

SECURITIZATION, INSURANCE, AND REINSURANCE

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ABSTRACT

This article considers strengths and weaknesses of reinsurance and securitization in managing insurable risks. Traditional reinsurance operates efficiently in managing relatively small, uncorrelated risks and in facilitating efficient information sharing between cedants and reinsurers. However, when the magnitude of potential losses and the correlation of risks increase, the efficiency of the reinsurance model breaks down, and the cost of capital may become uneconomical. At this juncture, securitization has a role to play by passing the risks along to broader capital markets. Securitization also serves as a complement for reinsurance in other ways such as facilitating regulatory arbitrage and collateralizing low-frequency risks.

INTRODUCTION

Insurance-linked securities (known as ILS) is a general term that covers different instruments designed to pass life and non-life insurance risks on to the financial markets. They range from ILS in the strict sense of the term to contingent capital, cat bonds, cat swaps, cat options, sidecars, collateralized quota shares, and industry loss warranties. Some observers would probably also include under the ILS banner specialist hedge funds and certain derivatives, such as weather or climate derivatives. For reviews of these contracts see Cummins (2005, 2008), Cummins and Weiss (2009), and Albertini and Barrieu (2009).

Insurance risk securitization remains marginal compared with the businesses of insurance and reinsurance. However, it has undergone rapid growth in response to major loss events such as Hurricane Andrew in 1992, World Trade Center terrorist attacks in 2001, and Hurricanes Katrina, Rita, and Wilma in 2005. After each of these disasters, the capital of reinsurers was seriously weakened and the usual means of rebuilding capacity—i.e., new company formation through initial public offerings, seasoned equity issues, and capital increases—were not sufficient to enable the market to rebuild to previous levels of capacity. In fact, ILS provided much of the additional risk capital

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that was unavailable through the usual channels. In 2007 and the first half of 2008, insurance and reinsurance companies continued to issue ILS even though the loss ratio for these years was moderate. Initially conceived as a supplement for rebuilding capacity exhausted by exceptional disasters, ILS seem to have gradually carved out a place for themselves in the insurance and reinsurance landscape (see also GC Securities, 2008).

This article provides an introduction to the economics of insurance securitization. What are the respective strengths of reinsurance and securitization as risk management mechanisms? Should the use of ILS be confined to the periods of capacity reduction that follow major catastrophes, or could they play a more structuring role in the industry's evolution? Should ILS be considered as substitutes for or as complements to insurance and reinsurance? Why do certain investors prefer to invest in ILS rather than found new reinsurance companies or issue stock? The recent financial crisis offers us an interesting natural experiment in this regard.

RISK FINANCING THROUGH REINSURANCE AND SECURITIZATION

The traditional mechanism for transferring and managing risks in the insurance industry is reinsurance. However, more recently securitized alternatives such as bonds, options, and swaps have become available. This section provides a theoretical overview of the advantages and disadvantages of reinsurance and securitization and an analysis of whether reinsurance and securitization are appropriately viewed as substitutes, complements, or some combination.

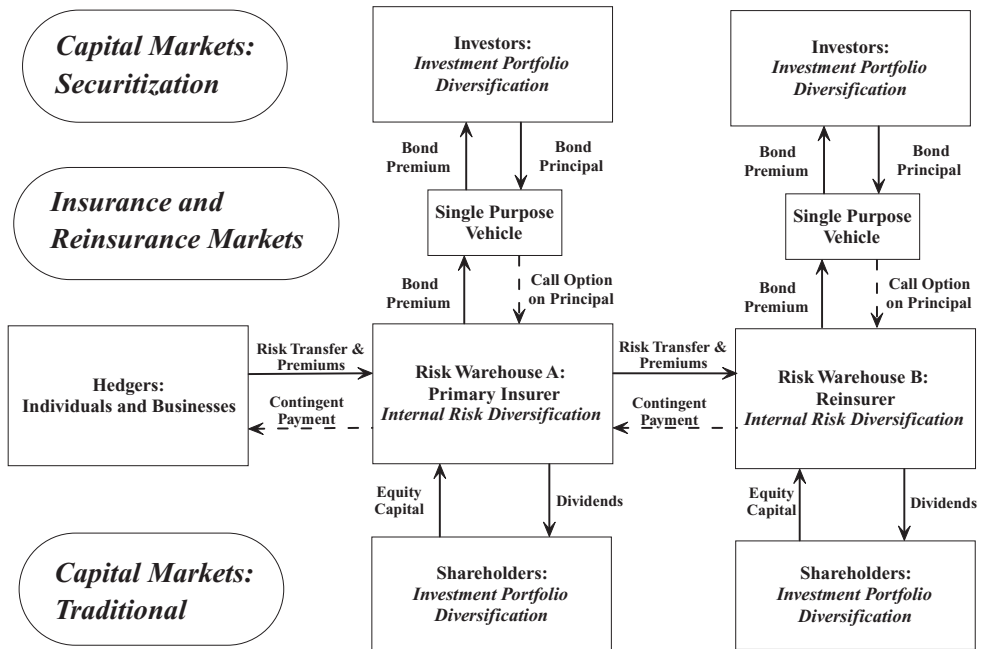
Reinsurance

The traditional and still prevalent model of risk diversification and risk transfer in the insurance industry is the risk warehouse; i.e., insurers and reinsurers served a *risk-absorption* or *risk-warehousing function* in the economy. Traditional reinsurers provide risk diversification and risk management products but typically do not pass the risks inherent in these instruments along to the capital markets but rather hold them on balance sheet.

The model of a risk warehouse is shown in the "Insurance and Reinsurance Markets" and "Capital Markets: Traditional" sections of Figure 1. In Figure 1, individuals and business firms exposed to insurable risks hedge these risks by transferring the risks to a primary insurance company (Risk Warehouse A). The hedgers pay premiums to the primary insurer and receive contingent promises that the insurer will reimburse them for specified insured events. The insurer retains most of the accepted risks for its own account; i.e., it warehouses the risks, holding them on balance sheet as current or contingent liabilities. Because the primary insurer covers many hedgers, whose risks are mostly statistically independent, it is able to reduce risk significantly through diversification.

However, some residual risk remains for various reasons, including correlation among risks, spikes in losses due to purely random fluctuations, natural disasters, and other factors. The primary insurer can transfer some of this residual risk to the reinsurer (Risk Warehouse B in Figure 1) in return for a premium payment. The traditional reinsurer, in turn, holds the risks internally and further diversifies the risk by issuing policies to many primary insurance companies from various geographical regions.

FIGURE 1
Reinsurance and Securitization



Note: The figure illustrates risk transfer and diversification in the insurance, reinsurance, and securities markets. Traditional arrangements in insurance, reinsurance, and securities markets are shown in the lower two-thirds of the figure. The central horizontal section of the diagram shows that individuals and businesses hedge risks by purchasing insurance policies, transferring the risks to the primary insurer (Risk Warehouse A) in return for a premium and receiving in return the contingent promise of the insurer to pay claims covered by the policy. The traditional primary insurer warehouses most of the assumed risks and reduces its risks through internal diversification by issuing policies to many different policyholders in a variety of lines of business and geographical regions. However, diversification is not sufficient to eliminate all risk. The primary insurer can hedge part of the residual risk of its insurance portfolio by purchasing reinsurance from a reinsurance company (Risk Warehouse B). The reinsurer holds the risks internally (i.e., warehouses the risks) and further diversifies the risk by issuing policies to a wide range of primary insurers in different geographical regions. The reinsurer can also hedge risk by retroceding risks to other reinsurers (not shown in the figure). Even after diversification, reinsurance, and retrocession, however, residual risk remains for both the primary insurer and the reinsurer. To hedge this risk and back their promises to pay claims even when claims are larger than expected, both the primary insurer and reinsurer hold equity capital by issuing shares to investors. The investors further diversify risks by holding diversified portfolios of stocks consisting of stocks in insurers, reinsurers, and firms in all other industries in the economy. The top part of the diagram portrays the role of securitization. Securitization provides another mechanism through which insurers and reinsurers can transfer risk to the capital markets. This is done by issuing ILS such as cat bonds to investors. Risk is transferred by forming SPVs. The SPVs raise funds by issuing securities (bonds and/or stock) to investors. The funds are held in trusts (not shown) and invested in safe securities such as Treasury bonds). The SPVs issue reinsurance contracts (call options) to the primary insurer or reinsurer, payable on the occurrence of a defined event such as a catastrophe. The investors diversify the risk of potential loss of principal by holding the ILS in diversified portfolios consisting of other bonds and stocks issued by firms in all segments of the economy. Thus, ILS represent “pure plays” in specific risks issued by insurers and reinsurers that do not expose investors to the overall business risks of the insurer or reinsurer, as is the case for traditional equity capital, and thus may realize a lower cost of capital in transferring insurable risks.

Once again, however, diversification reduces but does not completely eliminate risk. The reinsurer can hedge part of its residual risk through retrocession, i.e., purchasing reinsurance from another reinsurance company (retrocession is not shown in Figure 1). However, reinsurance and retrocession both can be expensive and subject to capacity limitations. Therefore, after internal diversification and reinsurance, the insurer and reinsurer still face the problem of residual undiversified risk, which can lead to unexpectedly high losses due to random fluctuations.

To back up their promises to pay claims under the terms of their policies, both the primary insurer and the reinsurer hold equity capital to provide sufficient funds in case of adverse loss or investment fluctuations. Traditionally, the equity capital is provided by stockholders, who own shares in the insurer and reinsurer (see Figure 1). The stockholders are the ultimate risk bearers or residual claimants in the reinsurance transaction. The stockholders in turn reduce their risks by holding widely diversified portfolios of shares in firms from various sectors of the economy. Thus, diversification in the traditional (re)insurance enterprise takes place through internal risk pooling, which reduces but does not eliminate the risk of random fluctuations, and through the capital markets, which diversify the residual risk of the risk warehouse across the economy via the mechanism of portfolio diversification by investors.

