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The Journal of Business, Vol. 74, No. 4 (Oct., 2001), 591-612.

Stable URL:
http://links.jstor.org/sici?sici=0021-9398%28200110%2974%3A4%3C591%3AROAMB%3E2.0.CO%3B2-5

The Journal of Business is currently published by The University of Chicago Press.

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We show that exposure from past business transactions—risk overhang—can reduce activity in related business lines, sometimes to the point where no new trade occurs. Our primary focus is the nonlife-insurance market, where our model predicts that the relative impact, duration, and character of supply disruptions are related to the extent of overhang. These predictions are consistent with differences between the mid-1980s liability-insurance crisis and the early-1990s catastrophe-reinsurance crisis. We also discuss applications of our overhang model to disruptions in lending and securities markets.

I. Introduction

In this article, we show that an overhang of risk from continuing exposure to past transactions can affect current business decisions, reducing activity. Our work builds on that of Froot, Scharfstein, and Stein (1993), who show that capital-market imperfections can make otherwise risk-neutral firms behave in a risk-averse fashion and that negative shocks to internal capital make firms more risk averse. Given these results, consider the firm's business lines as a portfolio. All else equal, an effectively risk-averse firm will try to smooth exposures across different areas. When risk acquired through past transactions is costly to diversify or hedge, overhang from past transactions increases existing exposure and reduces the additional amount of exposure the firm is willing to take on in related business lines. This translates into a reluctance to supply more products or services in that line. The impact of the overhang is greater as either the magnitude of old exposures or the correlation between old

* We thank Allen Berger, Georges Dionne, Michael Goldstein, Craig Holden, Albert Madansky (the editor), Richard Shockley, and especially Jack Kareken, for their helpful comments, as well as seminar participants at DePaul University, the 2000 Indiana University Finance Symposium on "Crisis Events in Financial Intermediation and Securities Markets," and the 2000 Risk Theory Society meetings.

(*Journal of Business*, 2001, vol. 74, no. 4)

0021-9398/2001/7404-0005$02.50

and new business exposures is greater. Under some conditions, the effect can be so great that no new transactions occur.

Our primary focus is the market for nonlife insurance, where severe disruptions of trade ("crises") are recurring events. A crisis typically begins with a sudden increase in insured losses; during the crisis, insurance prices increase sharply while quantities decline, with some types of coverage being completely unavailable. The most common explanation is that industry-wide losses diminish insurers' existing capital base, and capital-market imperfections make it costly to raise more capital quickly; the resulting shortage of capital sharply diminishes insurers' capacity to take on more risk by writing more policies. A limited number of skilled underwriters delays new entry.[1] These elements are essential to all explanations of temporary market disruptions.

Nevertheless, capital-market imperfections alone do not explain the differential impact of crises across different lines of insurance. Consider the two most recent crises: the mid-1980s crisis in liability insurance and the early 1990s crisis in catastrophe reinsurance. Problems in the liability-insurance market persisted for years, while the catastrophe-reinsurance market returned to normal relatively quickly.[2]

Our model provides a simple explanation of this difference. It is well known that the length of time ("tail") that it takes for claims to be entered against an old insurance policy varies with the line of insurance. Claims against liability insurance often take many years to be realized, whereas claims against property insurance (which covers damage to the policyholder's property) typically come in soon after the damage is sustained. Furthermore, as we discuss in Subsection IIB below, there is good reason to expect a positive correlation between currently realized claims against old policies and claims against new policies. This provides a natural application of our model: liability insurers face a great deal of overhang from old policies, whereas catastrophe reinsurers face relatively little. Thus, during the liability-insurance crisis, a large overhang from old policies reduced liability insurers' ability to take on more liability risk for a significant length of time. By contrast, during the catastrophe-reinsurance crisis, the overhang from old policies diminished more quickly, so catastrophe reinsurers' ability to supply catastrophe reinsurance recovered more quickly as well.

A second feature of crises is insurers' refusal to sell specific lines of in-

1. Limited capacity has been used more generally to explain the overall pattern called the insurance cycle, of which crises are a part. A typical cycle starts with a crisis, which is followed by a few years of relatively high prices, restricted but no longer declining availability, and high profitability. This evolves into a market where prices and profitability are eroding and insurance is relatively abundant. After several years of these declining market conditions for insurers, another crisis repeats the cycle. See Stewart (1984), Winter (1988, 1991), and Gron (1994).

