastrophe risk help one understand whether financial imperfections are present? Most important is the transparency in cat-risk hurdle rates. In an essay published a few years ago, I constructed the returns from bearing cat risk exposures over a 20-year period using historical cat re-insurance contracts. I argued that historical cat losses as well as returns on catastrophe re-insurance appear uncorrelated with returns on other major asset classes.[3] This suggests that the classical hurdle rate for cat risk is the risk-free rate, which is readily observable. The implication is that cat re-insurance premiums should equal cat re-insurance expected losses. While we cannot observe expected losses directly, they can be estimated indirectly using models produced by independent catastrophe modeling firms, of which there are several. While these models are no doubt imperfect, they provide objective, scientific estimates of expected contract losses. Thus it is possible to construct a crude, but presumably unbiased, estimate of the cat risk embedded in each cat contract.

Data on cat re-insurance contracts since 1970 suggest that, first, re-insurance premiums have on average exceeded expected contract losses. To reach this conclusion, Paul O'Connell and I model the event-loss distributions from five different natural perils across five U.S. regions. We then use the exposure patterns of U.S. insurers to develop estimates of the cat risk imbedded in the re-insurance treaties purchased by these insurers. We find that average premiums exceed expected losses by a multiple of four or five. That is, premiums have historically been four or five times expected losses, a shockingly large differential. Even allowing for considerable measurement error in the models of actuarial risk, this suggests that cat premiums are far too high to be successfully explained by classical hurdle rates.[4]

In the same paper, we also demonstrate that after a cat event, cat re-insurance premiums increase strongly while the quantity of cat re-insurance purchased by insurers falls. These simultaneous movements in price and quantity are important in identifying the role of supply-versus-demand shocks. Prices could increase after a cat event because capital is depleted and re-insurers raise hurdle rates (that is, supply of re-insurance contracts when capital is depleted). Alternatively, premiums could increase because there is a surge in insurance and re-insurance demand following a cat event (that is, demand for re-insurance increases when there is an event). The change in quantity purchased is decisive in separating these two explanations: in the former, quantity decreases, whereas in the latter quantity rises. Our finding that the quantity of re-insurance purchased falls subsequent to an event suggests that a reduction in the supply of re-insurance is more important than any increase in demand for explaining premium levels and changes.

Next, we estimate re-insurance supply and demand curves explicitly in order to examine a critical prediction of the financial imperfection models: that intermediary hurdle rates reflect the co-variance of a particular cat risk with the intermediary's preexisting portfolio. We find that re-insurers do indeed increase their hurdle rate for those cat risks that are positively correlated with their pre-existing portfolios. In other words, the supply of re-insurance for a particular cat risk falls as the risk is more highly correlated with U.S. nationwide cat risks. This is a direct contradiction of the classical hurdle rate approach, and is consistent with the Froot and Stein model of financial intermediaries described earlier.

Some of these conclusions require us to assume that cat events do not trigger updates in the perceived (and modeled) probability of such events going forward. This assumption may not hold up however. The distribution of cat risk perceived by market participants may shift when events occur. This could lead event losses to be correlated with premium increases and for correlated risks to (potentially) command even higher premiums. To address this "probability updating" hypothesis, O'Connell and I examine how the re-insurance premiums on one type of peril change when a different peril occurs. For example, we look at how the premiums for southeastern U.S. hurricane risks change when an earthquake occurs in the western United States. We assume that earthquake losses do not help us understand how well Florida construction will hold up in high winds, even though an earthquake may teach us something about the vulnerability of California construction to ground motion. The data demonstrate strongly that an event loss from a particular peril increases subsequent re-insurance premiums for that peril, but also for all other perils. Probability updating cannot explain this result. Instead, it is consistent with the financial imperfections story, which predicts that re-insurer losses lead to higher charges for re-insurer risk assumption.[5]

A final pervasive fact about the cat-risk market is how little cat-risk transfer occurs. U.S. households and businesses are underinsured in general, and businesses in particular have relatively little cat-risk protection. Insurers who accumulate cat exposures by writing individual insurance policies purchase only a small amount of re-insurance, given the size of their exposures. In a well-

functioning capital market, a much larger fraction of cat exposures would be hedged. Inefficiency is suggested when a Long Island regional home insurer asks its policyholders to bear some of the risk that a large hurricane will strike Long Island, precisely the risk policyholders are trying to avoid.

While the financial imperfections theory explains these facts, a number of other explanations are also helpful, including 1) monopoly power on the part of re-insurers; 2) tax and agency inefficiencies in the organizational form that re-insurance takes; 3) the high frictional costs of re-insurance (attributable to the illiquidity of contracts and the ways in which they are transferred); 4) the presence of adverse selection and moral hazard, which tend to degrade the quality of the cat-risk market; 5) regulation of insurance rates by state insurance commissioners, which influence insurers' willingness to purchase re-insurance; 6) ex post reimbursements for cat losses from the government and industry pools, which distort incentives to purchase re-insurance; and 7) behavioral factors that may dampen demand for re-insurance, and particularly so for large event losses. In a recent essay, I examine the financial imperfections explanation in addition to these other explanations of the low levels of risk transfer.[6] I conclude that financial imperfections are the single most robust explanation (although combinations of these other factors are very important). I also argue that recent and future developments in this market are going to be critical to finding the right answer.