In their role as risk warehouse, reinsurers provide several types of reinsurance to primary insurers, often called “ceding companies” or “cedants.” These include various types of proportional and nonproportional reinsurance covers as well as catastrophe and stop-loss contracts. Reinsurers diversify by reinsuring risks from various geographical regions around the world as well as various lines of insurance such as property, liability, life, marine insurance, annuities, etc. Reinsurers also create economic value and sometimes earn fee income by providing underwriting and pricing advice to primary insurers. Their broad experience in reinsuring risks from around the globe has enabled the leading reinsurers to develop extensive expertise in insurance underwriting, pricing, and exposure management that offers significant economic value to their customers.

Historically, an important reason for the risk warehousing role of the (re)insurance industry is that traditional insurance products are not sufficiently liquid or transparent to be traded directly in capital markets. In addition, transactions cost considerations would make it uneconomical to directly trade relatively small insurance policies. However, technological advances have significantly reduced these problems and have enabled insurers, reinsurers, and other hedgers to transfer at least some types of risk directly to capital markets. An important objective of this discussion is to analyze the relationship between the indirect risk-bearing function of capital markets in the risk warehousing model and the direct investment in risk instruments through the securitization model.

To understand the limits of the traditional reinsurance risk warehousing approach, it is useful to consider in more detail how risk is reduced through pooling in an insurance enterprise. To begin the discussion, we consider risk reduction through pooling in a standard mean-variance context. The mean-variance model illustrates the role of the law of large numbers, which provides the statistical foundations for

insurance. Consider a reinsurer that has issued coverage on N risks. The risks are all insured for a single period, and the losses of the risks during the period are denoted by the random variables $X_1, X_2, \dots, X_N$. The risks have finite means, μ_i , and finite variances, σ_i^2 . It is helpful to assume that the risks are identically distributed, although they are not necessarily statistically independent. The *law of large numbers* states that

$$\lim_{N \rightarrow \infty} \Pr[|\bar{X} - \bar{\mu}| < \omega] = 1, \quad (1)$$

where $\bar{X} = \frac{1}{N} \sum_{i=1}^N X_i$ is the sample mean based on a realization of losses from the N policies, $\bar{\mu} = \frac{1}{N} \sum_{i=1}^N \mu_i$, and ω = an arbitrarily small number. Intuitively, the law of large numbers says that the sample mean becomes arbitrarily close to the population mean as the sample size increases. Thus, the expected loss is highly predictable in a sufficiently large sample.

We can use the central limit theorem to specify the amount of equity capital needed by the insurer. We assume that insurers hold equity capital to achieve a specified insolvency probability, ε . Target insolvency probabilities or, more generally, *tail value at risk* (TVaR) probabilities are widely used by insurers and reinsurers in risk management to accomplish business objectives as well as to satisfy regulators and rating agencies (Swiss Re, 2009). Even though we utilize mean-variance analysis to analyze insolvency probabilities, we are not making any assumptions at this stage about (re)insurance company utility functions or preferences, only that the (re)insurer seeks to achieve a target insolvency probability or TVaR.

Insolvency probabilities are not driven to zero because holding capital in an insurance company is costly due to corporate income taxation, agency costs, regulatory costs, accounting rules, and other factors (Jaffee and Russell, 1997). We utilize the central limit theorem to illustrate insolvency probabilities in a mean-variance context. The central limit theorem specifies that the following variable approaches normality as the sample size increases¹

$$z = \frac{\sum_{i=1}^N X_i - N\bar{\mu}}{\sigma_N}. \quad (2)$$

¹We assume that the conditions required for the applicability of the central limit theorem are satisfied (e.g., see Billingsley, 1995). The conditions are weakest for independent, identically distributed random variables and somewhat more stringent for independent random variables that are not identically distributed. For correlated (dependent) random variables, the theorem applies only under limited conditions. However, we are utilizing the theorem here primarily for illustrative purposes. We also emphasize that in practice, insurance claim distributions tend to be highly skewed and hence insurer total claims distributions may not approach normality at all or may converge to normality very slowly, with considerable residual skewness. Hence, actual capital requirements tend to be significantly higher than predicted by the normal distribution.

The parameter σ_N^2 = the variance of the reinsurer's losses, is defined as

$$\sigma_N^2 = \sum_{i=1}^N \sigma_i^2 + \sum_{j=2}^N \sum_{i=1}^{j-1} \sigma_{ij}, \quad (3)$$

where $\sigma_{ij} = \text{cov}(X_i, X_j)$. The normal distribution implies that

$$\Pr \left[\frac{\sum_{i=1}^N X_i - N\bar{\mu}}{\sigma_N} < z_\varepsilon \right] = 1 - \varepsilon, \quad (4)$$

where z_ε is the value of the standard normal variate z such that $\Pr[z > z_\varepsilon] = \varepsilon$. Therefore, the amount of equity capital needed to achieve a target insolvency probability of ε is $z_\varepsilon \sigma_N$, assuming that policyholder premiums cover the expected loss.

The standard normal result for equity capital can be used to illustrate the effects of risk diversification through pooling. Assume that the N risks in the portfolio are statistically independent, so that all of the covariances in Equation (3) are zero. Then equity capital per policy is

$$\frac{z_\varepsilon \sigma_N}{N} = \frac{z_\varepsilon \sqrt{\bar{\sigma}^2}}{\sqrt{N}}, \quad (5)$$

where $\bar{\sigma}^2 = \frac{\sum_{i=1}^N \sigma_i^2}{N}$ = the average variance. Thus, equity capital per policy goes to zero as N goes to infinity, implying that large reinsurers covering independent risks with reasonably small variances can charge a premium very close to the expected value of loss. Moreover, because the amount of required equity capital per policy is small, the cost of capital charge in the premium will also be small, leading to an efficient market for insurance.

The limitations of reinsurance markets begin to become apparent when we relax some of the assumptions under the simple mean-variance model. One important complication, which affects markets for catastrophic risks, is that the risks in the portfolio may not be statistically independent. If dependencies are present, more equity capital will be required and the cost of capital charge in the premium will be higher. To incorporate correlated risks (statistical dependencies), we relax the assumption of independence and assume instead that $\text{Cov}(X_i, X_j) = \sigma_{ij} \neq 0$, $i \neq j$. Assuming that the central limit theorem applies, the amount of equity capital needed per risk to achieve a given insolvency target becomes

$$\frac{z_\varepsilon \sigma_N}{N} = \frac{\sqrt{N\bar{\sigma}^2 + N(N-1)\bar{\sigma}_{ij}}}{N}, \quad (6)$$

where $\bar{\sigma}_{ij}$ = the average covariance among the N risks. Under these conditions, as $N \rightarrow \infty$, the amount of equity capital needed per policy approaches $z_\varepsilon \sqrt{\bar{\sigma}_{ij}}$. If the average covariance is small, providing risk transfer through reinsurance may still be efficient, but for relatively large values of average covariance, the market outcome will be inefficient in the sense that the premium loading for the cost of capital may become prohibitively high.

To illustrate the effects of covariability among risks, consider a simple example, where a reinsurer covers risks subject to Poisson frequency and lognormal severity. The Poisson parameter is 0.1, implying that the expected number of claims per policy in one period is 0.1. The loss severity distribution is assumed to be lognormal, with parameters $\mu = 10$ and $\sigma = 0.8$, where if Y is lognormal, $\mu = E[\ln(Y)]$ and $\sigma^2 = \text{Var}[\ln(Y)]$. Under these assumptions, the distribution of total claims X from each policy has mean $E(X) = 3,033.33$ and standard deviation, $\sigma(X) = 13,209.71$, such that the coefficient of variation = $\sigma(X)/E(X) = 4.35$.² In the context of reinsurance, these would be relatively small, low-risk policies.

If the policies are independent and if a large number of risks are insured so that the risk loading approaches zero, the premium would be slightly greater than the expected value of loss, i.e., Premium $\approx 3,033.33$.³ However, consider what happens when the risks are correlated. We consider two cases, where the average correlation among risks = 0.1 and where the average correlation = 0.25. The general expression for the premium in the correlated risks case is

$$P = E(X) + r_c z_\varepsilon \sqrt{\bar{\sigma}_{ij}}, \quad (7)$$

where X = total claims from one policy, r_c = the reinsurer's cost of equity capital, z_ε = value of the standard normal variate such that $\Pr(z > z_\varepsilon) = \varepsilon$, and $\bar{\sigma}_{ij}$ = the average covariance. If we assume that the reinsurer's target probability of ruin is 0.001 and its cost of capital is 10 percent, the premium would be 4,324 for an average correlation of 0.1 and 5,074 for an average correlation of 0.25; i.e., the premium would be 30 percent or 67 percent higher, respectively, than if the average correlation among risks were zero. For larger, higher risk policies, the premium increases due to covariability would be even higher, perhaps leading to a breakdown in market efficiency; i.e., the cost of capital loading may become so high such that risk-averse buyers are better off not purchasing insurance policies.

The effects of covariability among insured risks are even more pronounced for important types of reinsurance such as excess of loss (XOL). XOL reinsurance has a payoff structure mathematically equivalent to a call option spread, i.e.,

$$X_R = \alpha \{\max[X - M, 0] - \max[X - U, 0]\}, \quad (8)$$

²It is a well-known actuarial result that the mean of the total claims distribution, $E(X) = E(K) * E(Y)$, where K = the number of claims and Y = loss severity for any given claim. For the case of Poisson frequency, the variance of total claims, $\text{var}(X) = E(K) * E(Y^2)$. See, for example, Klugman, Panjer, and Willmot (2008).