2. Liability insurance covers losses from third-party claims against the policyholder; the 1980s liability crisis was particularly severe in commercial liability lines such as product liability, professional liability, and environmental liability. Reinsurance refers to insurance purchased by insurers as opposed to other firms or households. Catastrophe reinsurance covers significant property losses associated with natural catastrophe events such as a hurricane, a windstorm, or an earthquake.

surance. For example, during the liability crisis many insurers withdrew from lines of insurance such as day-care liability, municipal liability, environmental liability, and directors' and officers' liability.[3] Existing explanations focus on asymmetric information and adverse selection between insurers and insurance buyers (see, e.g., Priest [1987] and Sec. III below). Although adverse selection is undoubtedly an important factor in insurance markets, this particular adverse-selection explanation does not explain why many but not all insurers withdraw from specific lines of insurance or why insurers cancel existing policies during a crisis. In contrast, our overhang model suggests that cancellations may occur as a means of reducing exposure in a given sector. As described in Section IV, our model does rely on asymmetric information or some other friction to make risk overhang difficult to hedge or diversify, but the critical information asymmetries in this case are those between existing insurers and reinsurers or new entrants into the market.

Our model also has applications beyond nonlife insurance. For example, "credit crunches"— "excessive" reluctance to lend by banks and other lenders during sector downturns—are consistent with risk overhang from existing loans, whose increased risk and illiquidity make this exposure difficult to unload. Consistent with actual behavior, our model suggests that a credit crunch will be most severe in the sector hit by the downturn, that lending in that sector may effectively cease, and that lenders may even be driven to call loans. Similarly, because securities such as junk bonds and mortgage-backed securities can become quite illiquid after a market downturn, securities firms active in these sectors can suffer from risk overhang: their risky unsellable inventories will constrain their underwriting and dealing activity in that area, deepening and extending the crisis. Finally, to the extent that nonfinancial firms face noninsured exposures from past business transactions in a given line of business, their interest in additional transactions in this line will be reduced—even if this additional business seems profitable by itself.

Although others have examined the implications of capital-market imperfections for financial institutions' portfolio choices, our work differs by focusing on the effects of risk overhang from past business transactions on institutions' decisions and market conditions. Froot and Stein (1998) examine capital-budgeting rules for institutions in a setting where some positions can be hedged and others cannot; their focus is on pricing rules and hedging decisions for an institution, taking market conditions as given. Froot and O'Connell (1996) examine insurance-market equilibrium in a setting where both insurers and insurance buyers are effectively risk averse, but they do not allow for exposures coming from past decisions. As we show, allowing for risk overhang from past business can have a dramatic effect on equilibrium price and quantity, in some cases leading to total cessation of the market.

Our article's structure is as follows. Section II begins by analyzing a simple portfolio model of risk-sharing between firms and insurers, analogous to that

3. See, e.g., U.S. Department of Justice (1986) and Priest (1987).

of Froot and O'Connell (1996), and by showing that it is consistent with typical insurance-cycle behavior. We then extend these results to the case where the insurer faces risk overhang from policies sold in earlier periods. We show that overhang reduces and can in some cases completely eliminate activity in the affected lines of insurance. Section III applies our model to the previously mentioned liability-insurance and catastrophe-reinsurance crises. Section IV contrasts our model with the standard explanation of insurance-market failures during crises that is based on increased information asymmetries and adverse selection, and it then discusses how the overhang model implicitly relies on either different information asymmetries or other market frictions. Section V applies our results to other financial intermediaries, while Section VI summarizes our findings and concludes.

II. Insurance-Market Equilibrium

Our framework builds on the work of Froot et al. (1993) in motivating risk-averse behavior by firms. In that model, firms have valuable future investments that require financing, and capital-market imperfections make it costly to acquire external funding: greater risk of internal cash flows results in greater expected funding costs, making otherwise risk-neutral firms behave in a risk-averse fashion. Our particular implementation follows that of Froot and O'Connell (1996) in applying this model to equilibrium in the insurance market; the critical distinction of our model from that of Froot and O'Connell is that they do not allow for an overhang of exposures from old policies. After modeling equilibrium in the absence of overhang, we allow for overhang and examine its impact.

A. *Market Equilibrium without Overhang*

We begin with two representative firms, A and B, which have investment projects that they wish to fund at the end of period 1. Projects can be funded out of internal funds, w, or external funds, e, where external funds are assumed to be more costly than internal funds. As shown by Froot et al. (1993), this asymmetry between internal and external funds means that each firm's objective function is increasing and generally concave in its stock of internal funds. Intuitively, more internal funds lessen the extent to which a firm must rely on costly external funds, but this benefit is generally decreasing, because at the margin there are fewer profitable uses for these funds. Denoting the indirect form of firm i's objective function as $P^i(w)$, we have $P^i_w > 0$, and $P^i_{ww} < 0$.