These recent developments are telling indeed. In the past few years, cat re-insurance contracts have been securitized for the first time (that is, sold into the capital market as securities rather than absorbed by re-insurers as re-insurance treaties). It is interesting to track the impact that these transactions have had. I detail the most important landmark cat securitization in a case focusing on the issue's pricing and its implications for risk management.[7] This 1997 transaction involved the sale of a large fraction of a major insurer's cat exposure to the capital market. The premiums received by investors were very large (but in line with historical results): the premium over the risk-free rate was approximately seven or eight times expected losses.

However, some of these generous premiums have been transitory. Even though relatively little cat risk has been securitized to date, premiums have declined precipitously. For example, in 1998, the same major-insurer cat exposure was sold in an almost identical securitization. Here investors received approximately five or six times expected loss. In 1999, the same exposure is expected to reach the market once again in a similar security. But this time indications are that it will fetch only about four times the expected loss.[8]

These developments suggest that, first, securitization permits additional risk-bearing capacity to be supplied by investors. Re-insurers are no longer the only suppliers of capital. Second, the potentially lower cost of this new source of capital allows premiums to be bid down. Even though securitizations account for a small fraction of cat-risk transfer, they have made the market contestable. Third, new pressures for re-insurers to reduce their costs of capital and improve the efficiency with which they use capital will keep them competitive. But considerable reform in the way re-insurers source funds will occur.[9]

Finally, the insurance and re-insurance industries are beginning to adjust to changes in capital-raising capabilities, in risk-management techniques, and in information technology. This will ultimately lead to considerable change in the organization of these industries, in the types of insurance policies and risk-management devices available to individuals and firms, and in the way these policies are distributed. Howard Kunreuther and I have started a project at the NBER devoted to understanding both the supply and demand sides of these changes. We held our first project meeting in February 1999, and the papers given at that meeting are posted on the NBER web site (http://www.nber.org).

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[1] *For a model of corporate risk management along these lines, see K. A. Froot, D. Scharfstein, and J. C. Stein, "Risk Management: Coordinating Corporate Investment and Financing Decisions," NBER Working Paper No. 4084, May 1992; revised in* Journal of Finance, *48 (December 1993), pp.1629–58.*

[2] *See K. A. Froot and J. C. Stein, "Risk Management, Capital Budgeting, and Capital Structure Policy for Financial Institutions: An Integrated Approach,"* Journal of Financial Economics, *47 (January 1998), pp. 55–82. (Revised from NBER Working Paper No. 5403, January 1996.)*

[3] *See K. A. Froot, B. Murphy, A. Stern, and S. Usher, "The Emerging Asset Class: Insurance Risk," Special Report from Guy Carpenter and Company, Inc., July 1995. Reprinted in* Viewpoint, *24, no. 3 (Summer 1995), pp.19–28.*

[4] *K. A. Froot and P. G. O'Connell, "On the Pricing of Intermediated Risks: Theory and Application to Catastrophe Reinsurance," NBER Working Paper No. 6011, April 1997.*

[5] *See K. A. Froot, and P. G. O'Connell, "The Pricing of U.S. Catastrophe Reinsurance," NBER Working Paper No. 6043, May 1997, in* The Financing of Catastrophe Risk, *K. A. Froot, ed. Chicago: University of Chicago Press, 1999.*

[6] *"The Limited Financing of Catastrophe Risk: An Overview," NBER Working Paper No. 6025, April 1997; Introductory essay in* The Financing of Catastrophe Risk, *K. A. Froot, ed. Chicago: University of Chicago Press, 1999.*

[7] *See K. A. Froot and M. Seasholes, "USAA: Catastrophe Risk Financing," Case no. N9-298-007, Harvard Business School, Boston, 1998.*

[8] *The evolution of these transactions is traced out in K. A. Froot, "The Market for Catastrophe Risk: A Clinical Examination," Harvard Business School and* Journal of Financial Economics *joint conference on clinical studies, July 1999, forthcoming. See also K. A. Froot, "The Evolving Market for Catastrophe Risk," Harvard University; published as a Marsh McLennan Securities and Guy Carpenter & Co. White Paper, September 1998.*

[9] *These issues are discussed in greater detail in the papers cited in footnote 8.*

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## NBER Profile: *Ann P. Bartel*

Ann P. Bartel has been a member f the NBER's Program on Labor tudies since 1974. She is also a rofessor of Economics and Director f the Human Resource Management rogram at the Columbia University raduate School of Business.

Bartel received her B.A. in eco- omics from the University of Penn- lvania and her M.A. and Ph.D. in conomics from Columbia Univer- ty. After teaching at the University Pennsylvania for two years, she joined the economics faculty of Columbia's Graduate School of Business in 1976. She rose from an assistant to an associate professor in 1979, and was promoted to professor in 1986.

Bartel's husband, Charles, is an attorney. They have three children: Joseph, 21; Sharon, 18; and Jessica, 15. When she is not teaching or doing research, Bartel enjoys playing tennis and spending time with her family.