³In an actual reinsurance market, of course, there would be a premium loading for underwriting and administrative expenses. We omit that part of the premium to focus on the premium components for the expected loss and the cost of capital.

where X_R = the loss paid by the reinsurer; X = the total loss; M = the point of attachment, i.e., the loss amount where the reinsurer first begins to pay; U = the point of exhaustion of the reinsurance layer; and α = the proportion of the covered loss paid by the reinsurer. The reinsurer thus does not make any payment for losses less than or equal to M and pays a maximum of $\alpha(U - M)$ on large claims. Although various types of XOL reinsurance exist, for illustrative purposes it is assumed here that reinsurance is triggered by a single loss severity event affecting one policy.

To illustrate the effects of covariability for XOL reinsurance, we analyze the same hypothetical set of exposures discussed above; i.e., we assume that a reinsurer covers a large number of policies with Poisson frequency (parameter = 0.1 per policy) and lognormal severity (parameters $\mu = 10$ and $\sigma = 0.8$ per policy). However, now we assume that the reinsurer does not cover the entire loss distribution but only the loss layer from $M = 25,000$ to $U = 45,000$; i.e., the reinsurer covers a layer of 20,000 beginning at $M = 25,000$. The expected value of total loss per policy in this layer is 582.66, and this would also be the premium charged under the assumption of zero underwriting expenses and perfect diversification (no correlation among risks). If the average correlation among risks in this portfolio were 0.1, the layer premium would be 1,194.02, and if the average correlation were 0.25, the layer premium would be 1,549.30.⁴ That is, correlation of 0.1 on average causes the reinsurance premium to double, and correlation of 0.25 causes it to increase by a factor of 2.66. The effect on the XOL reinsurance premiums is greater because the proportion of the overall risk (variance) transferred to the reinsurer exceeds the proportion of the overall expected loss covered by the layer; i.e., reinsurers generally are taking on the high-risk segments of the reinsured loss distributions.

The above illustrations show the potential effects of loss covariability on reinsurance prices. However, although we can gain insights into reinsurance pricing by utilizing the assumption of normality and the mean-variance diversification model, this model generally is not appropriate for real-world reinsurance pricing, for two major reasons: (1) many real-world risks are not normally distributed but are highly skewed, with the skewness sufficient such that the loss distribution does not come close to normality even in very large pools,⁵ and (2) the cost of capital for reinsurers is likely to deviate from the levels implied by conventional capital market theory, reflecting various factors including skewness and the stress that the riskiest reinsurance policies place on reinsurer capital and insolvency probabilities. In fact, the cost of capital may be considerably higher than the 10 percent level assumed in our illustrations.

To consider the issue of the cost of capital, we first consider the cost of capital that would be predicted for reinsurers by conventional capital market theory. Specifically,

⁴The premium calculations are based on Equation (7), with the portfolio variances calculated using the limited expected value formulas for the lognormal given in Klugman, Panjer, and Willmot (2008). These calculations retain the assumption that the cost of capital is 10 percent.

⁵Indeed, some risks covered by insurance and reinsurance may not converge to normality but rather to some other member of the stable family of distributions, which may have nonexistent higher moments, e.g., infinite variance.

the standard capital asset pricing model (CAPM) provides the following formula for the cost of capital

$$E(r_c) = r_f + \beta_c[E(r_m) - r_f], \quad (9)$$

where $E(r_c)$ = the cost of capital for a specified firm, r_f = the risk-free rate of interest, β_c = the market systematic risk (beta) coefficient for the firm, and $E(r_m) - r_f$ is the market risk premium for systematic risk.⁶ The CAPM model compensates investors only for market systematic risk because it is assumed that investors hold broadly diversified portfolios such that idiosyncratic risk applicable to individual stocks is diversified away. The model also includes no component reflecting insolvency or financial distress risk, the cost of capital is determined solely by the covariability of the firm's cash flows with those of the market portfolio.

Although the CAPM provides some significant insights into reinsurance pricing, researchers have recognized that it does not necessarily apply to all firms under all circumstances. Specifically, there is increasing recognition that this model does not necessarily apply to some types of intermediated risk projects such as those undertaken by banks, insurance companies, and other financial institutions. Froot and Stein (1998) develop a model of capital budgeting and capital structure for financial institutions where the valuation of intermediated risks incorporates pricing factors that are not reflected in standard perfect markets financial pricing models. They posit that financial institutions invest in liquid assets, which are perfectly hedgeable in financial markets, but also invest in illiquid assets, which are not frictionlessly hedgeable because they are information intensive and have unique features. Examples of illiquid, imperfectly hedgeable assets in the insurance industry include most types of property-liability insurance policies, including commercial liability insurance and catastrophe reinsurance.

Froot and Stein (1998) hypothesize that holding capital is costly for financial institutions, implying that raising capital and investing it in the firm's assets leads incurs a type of "tax" whereby the value of the assets will be less than the amount of capital invested. Capital is costly due to various frictional costs such as corporate income taxation, agency costs, regulatory costs, moral hazard, and adverse selection issues, and behavioral factors. Hence, it is not feasible for institutions to hold sufficient capital to eliminate the possibility of having to raise external capital under unfavorable conditions due to adverse investment outcomes.

Raising new external capital is costly because of informational asymmetries between firms and capital market and for other reasons (Myers and Majluf, 1984; Froot, Scharfstein, and Stein, 1993). For example, the reinsurer inevitably knows more about its risk exposures and investment opportunities than external capital providers, such that capital providers may require a cost of capital higher than justified purely by the risk of the firm's project cash flows to cover the possibility that cash flows may be riskier than publicly available information suggests. There also may be agency costs associated with motivating and monitoring managers who would otherwise act in their own interests rather than pursuing the interests of owners. Froot et al. (1993) and Froot and Stein (1998) argue that financial intermediaries face convex costs of

⁶The beta coefficient is defined as $\beta_c = \text{cov}(r_c, r_m) / \text{var}(r_m)$.

raising external capital; i.e., the per unit cost of raising external capital is increasing in the amount of external capital sought.

Besides facing convex costs of raising external capital, financial institutions are hypothesized to invest in informationally intensive, illiquid assets that cannot be fully hedged in financial markets.⁷ Under these conditions, Froot and Stein (1998) show that the hurdle rates and hence the prices of illiquid intermediated risk products are given by a two-factor model, consisting of the standard CAPM market systematic risk factor and a factor reflecting the covariability of the risk product's returns with the institution's preexisting portfolio of nontradable risks. The price of the latter covariability term depends upon the institution's *effective risk aversion*, which is driven by the convexity of the cost function for external capital as well as the capital structure of the institution.⁸ Specifically, the prices of intermediated products are inversely related to the amount of capital held by the firm because effective risk aversion declines as capital increases. Thus, the principal predictions are that the price of an intermediated risk will be positively related to its covariability with the other risks in the institution's portfolio and will be inversely related to the institution's capitalization.

An extension of the Froot and Stein (1998) model is presented in Froot (2007) based on the observation that insurance and reinsurance companies in particular are likely to be especially sensitive to insuring risks that adversely affect solvency. Also, because insurance pays off when the marginal utility of customer wealth is relatively high, insurance customers are likely to be "more averse to an insurer's failure to perform than to a debtor's failure to perform, even if the performance failure is of equivalent size" (Froot, 2007, p. 274). Insurers are also likely to be especially sensitive to the costs of holding risks because their project return distributions tend to be characterized by negative skewness. Froot (2007) generalizes the Froot–Stein model to incorporate policyholder insolvency aversion and negatively skewed return distributions.

The result of Froot's (2007) modeling is the following three-factor pricing model for nontradable, negatively skewed insurance risks

$$E(r_i) = r_f + \beta_i[E(r_m) - r_f] + \lambda_i \text{cov}(\omega, \varepsilon_i) + \eta_i \text{cov}(\varepsilon_p, \varepsilon_i), \quad (10)$$

where $E(r_i)$ = cost of capital (hurdle rate) for incremental project i , β_i = the incremental project's market systematic risk beta coefficient, λ_i = the price of overall firm risk, η_i = price of asymmetry risk, ω = the reinsurer's random return on existing projects, ε_i = random part of the return on incremental project i , and ε_p = the asymmetrically distributed component of internal funds. This model incorporates the usual pricing

⁷In the case of property-liability insurers, the illiquid, unhedgeable projects are insurance liabilities created by issuing various types of insurance policies. Insurers generally invest in traded assets such as stocks and bonds.

⁸Froot and Stein (1998) do not argue that financial institutions are inherently risk averse in the usual sense of consumer decision making. Rather, because they invest in nonhedgeable risks and face convex costs of raising new external capital due to capital market imperfections, institutions are hypothesized to behave as if they were risk averse. The effective risk aversion drives the price of the covariability term for nonsystematic, unhedgeable risk in the Froot–Stein model.

factor for systematic market risk but adds factors for the covariability of the new project with the firm's existing projects and for the new project's contribution to the asymmetry of the reinsurer's overall rate of return distribution.

The two additional factors in Froot's pricing model are present because of the existence of costly capital and the convex costs of raising new external capital. Relatively high covariability of a new project with the firm's existing projects is undesirable because it increases the likelihood that the firm will suffer a capital depletion. If its capital is reduced, the firm may have to forego potentially profitable new projects because the cost of capital is too high or may have to raise costly external capital at a high price. Hence, even though this component of risk is nonsystematic in the usual capital market sense, it will be incorporated in the price of reinsurance. The skewness factor is present for similar reasons. That is, because losses from non-life insurance tend to be positively skewed, writing non-life reinsurance creates negative asymmetries in the reinsurer's overall rate of return distribution. Such asymmetries are undesirable because they increase the probability that the reinsurer will suffer adverse capital shocks and be forced to forego new projects or to raise costly external capital.