Each firm begins period 1 with w_{i0} in internal funds. If it purchases no insurance, at the end of the period firm i will have internal funds $\tilde{w}_{i1} = w_{i0} - \tilde{\eta}_i$, where $\tilde{\eta}_i$ is an insurable shock to that firm. For simplicity, shocks are normally distributed, with mean μ_i, variance σ_{ii}, and covariance σ_{AB} between shocks to A and B. Each firm may also purchase a proportional insurance contract. Let q_i denote firm i's fractional coverage of its shock in period 1. The total cost ("premium") of insurance against shock i is $(1 + p_i)\mu_i q_i$; thus, a premium with "price" p_i equal to zero would be actuarially fair. With these definitions, it follows that, if firm i purchases coverage q_i, its internal funds at the end of period 1 will be

$$\tilde{w}_{i1} = w_{i0} - (1 - q_i)\tilde{\eta}_i - (1 + p_i)\mu_i q_i. \tag{1}$$

Firm i chooses coverage at the beginning of the period to maximize the end-of-period expected value of its objective function, $E[P^i(\tilde{w}_{i1})]$, taking insurance prices as given. The first-order conditions for the optimum are

$$\begin{aligned} E\left(P_w^i \frac{\mathrm{d}\tilde{w}_{i1}}{\mathrm{d}q_i}\right) &= E\left(P_w^i[\tilde{\eta}_i - (1 + p_i)\mu_i]\right) \\ &= -p_i\mu_i[E(P_w^i)] + \mathrm{Cov}\,(P_w^i, \tilde{\eta}_i) \\ &= 0, \end{aligned} \tag{2}$$

where we have made use of the identity $E(xy) = E(x)E(y) + \mathrm{Cov}\,(x, y)$. Since shocks and internal funds are normally distributed, Stein's Lemma implies that $\mathrm{Cov}\,(P_w^i, \tilde{\eta}_i) = E(P_{ww}^i)\,\mathrm{Cov}\,(\tilde{w}_{i1}, \tilde{\eta}_i)$.[4] It follows that firm i's demand for insurance is given by

$$q_i^D = 1 - \frac{p_i\mu_i}{G_i\sigma_{ii}}; \quad i = A, B, \tag{3}$$

where $G_i = -[E(P_{ww}^i)]/[E(P_w^i)]$ measures the firm's effective risk aversion induced by the costs of external finance.

Turning to the other side of the market, the representative insurance company, I, faces a similar problem. The insurer must maintain reserves and surplus so as to make good on its policies with a high degree of certainty, but this means that, if it suffers losses, it may have to resort to costly external finance to replenish its reserves. If the insurer begins the period with w_{I0} in net worth, then its end-of-period funds are

$$\tilde{w}_{I1} = w_{I0} + (1 + p_A)\mu_A q_A - q_A\tilde{\eta}_A + (1 + p_B)\mu_B q_B - q_B\tilde{\eta}_B. \tag{4}$$

In a fashion analogous with firms, costs of external finance will give the insurer an indirect utility of internal funds function, which we denote as $P^I(\tilde{w}_{I1})$; once more, $P_w^I > 0$, and $P_{ww}^I < 0$. The insurer chooses the coverage it offers to firms A and B so as to maximize $P^I(\tilde{w}_{I1})$, taking insurance prices as given.[5] Thus the insurer has two first-order conditions:

4. Stein's Lemma states that if x and y are normally distributed, $\mathrm{Cov}\,[a(x), y] = \{E[a'(x)]\}[\mathrm{Cov}\,(x, y)]$. See Stein (1981).

5. We assume that insurers and buyers operate in competitive markets. Other assumptions about the form of competition, such as Cournot, yield similar outcomes (see Froot and O'Connell 1996).

$$E\left(P_w^I \frac{d\tilde{w}_{I1}}{dq_i}\right) = E\{P_w^I[\tilde{\eta}_i - (1+p_i)\mu_i]\}$$
$$= -p_i\mu_i[E(P_w^I)] + \mathrm{Cov}\,(P_w^I, \tilde{\eta}_i) \quad (5)$$
$$= 0; \; i = A, B.$$

Once again, making use of the definition of covariance and Stein's Lemma, rearranging, and defining $G_I \equiv -[E(P_{ww}^I)]/[E(P_w^I)]$ as the insurer's "risk aversion," we have

$$q_i^S = -q_j^S \frac{\sigma_{ij}}{\sigma_{ii}} + \frac{p_i\mu_i}{G_I\sigma_{ii}}; \quad i = A, B, \quad (6)$$

where j indicates the other firm (i.e., if i is A, j is B). Thus, as in Froot and O'Connell (1996), if the two firms' shocks are more positively correlated, the insurer is less willing to supply insurance to either firm.

If the two firms' shocks are uncorrelated ($\sigma_{AB} = 0$), (6) simplifies to $q_i^S = (p_i\mu_i)/(G_I\sigma_{ii})$, and we have the following lemma.