The prices of the firmwide risk and asymmetry factors are determined by the firm's capital structure and the convexity of the cost function for external capital. The price of these two terms reflect the firm's effective risk aversion, which is determined endogenously from its optimization of firm value in the presence of costly external capital and risky project return distributions. The prices of these two factors are increasing in the convexity of the cost of capital and decreasing in the amount of internal capital held by the firm. Thus, reinsurers that face relatively high costs of external funds and hold relatively low internal capital will have higher prices than firms with lower costs of capital and higher internal funds. This helps to explain the well-documented swings in reinsurance prices and supply of coverage over the underwriting cycle (Cummins and Weiss, 2009). That is, when reinsurers sustain a capital shock due to a large catastrophe or unusual investment loss, their effective risk aversion rises, leading to higher prices for reinsurance policies that are correlated with existing projects or increase return asymmetries.

The mean-variance analysis and the Froot and Stein (1998) and Froot (2007) capital market analyses imply that reinsurance markets are likely to be highly efficient for diversifying relatively small, relatively symmetrical, statistically independent risks. Risks that are larger and correlated are likely to have much higher prices, even under the assumption that the cost of capital is relatively low and reflect only market systematic risk. Capital market imperfections provide another source of inefficiency in the reinsurance market. To the extent that capital is costly and costs of external capital are convex, the price of risks that covary with the reinsurer's existing portfolio will rise even higher. These effects are aggravated for risks that create significant asymmetries in the reinsurer's return distribution and become more important after the reinsurer has suffered an adverse shock to capital due to underwriting or investment losses.

This discussion of reinsurance pricing is not meant to imply that reinsurers exert monopoly power or that reinsurance markets are not competitive. Although the largest reinsurers may indeed have some market power, the reinsurance pricing effects due to correlated risks, asymmetries, and costly capital would be present even in a perfectly competitive market. In a competitive market, reinsurers are assumed

to formulate policy offers in accordance with the theories of pricing discussed in the preceding section. Hence, price quotations will reflect expected loss costs, underwriting expenses, and a risk charge. The risk charge is assumed to reflect market systematic risk, the covariability of risks with the insurer's existing portfolio, and the contribution of risks to the negative asymmetry of the insurer's profit distribution.

Reinsurers are assumed to make price-quantity offers to potential policyholders, and buyers are allocated among insurers through the operation of competitive insurance markets. Price-quantity offers for any given reinsurance placement will differ across reinsurers in the market depending upon their existing risk portfolio, costs of capital, and quantity of internal capital. Reinsurance buyers are assumed to shop across the industry for the best price-quantity offers either directly or through reinsurance brokers, who obtain price quotes from a range of insurers (Swiss Re, 2004; Cummins and Doherty, 2006). Because reinsurer price quotes are heterogeneous, any given insurance placement will tend to go to the reinsurer with the lowest price quote, conditional on coverage quality and insolvency risk. The reinsurer that wins the contract is likely to be the one with the lowest covariability, i.e., the insurer for which the risk is most beneficial in terms of diversification or least costly in terms of insolvency risk.⁹ Thus, pricing reflects differences in insurer underwriting portfolio configurations, but risk allocation and price determination result from market competition rather than reinsurer market power.

To set the stage for the discussion of securitization, it is useful to summarize the advantages and disadvantages of the traditional model of risk transfer and diversification in the insurance industry. The traditional model involves the pooling of risks held in risk warehouses, which access capital markets primarily by issuing stock to investors (Figure 1). This model obviously has some compelling advantages, which explain why it has been the predominant approach to risk transfer for such a long period of time and likely will continue in this role in the future. By internalizing the benefits of the law of large numbers, the risk warehouse approach enables reinsurers to achieve a high degree of risk reduction through diversification. This means that a relatively small amount of equity capital can support reinsurance coverage with policy limits many hundreds of times larger than the amount of equity committed while still maintaining acceptable levels of insolvency risk. By warehousing risks over a long period of time, the reinsurer also internalizes significant amounts of information about risk underwriting, risk management, and exposure management; i.e., the reinsurer achieves economies of scale in information acquisition and analysis. The benefits of this information can be transferred to the reinsurer's clients at a relatively low cost.

Even though risk warehousing creates important market efficiencies, it also has disadvantages, which have led to the development of capital market solutions. Reinsurance contracts held on balance sheet tend to be opaque to the securities market, making it

⁹Insurer underwriting portfolios and risk management strategies change over time such that commercial risks shop their coverage annually, and it is quite common for commercial buyers to switch insurers frequently to obtain better prices. In fact, the commercial lines property-liability market is often characterized as "commoditized," i.e., highly price sensitive and with little brand loyalty, contingent on financial ratings (Cummins and Doherty, 2006).

difficult for equity holders to evaluate the firm and creating informational asymmetries that raise the cost of capital. Capital costs also are high because risk warehouses are subject to corporate income taxation and have relatively high agency costs due to their opacity and complexity. Capital costs and informational asymmetries provide an explanation for the reinsurance underwriting cycle, which is a major source of reinsurance market inefficiency. Finally, the market begins to crumble when faced with very large, highly skewed risks whose realizations could create major shocks to the reinsurance capital base. For such risks, and perhaps also for some more routine risks, it is not necessarily clear that the best or only way to access the capital market is through issuing shares of stock. This argument provides the *entre* for securitization.

Securitization

As we have seen, the traditional reinsurance model begins to break down when risks are correlated, add significantly to the reinsurer asymmetry risk, and are large relative to the reinsurer's equity capital. The cost of capital is also increased by informational asymmetries between reinsurers and capital market and by agency costs and other market frictional costs. Under these conditions, the price of reinsurance may be prohibitively high, and the supply of coverage may be restricted.

Securitization can help to resolve reinsurance market inefficiencies in several ways:

1. Risks that are correlated within insurance and reinsurance markets may be uncorrelated with other risks in the economy. For example, the risk of property catastrophes such as hurricanes and earthquakes leads to covariability of risk within the reinsurance industry, but such risks are largely uncorrelated with the economic forces that drive securities markets. Hence, if these risks can be passed directly to securities markets, it may be possible to significantly reduce the covariability loading in the premium. The low covariability with other investment risks also make the contracts attractive to investors for purposes of diversification, potentially permitting risks to be transferred at relatively low cost in comparison with reinsurance.
2. In comparison with the total volume of securities traded in capital markets, the equity capital of insurers and reinsurers is miniscule. In addition, the largest projected insured loss events are also very large relative to the total capitalization of the insurance industry. Modeling firms have estimated that a \$100 billion event in Florida or California has a probability of occurrence in the 1–2 percent range. Such events are large relative to the capacity of the global reinsurance industry but would be less than 0.5 of 1 percent of the value of stocks and bonds traded in the United States alone. Hence, it is likely to be much more efficient to transfer such risks directly to securities markets.
3. If properly structured, securitized financial instruments can significantly reduce or eliminate the credit risk (insolvency risk) inherent in reinsurance policies.

The various types of ILS are described in detail in Cummins and Weiss (2009), Cummins (2008), and other sources. For present purposes, we focus the discussion on insurance-linked bonds, which have been by far the most successful securitization structure to date. And, in particular, we compare the capital market role in

supplying risk capital through insurance-linked bonds with the traditional approach of supplying equity capital to the risk warehouse (insurer or reinsurer).

To illustrate insurance-linked bonds, we focus on bonds for catastrophic property risk, known as cat bonds.¹⁰ The role of securitization through cat bonds is shown in the "Capital Markets: Securitization" section of Figure 1. A cat bond transaction is typically initiated by a sponsoring insurer or reinsurer, who establishes a special purpose vehicle (SPV). The SPV is a free-standing entity that is off balance sheet for the insurer/reinsurer. The SPV raises capital by issuing bonds to investors.¹¹ The funds raised in the bond issue by the SPV are held in a trust and invested in safe securities such as Treasury bonds. The SPV enters into a reinsurance transaction with the sponsoring insurer or reinsurer, which involves the agreement to release funds from the trust to the sponsor on the occurrence of a defined catastrophic event. The reinsurance payoff is usually structured as a call option spread, similar to the XOL reinsurance payoff function shown in Equation (8). In return for taking on the risk of possibly losing the bond principal, the investors receive a premium, ranging anywhere from 2 to 9 percent. Thus, their total return on the bond, in the event that no event occurs, is equal to the return on the securities in the trust plus the bond premium. The premium is paid by the sponsor in return for the reinsurance coverage.

Securitization differs from the traditional model of the risk warehouse shown in Figure 1, which internally diversifies risk and issues equity capital in the securities markets to cover the residual risk not eliminated through pooling. In an insurance-linked bond securitization, the reinsurer transfers specific risks from its warehouse directly to the capital market, in effect insulating its balance sheet from these risks. This direct capital market access creates "pure play" securities in specific types of insurable risks. In comparison to investing in insurer or reinsurer stocks, such pure play securities insulate the investor from the general business risks, agency costs, regulatory costs, and other frictional costs of operating a reinsurance company and hence the risks may be transferred at a lower cost than using traditional equity capital.

It is instructive to consider further the relative position of the investors in the cat bond and the shareholders of a reinsurer. The equity investor in the traditional risk warehouse is the residual claimant on the reinsurer's net worth. As long as the total portfolio of the reinsurer remains profitable, the equity investors make money on their investment. Specific, individual losses do not necessarily lead to losses by equity holders as long as they are offset by favorable experience elsewhere in the reinsurer's portfolio of insured risks. In essence, the equity holder is taking insurance risk by buying into an already diversified underwriting portfolio. The equity holder diversifies the residual risk inherent in the risk warehouse by holding a diversified portfolio consisting of insurance and noninsurance stocks.