LEMMA 1. Suppose that $\sigma_{AB} = 0$. Then the equilibrium price and quantity of insurance against shock i are

$$p_i^e \equiv \frac{\sigma_{ii}}{\mu_i}\left(G_I^{-1} + G_i^{-1}\right)^{-1}; \quad q_i^e \equiv \frac{G_i}{G_I + G_i} = \frac{G_I^{-1}}{G_I^{-1} + G_i^{-1}}. \quad (7)$$

Note that the firm insures a fraction of the shock equal to its share of total risk aversion, so an increase in its risk aversion relative to the insurer's leads to an increase in the fraction insured. (Alternatively, the insurer provides insurance coverage equal to its share of total risk tolerance, which is the inverse of risk aversion.) Also, an increase in either the firm's or the insurer's risk aversion increases the price of insurance. Ignoring indirect effects on firm or insurer risk aversion, an increase in the variance of the shock tends to increase the price of insurance, whereas an increase in its mean tends to decrease price. These changes will also affect risk aversion. For example, Froot et al. (1993) argue that the indirect utility function over internal funds exhibits decreasing absolute risk aversion (DARA); intuitively, the higher the firm's initial internal funds, the less likely it is that the firm will require costly external finance even for poor outcomes, reducing its effective aversion to risk. Using (1), an increase of $\Delta\mu_i$ in the mean of the shock is equivalent to a decrease of $(1 + p_iq_i)\Delta\mu_i$ in the firm's initial internal funds level; under DARA, this increases the firm's effective risk aversion G_i. Similarly, since the insurer's expected wealth increases by $p_iq_i\Delta\mu_i$, the insurer's risk aversion G_I should decrease.

This model is consistent with the previous description of insurance cycles. Here, insurance cycles are caused by temporary industry capacity shortages resulting from sudden declines in insurers' net worth caused by unexpected changes in insurer costs, such as large catastrophes, higher-than-expected cost inflation, or unforeseen changes in tort law.[6] The declines in insurer net worth increase insurers' effective risk aversion; lemma 1 shows that, as long as buyers' risk aversion is relatively unchanged, the price of insurance will increase, and the quantity will decrease. Indeed, temporary capacity shortages are a leading explanation of insurance cycles.[7] Of course, in order for declines in net worth to produce significant market effects, there must be a delay in new entry or expansion by existing firms. There are several potential sources for this delay, including limited supply of knowledgeable underwriters and other personnel needed by new entrants, information advantages for insurers currently writing specific lines, and asymmetric information between existing firms and capital markets. We discuss barriers to entry in greater detail in Section IV.

This model is also consistent with the apparent randomness of market disruptions. Suppose that, during "normal" times, insurer capital is relatively abundant as compared with that of insured firms (the notion being that diversified intermediaries such as insurers have lower costs of accessing equity markets than do many small and middle-market nonfinancial firms). Thus, G_I will be close to zero, q_i^e will be close to one, and p_i^e will be close to zero.[8] In this case, unless a negative shock to insurers is very large, it is unlikely to have much effect on insurer risk aversion and equilibrium prices and quantities. By contrast, if insurers do suffer a very large shock, or if a moderately large shock comes at a time when a series of losses have already depleted insurer capital, such an event will have a relatively greater effect on insurer risk aversion and equilibrium price and quantity.

Although this model is consistent with the general notion of insurance cycles, it does not provide much insight into the duration of disruptions across different lines, nor does it explain why some insurance markets break down, with no insurance being available at any price. Risk overhang from old policies has the ability to provide these insights. We now extend the model to include such an overhang of risk.

B. Market Equilibrium with Risk Overhang from Old Policies

Until this point, we have implicitly assumed that all claims arising from any "date 0" policies have settled by the beginning of the current period; thus, while they might affect the initial funds level of each firm (and their insurer

6. Note that all these events will result in a significant decline of net worth across the industry, or at least across a large segment of the industry, thus producing the industry-wide effects. A large catastrophe will reduce net worth in the primary-insurance market and at the same time reduce net worth in the reinsurance market, which typically supplies needed liquidity for the primary-insurance market. Higher-than-expected cost inflation will have a significant effect if it is much higher than expected or if it occurs in a line of business composing a significant share of insurers' costs, such as automobile insurance. Finally, unexpected changes in tort law will tend to affect the expected claims associated with all liability contracts, both past and present, which can constitute a significant amount of the net worth of insurers selling liability contracts.