The holder of a cat bond might seem to be in very different position by buying a security, which covers a carefully defined, nondiversified risk rather than buying into a diversified underwriting portfolio. However, this overlooks the fact that the

¹⁰The structure of cat bonds is discussed in detail in Cummins and Weiss (2009).

¹¹The investor base for cat bonds has become very broad and includes hedge funds, dedicated cat mutual funds, high-wealth individuals, and financial institutions. See Cummins and Weiss (2009).

cat bond investor can create “homemade” portfolio diversification by investing in a wide range of cat bonds covering other specifically defined insurable risks and also investing in stocks and bonds covering other types of non-insurance-linked risks. Dedicated mutual funds focusing on cat bonds have been created precisely to assist the investor in diversification. Hence, the ultimate diversification takes place through investment markets, and in theory, there is no need for the risk warehouse.

Cat bonds have also been criticized for having high spreads relative to reinsurance. However, because data have been slow to develop, the analysis of cat bond pricing is still in its infancy. The studies that have been done, however, show that spreads have declined significantly over time. An analysis of bonds issued during the period 1997–2000 showed a median ratio of bond premiums to expected loss of 6.77 (Cummins, Lalonde, and Phillips, 2004). However, beginning in 2001, bond premiums declined sharply and were trading in ratios of about 2.3 on average prior to Hurricane Katrina in 2005. Although spreads increased following Katrina, they returned to about 3.0 by early 2008 (Cummins and Weiss, 2009). Based on an analysis over the period 1997 through the first quarter of 2008, Lane and Mahul (2008) find ratios of long-term bond premiums to expected losses of 2.69, unadjusted for the reinsurance market cycle, and 2.33, adjusted for the cycle. Dieckmann (2008) finds average cat bond spreads of 4.3 times expected losses with a median of 3.8, but his analysis focuses on Hurricane Katrina and is limited to a relatively small sample of bonds in existence when Katrina made landfall. In addition, his multiple regression analysis implies lower spreads than the simple averages, between 2.0 and 3.0. Thus, the consensus of findings is that current spreads are no more than about 4 and probably in the range of 2.0 to 3.0.

The analysis of comparative pricing of cat bonds and reinsurance is even less developed than the analysis of cat bond spreads. Comparison of cat bond and reinsurance prices is difficult, for the following reasons (among others): (1) cat bonds have multiyear terms, while reinsurance contracts are typically for 1 year; (2) cat bonds are collateralized and thus have lower counterparty risk than most reinsurance transactions; and (3) reinsurance contracts usually include reinstatement provisions, whereas cat bonds do not. The multiyear feature tends to increase cat bond spreads relative to reinsurance because of the usually upward sloping term structure of interest rates. The lack of a reinstatement provision also would tend to increase cat bond spreads relative to reinsurance on the rationale that the reinsurer can count on another source of income following a loss, whereas cat bond investors cannot (GC Securities, 2008). Collateralization should reduce cat bond prices relative to reinsurance.

Also relevant in analyzing prices of cat bonds are comparisons with reinsurance prices, on the one hand, and corporate bond prices, on the other. Froot (2001), based on data from Guy Carpenter, reports reinsurance premiums more than seven times expected losses during the period 1992–1997, and this finding is reinforced by Cummins and Weiss (2009), who show that the premium to expected loss ratio for reinsurance is in this range for expected loss levels comparable to those covered by cat bonds during 2006, following Katrina–Rita–Wilma. However, Cummins and Weiss show lower reinsurance price spreads for 2006–2008, 4 to 6 for a loss probability of 1 percent and 2.5 to 4 for a loss probability of 2 percent. Thus, cat bonds do not seem to have excessive prices in comparison with reinsurance.

In comparison with comparably rated corporate bonds (BB rating) cat bonds seem to trade at a premium over corporates (GC Securities, 2008), although because of the relatively small number of cat bond transactions, each of which is unique, cat bond data are “noisier” than data on BB-rated corporate debt. Dieckmann (2008) finds that the average yield spread of cat bonds in 2005 was 2.2 times the spread of corporate bonds with comparable ratings and time to maturity. Although the Guy Carpenter’s analysis shows relatively high differences between cat and corporate bond spreads in 2005 compared to earlier and later years, it does seem that cat bonds have spreads that are at least somewhat higher than comparable corporate bonds.

An important question is what is expected theoretically in terms of spreads on cat bonds, and comparable ILS. The early literature on cat bonds suggested that ILS are “zero-beta” securities in the capital market sense and hence can enable investors to move the efficient investment frontier in a favorable direction due to their value as diversifying assets (Litzenberger, Beaglehole, and Reynolds 1996; Canter, Cole, and Sandor, 1997). Thus, a strict CAPM interpretation would imply that yields on cat bonds should eventually converge to the risk-free rate of interest (see Equation 9). The prediction of low spreads is not changed by the pricing model of Froot (2007) (Equation 10) because this model applies to financial intermediaries such as reinsurers that hold equity capital and invest in relatively illiquid, unhedgeable projects, not to claims traded freely in financial markets. Therefore, to go beyond the zero-beta security argument, we need to look elsewhere.

A recent paper develops a theoretical model that may help to explain why cat bonds will continue to trade at nonzero spreads above the risk-free rate even as the market expands. Dieckmann (2008) adapts an earlier model developed by Campbell and Cochrane (1999) to explain cat bond spreads. The Campbell–Cochrane model is a generalization of the familiar representative-agent, consumption-based asset pricing model, which adds a slow-moving habit, or time-varying subsistence level of consumption to a basic power utility function. Representative agents are assumed to maximize the following intertemporal utility function

$$U(C, X) = \sum_{t=0}^{\infty} e^{-rt} \frac{(C_t - X_t)^{1-\gamma} - 1}{1 - \gamma},$$

where r = the discount rate; C_t = consumption in period t ; X_t = level of habit, i.e., a slow-moving subsistence level of consumption; and γ = the risk aversion parameter. The relationship between consumption and habit is modeled via the *surplus consumption ratio* $S_t = \frac{C_t - X_t}{C_t}$, where S_t approaching 0 corresponds to an extremely bad state in which consumption is equal to habit, and $S_t > 0$ implies more prosperous states of the world.¹² It is easy to demonstrate that relative risk aversion under this model is $\eta_t = \frac{\gamma}{S_t}$. Hence, relative risk aversion is highest when consumption is close to the level of habit, making consumers especially averse to states of the world where S_t is low. Thus, “as consumption declines toward the habit in a business cycle trough, the

¹²In the model, habit adjusts nonlinearly to the history of consumption, such that habit is always below consumption, keeping marginal utility always finite and positive.

curvature of the utility function rises, so risky asset prices fall and expected returns rise" (Campbell and Cochrane, 1999, p. 206).

In Campbell and Cochrane (1999), consumption is subject only to "regular economic risk," which enters the model through a lognormal process. Dieckmann (2008) generalizes the model to allow also for catastrophic risk, which enters the model through Poisson-distributed random event arrivals, with random impact size. The intuition inherent in these models is that adverse shocks to consumption drive consumers toward the level of habit, raising risk aversion and leading to prices that are relatively high for assets that do poorly during economic downturns. As Campbell and Cochrane point out, "consumers do not fear stocks because of the resulting risk to wealth or to consumption per se; they fear stocks primarily because stocks are likely to do poorly in recessions, times of low surplus consumption ratios."

Analogously, Dieckmann (2008) argues that the catastrophe version of the model can be used to explain spreads on cat bonds, which lead to adverse shocks to bond-holders during periods when the economy has just suffered a catastrophe and thus consumption is relatively low. Based on a reasonable calibration of his model, Dieckmann finds that potential negative economic shocks of 1.9 percent of consumption for windstorm risk and 2.5 percent for nonwindstorm risk, would imply the pre-Katrina levels of cat bond spreads. That is, the model requires only a small amount of catastrophic risk relative to total economic risk to generate observed spreads on cat bonds during "normal," e.g., pre-Katrina periods. The model also predicts increases in spreads following a catastrophe that are consistent with the increases that occurred post-Katrina. Thus, the consumption-based asset pricing model seems to offer a potential explanation for observed cat bond spreads. Further empirical research is needed to test the predictions of the model and perhaps to develop a model that could be used in cat bond trading.

Substitutes or Complements

Based on the above discussion, we can draw some conclusions regarding whether reinsurance and securitization are substitutes or complements as risk financing techniques. On balance, we conclude that the two approaches generally are complements but may be substitutes for certain types of risk, such as the risk of large catastrophes.

As mentioned, the traditional risk warehousing model whereby risks are diversified internally by an insurer or reinsurer continues to be a powerful approach to financing risk. However, this technique works best when risks are numerous and statistically independent and where maximum probable losses are relatively small. With many, relatively small, independent risks, the amount of equity capital required is also relatively small, such that the cost of capital tends to be low and the price of insurance is close to the expected loss plus the expense loading.

In practice, as we have seen in the above discussion, risk warehouses create potential efficiencies that have led to their long-term success. In addition to their ability to diversify relatively small, independent risks, insurance risk pools tend to generate informational and transactions costs efficiencies. As discussed above, reinsurers are able to achieve significant scale economies in accumulating and analyzing underwriting information and providing information-related services to their clients. In addition,

it is likely (although possibly debatable) that the transactions costs of issuing ILS are significantly higher than those of the risk warehouse, at least for relatively small, statistically independent risks. This is primarily because each cat bond issued requires the establishment of a separate SPV, with the attendant legal, actuarial, accounting, and administrative costs. Nevertheless, issuance costs have decreased significantly as the market has matured, and market participants have developed mechanisms that enable them to spread issuance costs over multiple issues.¹³

When the risks insured begin to depart from the assumptions underlying the traditional risk pool, however, pressures begin to develop for securitization. As we have seen, correlation among risks may both dramatically increase the amount of equity capital required to support the risk warehouse and raise the cost of capital the risk warehouse will have to pay. The effects are even more dramatic for risks that are not only correlated but highly skewed, as Froot's (2007) pricing model demonstrates. Risks with large maximum probable losses also stress the capacity of traditional insurance and reinsurance markets. For such risks, securitization may be the most efficient solution. As the costs resulting from covariability, skewness, and high potential losses increase, securitization begins to substitute for reinsurance, but for the very highest level of risk reinsurance may be uneconomic and hence reinsurance and securitization are complementary. Thus, given the efficiencies of risk warehouses in handling numerous, relatively small, independent risks, we do not expect that securitization will replace reinsurance. However, for larger, more correlated risks, securitization begins to compete with reinsurance, and securitization may be the only solution for the largest, most catastrophic risks.