7. See, e.g., Winter (1991) or Harrington and Neihaus (1998).

8. Froot and O'Connell (1996) make this point in the context of reinsurers.

as well), no more uncertainty remains. In practice, this is not always the case; some lines of insurance are particularly "long-tailed," meaning that it takes years for most claims arising from the coverage period to emerge and be settled. Suppose that, in previous periods, firm A insured q_A^0 of its risks and firm B insured q_B^0. We assume that firm A's exposures are long-tailed, that is, the firm will experience a shock of $\tilde{\eta}_A^0$ stemming from date 0 exposures, where $\tilde{\eta}_A^0$ is normally distributed with mean μ_A^0 and variance σ_{AA}^0. The covariance between past exposures and firm A's date 1 shock $\tilde{\eta}_A$ is denoted by σ_{int} (for "intertemporal"); we assume that σ_{int} is positive, as discussed below. By contrast, firm B's exposures are short-tailed, so that there are no shocks now or later that apply to firm B's date 0 policies (in other words, all of firm B's period 0 exposures have already settled). In what follows, we assume that the shocks affecting firms A and B are uncorrelated, in order to focus on the correlation between a given firm's current and previous shocks. We also assume that period 0 risks are not easily insured or hedged in period 1.[9]

A number of systematic factors make it likely that currently realized claims against old policies and claims against new policies will be positively correlated. For example, an unexpected increase in inflation increases the cost of settling claims, whether the claims stem from old or new policies. Another example of a systematic risk is the legal environment with respect to both the interpretation of policy terms and rules on negligence. Also, if a given firm's products are later found to have unexpectedly high risks to consumers or the environment, this will affect claims on both old and new policies in the same direction.

With these assumptions, firm A's internal funds at the end of period 1 will now be

$$\tilde{w}_{A1} = w_{A0} - (1 - q_A^0)\tilde{\eta}_A^0 - (1 - q_A)\tilde{\eta}_A - (1 + p_A)\mu_A q_A. \tag{8}$$

Note that the firm does not have to pay an additional insurance premium for its date 0 coverage, since this was paid previously and is reflected in the initial funds level w_{A0}. Deriving the first-order condition and rearranging terms, it is easy to show that firm A's demand for date 1 coverage q_A is now

$$q_A^D = 1 + (1 - q_A^0)\frac{\sigma_{\text{int}}}{\sigma_{AA}} - \frac{p_A \mu_A}{G_A \sigma_{AA}}. \tag{9}$$

The overhang from previous periods' shocks tends to increase the firm's desire for coverage to the extent that (1) the firm didn't already have full coverage of previous shocks ($q_A^0 < 1$) and (2) previous shocks are positively correlated with current shocks ($\sigma_{\text{int}} > 0$). Once more, the overhang may also have indirect effects; an unexpected increase in mean losses stemming from previous periods' exposures may increase the firm's risk aversion G_A, further increasing the firm's desire for insurance.

9. In Sec. IV, we discuss asymmetric information as a possible source of this friction.

Turning to the insurer, its reserves and surplus at the end of period 1 are now

$$\tilde{w}_{I1} = w_{I0} - q_A^0\tilde{\eta}_A^0 + (1 + p_A)\mu_A q_A - q_A\tilde{\eta}_A + (1 + p_B)\mu_B q_B - q_B\tilde{\eta}_B, \quad (10)$$

and it follows that its supply of insurance coverage to firm A is now

$$q_A^S = -q_A^0\frac{\sigma_{\text{int}}}{\sigma_{AA}} + \frac{p_A\mu_A}{G_I\sigma_{AA}}. \quad (11)$$

Thus, claims from previous periods reduce the insurer's willingness to supply more insurance to firm A. Also, to the extent that this overhang of claims reduces the expected level of the insurer's wealth, G_I will increase, further diminishing supply.

PROPOSITION 1. Suppose that A's exposure from previous periods generates $\tilde{\eta}_A^0$ in current losses and q_A^0 of this is covered by insurance. Then the equilibrium price and quantity of insurance against new shocks to A are

$$p_A^e \equiv \frac{\sigma_{AA} + \sigma_{\text{int}}}{\mu_A}(G_I^{-1} + G_A^{-1})^{-1}; \quad q_A^e \equiv -q_A^0\frac{\sigma_{\text{int}}}{\sigma_{AA}} + \left(1 + \frac{\sigma_{\text{int}}}{\sigma_{AA}}\right)\left(\frac{G_A}{G_I + G_A}\right), \quad (12)$$

while the equilibrium price and quantity of insurance against new shocks to B are

$$p_B^e \equiv \frac{\sigma_{BB}}{\mu_B}(G_I^{-1} + G_B^{-1})^{-1}; \quad q_B^e \equiv \frac{G_B}{G_I + G_B}. \quad (13)$$

Firm A pays a higher price as the covariance between old and new shocks increases and as either its risk aversion or the insurer's risk aversion increases. If the covariance between old and new shocks is positive, the equilibrium quantity of insurance decreases in the amount of old coverage and increases in firm A's risk aversion. By contrast, firm B's price and quantity of insurance have the same form as equation (7): firm B's demand for insurance is unaffected by A's overhang, while the insurer's supply of insurance to firm B is only affected through possible changes in the insurer's risk aversion, G_I.[10] By the same token, if the correlation between old and new shocks is zero, overhang has no direct effect on the demand and supply of insurance to firm A, and the equilibrium price and quantity are given by (7); however, the overhang would have an indirect effect by increasing the effective risk aversion of both the insurer and firm A.