Another dimension of the complementarity between reinsurance and securitization relates to credit risk. Insurance-linked bonds generally are fully collateralized, providing the hedger with a high degree of protection against the risk of default. By contrast, reinsurance substitutes diversification for collateralization when it comes to hedging the risk. But the diversification offered by reinsurance is only efficient as long as a substantial number of the reinsured events do not occur at the same time. In this latter case, which is rare but which the cedant cannot afford to ignore, the reinsurance company in question is normally in default. The assets of the company are then divided ratably among the cedants on the basis of the indemnities that are in fact owed. But this pro rata rule is not efficient because it leads to different exposures of the cedants to the default risk. Indeed, the cedants that have passed on extreme risks (i.e., low-frequency/high-loss risks) are penalized with respect to those cedants that have transferred average risks (i.e., higher-frequency/lower-loss risks). This inefficiency arises due to the rules for allocating the assets among the claimants in the event that the insurance or reinsurance company defaults. The securitization of the low-frequency risk allows for the attenuation of this asymmetry insofar as it offers, for the corresponding fraction of the risk, a secured hedge against the default risk of the reinsurer, because it is collateralized (Lakdawalla and Zanjani, 2006). In other words, securitization corrects for the inefficiency of the reinsurance market linked to the heterogeneity of the cedants, combined with the incomplete nature of reinsurance contracts.

¹³One important development is the *shelf registration*, which gives the sponsor the option to issue additional bonds (takedowns) over a specified risk period.

In addition to its ability to pool relatively predictable, uncorrelated risks, the reinsurance market also has the advantage of maintaining long-term relationships between reinsurers and cedants. For the more predictable risks, at least, the reinsurance market remains open at all times, while the securitization market has been marked by sharp discontinuities, depending on economic conditions, and there have been times, including the financial crisis of 2008, when the securitization market closed down entirely. Reinsurance therefore is expected to remain the dominant player in markets that are not very opportunistic, in the sense of shifting risk management strategies in response to relatively small price differences. The stability of the client relationship and the relative stability of supply over the course of the underwriting cycle are likely to maintain an important role for reinsurance for nonopportunistic cedants, especially those with relatively small, uncorrelated exposures. Client relationships are the bread and butter of diversified reinsurers, as opposed to specialized, monoline reinsurers, which have generally developed opportunistic strategies largely based on the securitization of the commodity they sell.

A theory of long-term relationships between insurers and reinsurers has been developed by Jean-Baptiste and Santomero (2000). They argue that long-term relationships allow the efficient sharing of information between insurers and reinsurers and allow new information to be incorporated in reinsurance pricing. This leads to more efficient risk allocation between insurers and reinsurers, with attendant benefits in terms of the quantity of reinsurance coverage, insurer profits, and the level of insolvency risk in the industry.

It is possible that this type of efficient risk sharing also could be achieved through securitization, and the increasing use of shelf offerings and dedicated ILS mutual funds represent steps in that direction. Informational asymmetries also may exist in the securitization market between the ILS sponsor and investors. For many types of ILS, potential informational asymmetries have been mitigated through disclosures in the ILS bond prospectuses and by the use of nonindemnity triggers.¹⁴ However, such asymmetries are likely to be somewhat more pronounced for broadly based securitizations such as those involving automobile insurance portfolios. Thus, the ILS market has some potential informational problems and in general is still in the process of establishing itself as a reliable, long-term source of risk capital.

In terms of being a direct substitute for reinsurance, securitization is primarily accessible to large insurers, who have sufficient mass to assemble significant securitization transactions to amortize the high costs of structuring. Larger insurers also tend to be recognized players—in many cases major ones—in the international financial markets via their own asset management entities, which gives them easier access to a pool of investors than smaller firms. This enables larger insurers to achieve optimal risk management by combining reinsurance and securitization. Such strategies are less accessible to small- and medium-size insurers, who generally cannot generate transactions of sufficient size to cover structuring costs and often lack the financial sophistication to put together securitization deals. This provides an important role

¹⁴ A theoretical analysis of the role of nonindemnity triggers in mitigating asymmetrical information problems is provided in Finken and Laux (2009).

for global reinsurers, who can make the benefits of securitization available to their smaller clients.

SECURITIZATION: OTHER ISSUES AND CONSIDERATIONS

This section discusses additional issues relating to securitization. We begin by discussing motivations for securitization other than risk financing. The discussion then turns to the advantages of ILS to investors. The section concludes by discussing the effects of regulation on the decision to utilize reinsurance or securitization to manage risks.

Other Motivations for Securitization

Aside from securitizations with the objective of optimizing the cost of risk, three other categories of securitization play an important role: the securitization of embedded value, the securitization of regulatory arbitrage, and complementary securitization, which provides additional underwriting capacity to (re)insurers or protects their equity capital.

The securitization of embedded value is probably the most important of the three categories today. This type of securitization makes it possible to monetize intangible assets in life insurance and reinsurance, such as deferred acquisition costs and future profits (Cowley and Cummins, 2005). The value of these assets is often not taken into account or is only partially taken into account under local accounting standards, under prudential standards, or by credit rating agencies, which means that they do not appear on the asset side of the balance sheet of companies, reducing their capital equivalently. Accountants, supervisors and credit rating agencies either do not recognize these assets or take them into account partially, due to the very nature of intangibles—revenues or profits that often will only emerge far into the future over a long time frame. The asset markets, which are subject to rules that are generally less stringent on the whole, assign a value to the expected value of these future revenues and profits. It may therefore be tempting for a company that wants to improve its balance sheet to realize a monetary value for these revenues and profits before they emerge. In addition, this may be a way of securing uncertain future revenues and profits, at the cost of paying a risk premium. From this perspective, securitization is not competing with insurance; on the contrary, it provides insurance with a new dimension of financial flexibility.

Securitization with the objective of arbitraging between different regulations (regulatory arbitrage) is also an important category. Its purpose is to work around the inefficiencies of prudential regulation. Although securitization developed initially as a way of hedging catastrophic risks, regulatory arbitrage securitization has shown a tendency to develop in less risky segments of insurance. It seeks to securitize risks for which regulators impose constraints—in particular, capital or reserve requirements—that are excessive given the reality of the risks involved, particularly compared with the measurement of these risks made using internal models. In fact, if on average reserve and capital requirements are excessive, companies will be encouraged to securitize those liabilities whose value-at-risk is lower than these requirements so as to self-finance only those risks that are the most dangerous, i.e., those risks whose value-at-risk is equal to or higher than these requirements. This is why some companies

pass on the senior tranches of their risks to the capital market, retaining only their junior tranches. The logic behind regulatory arbitrage securitization is therefore quite the opposite of that of catastrophic risk securitization, where only junior tranches of the risk are transferred to the market.

Regulatory arbitrage securitization has undergone the most extensive development in life insurance, following the adoption in the United States of the XXX and XXX regulations on term life and universal life products (Cowley and Cummins, 2005). In the case of these products, even the credit rating agencies feel that the reserve requirements exceed the risks involved.¹⁵ Recently, it has spread to other insurance segments, such as motor insurance in Europe, where Solvency I undoubtedly placed the bar too high on capital requirements. This form of securitization can compete directly with reinsurance transactions whenever the latter are subject to prudential standards that are identical to those applicable to the underlying insurance.

Insurance securitization also allows companies to get around restrictions on reinsurance capacity or the rise in reinsurance rates, particularly during periods that follow major insurance disasters. This function can be viewed as complementary to the activities of topping up the underwriting capacity of an insurance company or safeguarding its capital. Indeed, reinsurance and securitization can be viewed either as mechanisms that enable the transfer of risk or as mechanisms that free up capital. And as long as they are correctly taken into account when solvency margin requirements are calculated, securitization and reinsurance lead to a proportionate reduction in the solvency margin requirements set by regulation or by the insurance rating. This freed-up capital can be used either to improve the solvency ratio (i.e., the constituted solvency margin ratio versus the required solvency margin) or to enhance underwriting capacity. This similarity between securitization and reinsurance places them in competition, as insurance companies and retroceding reinsurance companies will choose between the two based on market availability and cost differential.

However, even during hard phases of the reinsurance pricing-availability cycle, ceding and retroceding insurers do not exercise a binary choice: either securitize all the risks they wish to remove from their balance sheet or reinsure all of these risks. Insurers have been more likely to use the two risk transfer techniques simultaneously and to use securitization to moderate the pressures of reinsurance cycles. As mentioned, this is because insurers and reinsurers view their relationship from a long-term perspective, in the interest of safeguarding at all times and even at periodically high prices, adequate access to reinsurance. Accordingly, the substitutability between

¹⁵Regulation XXX, formally known as National Association of Insurance Commissioners (NAIC) Model Regulation 830, "Valuation of Life Insurance Policies," was adopted in the United States in 2000. The regulation established very conservative reserving standards for level premium term life insurance contracts. Regulation XXX (NAIC Actuarial Guideline 38) establishes similar guidelines for universal life policies. These reserves are widely believed to exceed the economic reserves actually needed to fund future policy obligations and thus lead to a reduction in insurer equity capital (surplus), which most insurers consider to be artificial (Potter, Dembeck, and Brill, 2007). By securitizing these obligations, insurers can reduce their regulatory reserves and increase regulatory capital at a reasonable cost because the capital markets evaluate the reserves closer to their true economic value. There are no comparable life insurance reserve requirements in Europe.

securitization and reinsurance exists, but within limits. This is particularly true of the relationships between regional or national insurers and globally diversified reinsurers that have been present in the market for many years. Conversely, it is less true of relationships with monoline reinsurers, which themselves have an opportunistic underwriting strategy that the ceding and retro-ceding companies themselves react to by implementing opportunistic strategies.