Suppose that the overhang of A's old exposures has suddenly increased, for example, legal interpretations or knowledge of medical side effects suddenly change so as to increase A's liability. For simplicity, assume that firm A's overhang was zero before the increase, so that firm A's equilibrium price and quantity of insurance were given by (7). After the increase, the equilibrium

10. It is easy to show that, if the shocks to A and B were positively correlated, the existence of overhang from A's old policies would decrease the insurer's supply of insurance to B.

price and quantity are given by (12). Also, as previously discussed, the increase in overhang will tend to increase the risk aversion of both firm A and the insurer; denote their new values of risk aversion by G_A^N and G_I^N, respectively, and their old values by G_A^O and G_I^O. It follows that an increase in overhang changes the equilibrium price by

$$\Delta p_A^e \equiv \frac{\sigma_{AA} + \sigma_{\text{int}}}{\mu_A}[(G_I^N)^{-1} + (G_A^N)^{-1}]^{-1} - \frac{\sigma_{AA}}{\mu_A}[(G_I^O)^{-1} + (G_A^O)^{-1}]^{-1}. \quad (14)$$

Since risk aversions increase and the covariance σ_{int} of old and new shocks is positive, it is easy to see that price increases. Similarly, the increase in overhang changes the equilibrium quantity by

$$\Delta q_A^e \equiv -q_A^0\frac{\sigma_{\text{int}}}{\sigma_{AA}} + \left[1 + \frac{\sigma_{\text{int}}}{\sigma_{AA}}\right]\left[\frac{G_A^N}{G_I^N + G_A^N}\right] - \frac{G_A^O}{G_I^O + G_A^O}. \quad (15)$$

Here, the direction of the effect is less immediate; although the direct impact of the overhang is negative, the overall effect need not be. The following result outlines when the overall effect is certainly negative.

PROPOSITION 2. The equilibrium quantity of coverage decreases as a result of overhang when the increase in overhang has a smaller relative effect on firm A's risk aversion than on the insurer's risk aversion, and the quantity of old coverage outstanding, q_A^0, exceeds the amount that the firm would buy in a single period absent overhang (i.e., the quantity given by [7]).

Absent overhang, firm A's coverage is just the ratio of its risk aversion to the sum of the risk aversions of itself and the insurer; thus, a smaller relative increase in its risk aversion guarantees that this amount will fall. The condition on q_A^0 guarantees that the terms in (15) multiplying $\sigma_{\text{int}}/\sigma_{AA}$ are also negative in total, and so the result follows.

How reasonable are these restrictions? The increase in overhang can reflect claims arising from many years of previous coverage; thus, even if firm A is growing, assuming that q_A^0 exceeds the amount of coverage that firm A would generally buy in a year is not outlandish. Moreover, as discussed in the previous section, if, in normal times, the firm's effective risk aversion greatly exceeds the insurer's, then the firm's typical preoverhang purchase of coverage will be close to one. In such a circumstance, an increase in overhang will have a greater expected wealth impact on the insurer than on the firm, and the insurer's risk aversion may well increase relatively more than firm A's.

Indeed, if q_A^0 is sufficiently great and the correlation between exposures from the past and from the present is high enough, the equilibrium amount of coverage given by (12) is negative. In this case, the insurer's preexisting exposure from old policies effectively closes down the market. The insurer would actually like to reduce its overhang if at all possible. For example, we may observe cancellations of policies currently in force—that is, the insurer may cancel policies for the remainder of their policy term and refund a proportional amount of the premiums.

Now consider the case where shocks to firm *A* and *B* are strongly correlated, as might be the case for liability insurance, where much of the risk has to do with legal changes that apply across all firms. It is easy to show that, from the insurer's point of view, insurance for *A* and for *B* are substitutes and are perfect substitutes if the risks are perfectly correlated. If firm *A*'s overhang is sufficiently great, neither firm *A* nor firm *B* will buy insurance—even if there is no existing overhang on policies to firm *B*. Thus, with overhang, new buyers may find themselves out of the market, in the sense that they choose not to get insurance at current prices.