Advantages of ILS to Investors

Much has been written in the prior literature about the advantages of ILS to investors, going back to early papers such as Litzenberger, Beaglehole, and Reynolds (1996) and extending to more recent works, including Swiss Re (2006), Albertini and Barrieu (2009), and Cummins and Weiss (2009). Consequently, our discussion will be brief and focus mainly on points not covered extensively by prior researchers.

For most of their history, the primary appeal of ILS, particularly cat bonds, to investors was their yields, which were quite high in comparison to stocks and other securities with comparable financial ratings. However, as we have seen in the above discussion, yields on cat bonds have been declining, and they now seem to be priced comparably to reinsurance and BB corporate bonds. Consequently, it does not seem to be the case that yields are now excessive in comparison to the risk borne. And, in fact, given the general efficiency of capital markets, yields disproportionate to risk would quickly attract new investors, driving yields downward.¹⁶ Although more research on the topic is clearly needed, a reasonable hypothesis is that the yield-risk trade-off is now more or less in proper alignment for the more widely sold ILS such as cat bonds.

Another attraction of ILS to investors is their relatively low correlation with traditional securities such as stocks and bonds and also with most classes of asset-backed securities. Although ILS are not truly zero beta, as claimed by early researchers such as Litzenberger, Beaglehole, and Reynolds (1996), available evidence indicates that they do have low correlations with most other asset classes (Cummins and Weiss, 2009). Thus, ILS will remain a valuable source of diversification for investors.

Some classes of ILS, particularly cat bonds and other insurance-linked bonds, also have the advantage of being fully collateralized, insulating investors from the credit risk of the sponsor. This has given ILS an advantage over reinsurance, where buyers are exposed to the reinsurer's credit risk. Nevertheless, such protection is not absolute;

¹⁶It is also possible that the oligopolistic structure of the ILS market influences yields, such that yields are higher than necessary given the risk. This is somewhat doubtful given the responsiveness of securities markets to arbitrage opportunities and the fact that insurers and reinsurers are in an ideal position to arbitrage price differences between ILS and reinsurance. However, it remains true that there are few structurers in the ILS market, even though the direct share of insurers and reinsurers on the buyer side of the new issues market has declined to less than 10 percent over the past 10 years (Cummins and Weiss, 2009). Available data are not sufficient to reveal whether insurers and reinsurers account for a significant proportion of the investment in dedicated ILS mutual funds, which currently account for more than half of all investments in ILS. To the extent that insurers and reinsurers represent a significant share of both the buyer and seller sides of the market, it would significantly limit the benefits that issuers can get from spreading their risk through securitization. It would be useful to have more research on this topic.

and during the recent financial crisis, several bonds have encountered difficulties because the assets in the trust were not truly low-risk assets and because of defaults of swap counterparties. Such adverse events affected only a small proportion of outstanding bonds, and steps are being taken to correct the problems that led to these events. These include stricter definitions of eligible trust assets, stricter “top-up” standards for swap counterparties in case of declining asset values, stricter rating standards for counterparties, and provision for replacement of counterparties who fall behind on their obligations (Lane, 2008). Thus, counterparty defaults and asset credit quality will not be problems for ILS in the long-run, but, as usual, investors must be vigilant.

Most insurance linked-bonds also have an advantage over other types of asset-backed securities such as mortgage-backed bonds (MBS) and collateralized debt obligations (CDOs) in that they are less complex and more transparent. The regions, perils, and events that trigger payment under insurance-linked bonds are clearly specified in the prospectus, along with simulations of loss exceedence curves and other actuarial data. Moreover, the structuring is more transparent and less complex than for mortgage-backed bonds and CDOs, giving investors a clearer idea of the risks assumed.

ILS also have the advantage of doing a better job of aligning the interests of investors and those of ceding companies, insurers or reinsurers, than banking securitization vehicles such as MBS and CDOs. Insofar as the risk remains confined to the balance sheet of the insurer or the reinsurer, insofar as the latter bears ultimate responsibility for covering the risk no matter what happens, insofar as the hedge provided by the ILS has an upper threshold (which is the amount of capital raised) while the insurance risk itself is not otherwise confined than in terms of probability, the ceding insurer or reinsurer clearly has the incentive to manage the risk correctly, and to invest the capital raised in safe instruments. In this way, ILS are the opposite of bank securitization and do not present the same risk of moral hazard that the latter does.

Insurance Securitization and the Financial Crisis of 2007–2009

The current financial crisis offers a good natural experimental framework for insurance securitization. Due to its weak correlation with financial risks, insurance securitization should have been able to resist the crisis better than other forms of securitization. In fact, this is what has happened. Until the summer of 2008, insurance securitization escaped the crisis relatively unscathed, with the exception of embedded value and regulatory securitization, which are more tightly correlated with financial risks. While the securitization counter rapidly closed for financial risks, precisely because of the explosion in spreads, it stayed open for insurance risks. And while spreads exploded for securitization in general, they remained relatively stable for the securitization of insurance risks. And, in fact, the market for these risks remained relatively liquid during this period, which was a nonnegligible plus for investors. To be sure, the good behavior of the insurance securitization market after July 2007 is not only due to the decorrelation of insurance and financial risks; it is also attributable to the investors who switched a portion of their funds gradually, as other segments of the financial market shut down.

The closing of the window on insurance securitization, which came in the course of the summer and fall of 2008 after the failure of Lehman Brothers, does not contradict

this observation. Admittedly, this late closing cannot be dissociated from the wake-up call to the reality of the bank counterparty risk related to the insurance securitization mechanism, but it was above all the result of the state of panic that overtook the market and that caused all market participants to take refuge en masse in liquidities to protect themselves from the risk of short-term illiquidity. The cat bond market appears to be rebounding in 2009, with \$725 billion in bonds issued through March 30. This puts the market on track to issue \$3 billion in bonds during 2009, which would exceed the \$2.8 billion raised in 2008, but still be less than the record issuance of \$7 billion for 2007 (McCarthy, 2009). As predicted by Lane (2008), the new issues in 2009 generally contained stronger provisions regarding swap counterparties and investment of collateral than earlier bonds. The life market, on the other hand, may take longer to recover because its bonds more closely resemble MBOs and CDOs.

There has been some discussion in the literature about whether the cat bond market has been successful. Cummins (2008), Cummins and Weiss (2009), the authors of this article, and numerous insurance industry sources (e.g., GC Securities, 2008) argue that the market has "taken off" and become a permanent part of the risk landscape. The principal detractors are Barrieu and Louberge (2009), who argue that the market has been "disappointing" and that hybrid securities providing catastrophe risk transfer as well as protection against a stock market crash are needed to complete the market. The arguments we present here indicate that reinsurance has significant advantages in dealing with informational problems in insurance markets, especially for relatively small and statistically independent risks, such that ILS would not be expected to replace reinsurance. Cat bonds and other ILS come into play where the risk-bearing capacity of reinsurance breaks down, as in the case of large correlated risks, where it becomes cost effective to incur the structuring costs of issuing ILS. Hence, Barrieu and Louberge seem to miss the point, and it is not clear that hybrid catastrophe-stock market securities are needed, especially given that most insurers are primarily bond investors and can already invest in stock market derivatives.

Regulatory Issues

Since the first European directives on life and non-life insurance, claims of insurers against reinsurers, even if those that are not localized in the European Union, are listed as assets allowed to cover technical or mathematical reserves.¹⁷ The directives anticipated that member states should fix a percentage so allowed but, in practice, most of them have implicitly accepted a percentage of 100 percent by not fixing any limit.¹⁸ Furthermore, for calculating solvency margin requirements, these directives have allowed European insurers to consider that reinsured risks are transferred to reinsurers. This is done not by calculating precisely the current reserves' reinsured share but by approximating it very roughly, i.e., by multiplying the gross basis to which the capital ratio is applied (the average gross claims for the past 3 financial years or the annual amount of gross premiums in non-life and the gross mathematical reserves at the end of the year in life) by the ratio existing in respect of the last financial year between:

¹⁷Cf. Life directive of March 5, 1979 (article 17 (2)) modified by life directive of November 5, 2002 (article 21 (Bf&h)) and non-life directive of July 24, 1973 (article 15 (3)).

¹⁸Cf. Code des assurances in France, for example.

1. In non-life insurance: the amount of claims remaining to be borne by the undertaking after deduction of transfers for reinsurance and the gross amount of claims in non life;¹⁹ this ratio may in no case be less than 50 percent;
2. in life insurance: the total mathematical reserves net of reinsurance cessions and the gross mathematical reserves;²⁰ this ratio may in no case be less than 85 percent except for policies on which the capital at risk is not a negative figure, for which it may in no case be less than 50 percent.

Because securitization, unlike reinsurance, was not mentioned in the aforementioned insurance directives, neither in the list of assets allowed to cover technical or mathematical reserves, which is defined as a restrictive list, nor in the ratio applied to the calculation basis for diminishing the solvency margin requirements, most European supervisory bodies concluded that securitization could not constitute an asset admitted to offset insurers' liabilities and that it could not be used for diminishing insurers' solvency margin requirements.