III. Application to Insurance Markets

The overhang model has several testable predictions, one of which is that a market disruption in long-tailed lines will last longer than a similar increase in the risk of short-tailed lines. In principle, adverse selection should not generate this result; uncertainty over policyholder type can be just as great for short-tailed lines (such as fire or automobile physical damage) as for long-tailed lines (such as product liability).[11] Unfortunately, the relative infrequency of insurance crises combined with a lack of precise data precludes formal testing of these predictions, but we can demonstrate that the characteristics of the most recent crises do fit the pattern predicted by risk overhang from old policies.

The two most recent significant insurance market disruptions occurred in 1984 in the commercial-liability market and in 1992 in the catastrophe-reinsurance market. A 1986 report characterized the conditions of the liability crisis this way: "[There has been] a dramatic change in the last 2 years in the availability, affordability and adequacy of liability insurance. Where insurance is available (and in some areas it simply is not), premium increases of several hundred percent over the last year or two have become commonplace. Few if any private or public entities that rely on liability insurance have escaped the problems generated by this crisis" (U.S. Department of Justice 1986, p. 1).[12] In addition to these problems, some insurers also stopped

11. The key feature for adverse selection is differential information of buyers and sellers. Although some might argue that short-tailed lines have more observables, that does not imply less differential information. Indeed, one might argue that an insurer dealing with many buyers might be better informed about tort-law uncertainty than any one buyer. Several empirical papers find evidence of adverse selection in automobile-insurance markets, e.g., Dahlby (1983), D'Arcy and Doherty (1990), and Dionne and Doherty (1994). D'Arcy and Doherty (1990) find evidence of significant adverse selection for new insurance companies, so that it is costly to develop new business or enter new markets.

12. The report documents effects in a number of specific lines, including environmental-impairment liability, sudden-and-accidental-pollution coverage, directors' and officers' liability, bank-fidelity-bond coverage, motor-carrier liability, liquor liability, medical-malpractice insurance, commercial general liability (including product liability), and excess coverage.

writing new policies and canceled existing policies.[13] Winter (1991) calculates that real premiums increased by a factor of three over the 1984–86 period and that by the middle of 1987 the market began to turn again.

The catastrophe-reinsurance crisis of the early 1990s was also marked by sudden, substantial increases in premiums with accompanying increases in deductibles and decreases in policy limits. The crisis began in August 1992 following Hurricane Andrew, which caused over $16 billion in insured losses. As with the liability crisis, buyers of catastrophe reinsurance faced stiff price increases, increased deductibles, and lower limits.[14] For example, Nationwide Insurance's catastrophe reinsurance deductible went from $30 million before Andrew to $100 million after; also, Nationwide was now responsible for a higher proportion of the loss, even though its policy premium was almost the same (Satterfield 1993).[15] A year later, prices were still rising; insurers with "earthquake and coastal storm" exposure were likely to see premium increases of 100% or more (McLeod 1993). Noncatastrophe property reinsurance was largely unaffected. By mid-1993, observers were predicting the end of the high prices and restricted availability within several months, and various sources report softening of catastrophe-reinsurance prices from January 1994 on (McLeod 1993; Froot and O'Connell 1996).

Our thesis is that the overhang model predicts the relative severity and duration of these two events. We argue that the relative differences in duration (roughly 3 years for the liability crisis as compared with 1.5 years for the catastrophe-reinsurance crisis) and features such as policy cancellations are consistent with the overhang model. To support our contention, we provide data on the relative magnitude of overhang in the two types of coverage and data on the duration and incidence of the two crises.[16]

As shown in table 1, other liability is a relatively long-tailed line, with less than 20% of eventual claims paid 2 years after the policy period and with only 64%–74% of claims paid after 6 years.[17] Furthermore, the length of the tail appears to have increased in the mid-1980s: the percent of total losses

13. For example, St. Paul Insurance Company stopped writing new medical-malpractice-insurance policies. Liability-policy cancellations were reported for cities, nurse-midwives, day-care centers, automobile-repair shops, and manufacturing companies (U.S. Department of Justice 1986).

14. There was also disruption in the "primary" market (that for homeowners and businesses located in areas subject to catastrophe losses). In Florida and other coastal areas, there were cases of policy cancellations and refusals to renew. See Kerr (1993).

15. Catastrophe reinsurance contracts are characterized by a deductible (also known as the point of attachment), a policy limit, and a co-payment rate. The co-payment rate is the proportion of losses above the deductible and below the policy limit that the buying insurer must pay itself.

16. Full documentation of the increase in price and decrease in quantity is complicated by the fact that both price and quantity are denominated in dollars. Industry statistics report premium revenues, a combination of price and quantity. Following premium changes for a particular firm is also misleading, since surveys indicate that deductibles are increasing and policy limits are declining simultaneously with large price increases (see, e.g., U.S. Department of Justice 1986; Weber 1987).

17. Other liability includes all commercial liability other than commercial multiple peril, workers compensation, commercial automobile, and medical malpractice.