This position may seem curious given that securitization is collateralized while other asset classes that are admissible to offset liabilities do not present the same guarantees. In fact, this is part of a more general mistrust of financial innovations—the supervisory bodies generally refused to recognize the hedge on the value of assets offered by derivatives, which were allowed by the directives of 1992 and 2002 but left at the discretion of member states. For European insurers, securitization was therefore of only limited interest financially compared to reinsurance.

The situation was entirely different for European reinsurers because they were not supervised in most European countries until the reinsurance directive 2005 or were subject to less stringent prudential regulation. European reinsurers were not constrained by an obligation to cover their technical and mathematical reserves with a restrictive list of assets and by solvency requirements. For them, securitization was a hedge that was recognized by the rating agencies. At the bottom, reinsurance provided insurers with an indirect way of accessing securitization: those risks that insurers would have liked to securitize were formally transferred to a reinsurer—i.e., they were reinsured—and the reinsurer securitized them. At least part of the important role played by reinsurers in the initial development of the ILS market is probably attributable to this asymmetry introduced by regulation in the treatment of securitization by insurers and reinsurers.

The recognition of securitization by European insurance regulation, within the framework of the 2005 reinsurance directive, fundamentally changed the landscape from this perspective, at least in Europe. This is all the more so in that it was associated, in Europe at least, with the extension of solvency supervision from insurers to reinsurers established and practicing in Europe, within the framework of the same directive.²¹

¹⁹Cf. Non Life directive of July 24, 1974 (article 16 (3)).

²⁰Cf. Life directive of March 5, 1979 (article 19 (A)) modified by life directive of November 5, 2002 (article 28 (2a&b)).

²¹Remember that directive is adopted by a codecision process, i.e., by the European commission (the executive of the European Union, the Council of European Union governments, deciding as a qualified majority) and the European parliament, with the same wording.

Solvency requirements and supervision are imposed on reinsurers by the article 35 of the directive. Solvency requirements are calculated the same way as for the non-life insurance solvency margin, in non-life as well as in life reinsurance, following articles 37 and 38 of the directive (except for some life reinsurance risks).

In fact, it was the second shift that forced European legislators to clarify the situation with regard to securitization in order to avoid creating problems for reinsurers that, while otherwise considered to be of good quality, used securitization for components of their liabilities. The reinsurance directive adopted in 2005 by the European Union allows member states to put the transfer of risks via securitization and via reinsurance on an equal footing. The directive does not impose such a treatment of securitization, but it allows member states to apply it to the insurers and reinsurers it supervises. The reinsurance directive refers to securitization as “special purpose vehicle” (SPV), which is defined as “any undertaking, whether incorporated or not, other than an existing insurance or reinsurance undertaking, which assumes risks from insurance or reinsurance undertakings and which fully funds its exposure to such risks through the proceeds of a debt issuance or some other financing mechanism where the repayment rights of the providers of such debt or other financing mechanism are subordinated to the reinsurance obligations of such a vehicle” (article 2). These SPVs:

1. have to be formally allowed by member states and given prior official authorization by them on the basis of defined fit and proper, professional qualification, internal control, etc.;
2. may cover technical reserves on an equal footing with reinsurance (articles 57, 58, and 60, which are amending the list of allowed assets in life and non-life) or retrocession (article 37 (4) and 38);
3. may be deducted as reinsurance (articles 57, 58, and 60, which are amending the ratio applied to premiums or claims in non-life and to mathematical reserves in life in order to take into account the net effect of securitization beside the one of reinsurance) as well as retrocession (article 37 (3) and 38) for calculating the net solvency margin requirements.

Some reinsurers claimed that this would put reinsurance at a competitive disadvantage with respect to securitization insofar as the SPVs could subscribe an insurance risk without having to meet solvency requirements,²² whereas reinsurers could not do so unless they built up a solvency margin to this effect. In fact, the competitive disadvantage is uncertain because it depends on several parameters, the effects of which have a tendency to more or less offset one another. The solvency margin, whose required amount is calculated the same way as the non-life insurance solvency margin, in non-life as well as in life reinsurance (articles 37 and 38 of the directive), imposes costs of immobilized capital insofar as this capital should earn a return that is on average 500 to 600 basis points above the risk-free interest rate. However, the funds backing securitization also have a cost in terms of advanced monies insofar as interest must be paid on them—as we have seen, in the amount of 200 to 500 basis

²²Following article 46 of the directive, it is up to the host member states to decide if it imposes or not solvency requirements on these vehicles. However, in fact they did not impose such requirements.

points above the risk-free rate. Naturally, the base to which these rates apply and the value-at-risk of these protections are different, which makes comparison difficult. However, the impression one is left with is not that clear competitive distortion exists to the detriment of reinsurance.

The latest generation of prudential standards, as presented in the Solvency II directive currently under discussion among the parliament, the Council of European Union governments, and the European Commission, confirms the full and unconditional recognition of securitization on the same terms and conditions as reinsurance. Securitization is allowed to cover technical reserves of both insurers and reinsurers and to be taken into account in the calculation of the standard capital requirements of insurers and reinsurers on the same footing as reinsurance.

For the calculation of solvency requirements, article 100 of the Solvency II project directive uses very general wording for taking into account reinsurance and securitization: "When calculating the Solvency Capital Requirement, insurance and reinsurance undertakings shall take account of the effect of risk mitigation techniques, provided that credit risk and other risks arising from the use of such techniques are properly reflected in the Solvency Capital Requirement." By risk mitigation techniques, the project directive means "all techniques, which enable insurance and reinsurance undertakings to transfer part or all of their risks to another party" (article 13), therefore reinsurance and securitization. For covering technical reserves, the project directive excludes any restrictive list of allowed assets but sets down a general freedom of investment principle (with very few exceptions) combined with a capital charge proportioned to asset risk, especially to the credit or counterparty risk included in the asset. According to the standard formula that is a default method the project directive, the Committee of European Insurance and Occupational (CEIOPS) supervisors proposes:

1. to value reinsurers and SPVs recoverables adjusting for their expected losses due to counterparty default;²³
2. to impose capital charges on reinsurers and SPV recoverables and risk mitigating effects on the standard capital requirement for underwriting risks: the amount of required capital is in proportion of their probability of default (for that purpose, CEIOPS suggests to use reinsurers' and SPVs' rating by credit rating agencies weighted by an Herfindahl measure of counterparty risk concentration)²⁴ after having taken into account the risk mitigating effects of collaterals and letters of credit;
3. to calculate solvency requirements for underwriting risks net of risk mitigation techniques, i.e., net of reinsurance and SPVs.²⁵

The capital charge on reinsurance recoverables and risk mitigating effects on the standard capital requirement for underwriting risks may seem misplaced and redundant when applied to supervised reinsurers, especially those supervised in Europe:

²³Cf. TS II B 21 of QIS 4 technical specifications, February 2008.

²⁴Cf. TS X of QIS 4 technical specifications, February 2008.

²⁵Cf. TS XI, XII et XIII of QIS 4 technical specifications, February 2008.

1. in fact, the capital charge that is thus imposed to European insurers is justified by the purpose to secure at 99.5 percent their reinsurance cover (the solvency capital requirement is calibrated to a 99.5 percent value-at-risk);
2. but, at the same time, the same project directive is requiring capital from European reinsurers for securing at 99.5 percent their commitments (when not requiring any capital from European SPV).

From this perspective, not only would supervised reinsurance be placed at a competitive disadvantage with respect to securitization but the addition of a capital charge at the level of insurers, on reinsurance risk mitigating effects and recoverables, and at the level of reinsurers, on reinsurance underwriting risks, would probably also charge twice the same risks.

Although it is difficult to fully measure the effects of regulation on the choice between securitization and reinsurance to cover extreme events, it is nonetheless clear that regulation has played and will likely continue to play an important role in the tradeoffs made by insurance companies between reinsurance cession and securitization, and by reinsurance companies between reinsurance retrocession and securitization.²⁶

CONCLUSION

Insurance securitization offers significant opportunities for (re)insurers that are likely to deeply modify the risk financing landscape. As we have seen, the traditional model of insurance and reinsurance, the risk warehouse, operates very efficiently for relatively small, mostly uncorrelated risks. The warehouse model also works well in mitigating informational efficiencies by capturing insurance exposure and underwriting information over a long period of time and establishing ongoing relationships between cedants and reinsurers that facilitate efficient information sharing. However, when the magnitude of potential losses and the correlation of risks begins to increase, the efficiencies of the traditional (re)insurance model begin to break down, and the cost of capital required to maintain acceptable solvency levels may become uneconomical. At this juncture, securitization has a role to play by passing the risks along to broader capital markets through bonds and options rather than through the traditional mechanism of (re)insurer equity capital being held by diversified investors. Securitization also serves as a substitute or supplement for reinsurance in other ways such as mitigating inequities in claims settlements in the event of reinsurer defaults, collateralizing the low-frequency risks that are likely to be hardest hit when the assets of a defaulted reinsurer are distributed, and facilitating regulatory arbitrage.

Because of the advantages of reinsurance in handling relatively small, independent risks and mitigating informational asymmetries, it is not expected that securitization will replace reinsurance. However, securitization is likely to play an important role in permitting insurers and reinsurers to achieve optimal combinations of risk diversification and risk shifting to the capital markets, especially for catastrophic risks. Finally, an important conclusion that we can draw from this analysis resides in the fact that insurance securitization, far from simplifying the landscape of insurance

²⁶For further discussion of regulatory issues, see Klein and Wang (2009) and Albertini and Barrieu (2009).

and reinsurance, in fact has made it significantly more complicated. Nevertheless, this complexity brings ample opportunities for the insurance and reinsurance industries to create more efficient markets for financing risks.

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