TABLE 1 **Timing of Claims Payments**

Policy Year	% of Total Losses Paid Out after 2 Years	% of Total Losses Paid Out after 6 Years
Other liability:		
1980	19.20	73.80
1981	19.19	72.38
1982	20.42	73.01
1983	19.29	72.52
1984	18.19	74.00
1985	17.77	72.07
1986	14.99	66.88
1987	15.09	64.31
Special property:		
1989	88.02	
1990	88.44	
1991	87.66	
1992	86.05	
1993	86.94	
1994	90.40	
1995	86.36	
1996	88.06	

SOURCES.—Losses paid 2 (6) years after policy year as reported in pt. 3 of Schedule P divided by estimated total losses from pt. 2 of Schedule P, as reported in A. M. Best's *Aggregates and Averages*. Special property includes fire, inland water, earthquake, glass, burglary and theft, and allied lines. Allied lines include windstorm, riot, fire-sprinkler leakage, and other perils. Other liability includes all commercial liability coverages (including product liability) except commercial automobile liability, medical malpractice, workers' compensation, and commercial multiple peril. Other liability uses data from A. M. Best (1990, 1991, and 1993); special property uses data from A. M. Best (1991–98).

realized within 6 years fell from 72% on policies written in 1985 to 67% on policies written in 1986 and then to 64% on policies written in 1987. This long tail comes from several features. First, there may be delays in identifying the event that triggers coverage; for example, a product "defect" may take years to become evident. Second, there are likely to be significant delays from legal proceedings. In contrast, catastrophe losses, approximated here by "special property" lines, are quite short-tailed, with almost 90% of losses paid during the 2 years after the policy period.[18]

Table 2 provides some overview of the crises associated with each of these lines. Years in which sudden price increases or significant losses occurred are marked by an asterisk: late 1984 for liability lines and 1992 for catastrophe reinsurance. The first set of data in table 2 relates to commercial liability. Prior to 1984, revenue growth was flat or declining, whereas liability insurance premiums increased 49%, 78%, and 21% in the 3 years after the crisis began. Although premiums are a measure of total industry sales, premium growth

18. Special property includes fire, allied lines (windstorm, riot, explosion, fire-sprinkler leakage, and other perils), inland marine, earthquake, glass, burglary, and theft. No data on the timing of settlements relative to policy period are generally available for catastrophe coverages or, more specifically, for catastrophe reinsurance. Prior to 1989, insurers were not asked to provide information on the timing of payments for special-property lines. Reinsurers are not subject to U.S. insurance regulation and so do not report figures; also, most reinsurers providing catastrophe reinsurance are located overseas.

TABLE 2 **Premium Growth, Profitability, and Price Indices: Selected Lines**

	Other Liability		Directors and Officers (D&O) Liability	
Year: Month	Premium Growth	Profit Measure	Average Survey Premium ($)	Coverage Index
1979		14.00		
1980	.80	7.30		
1981	−7.49	3.50		
1982	−6.31	−6.40	20,000	121.4
1983	.21	−13.80		
1984	9.08*	−25.10*	25,278	122.4
1985	49.05	−25.80		
1986	78.02	−2.50	304,569	111.2
1987	21.04	3.70		
1988	−1.70	8.50	432,389	103.4
1989	−6.14	12.00	399,327	99.1
1990	−1.63	13.30	425,463	96.6
1991			419,396	98.1
1992			436,571	100.0

	Catastrophe-Reinsurance Prices	
	Price Index	% Increase
1985: January	1.00	
1986: January	1.18	18.0
1987: January	1.37	16.1
1988: January	1.10	−19.7
1989: January	.93	−15.5
1990: January	1.02	9.7
1991: January	1.18	15.7
1992: January	1.41	19.5
1993: January	2.26	60.3
1993: July	2.42	7.1
1994: January	2.37	−2.1
1994: July	2.47	4.2
1995: January	2.32	−6.1
1995: July	2.16	−6.9
1996: January	2.14	−.9
1996: July	2.06	−3.7
1997: January	1.85	−10.2
1997: July	1.81	−2.2

SOURCES.—Other liability: A. M. Best (1989, 1997); D&O liability: Wyatt Survey as reported in Norton and Bastian (1996); catastrophe-reinsurance price index: Paragon Risk Management Services, Inc. (1985–97) as reported in an E.W. Blanch Holdings press release, "Paragon Reinsurance Risk Management Releases Updated Catastrophe Price Index," which was available in 1998 at http://www/blanch.com/html/pr111198.htm; the current 2001 information is available at http://www.blanch.com; follow links from "Press Releases" to the similarly named press release (July 7, 2001).

NOTE.—Premium growth is measured as the percent annual change in earned premiums (A. M. Best, various years). The profit measure is equal to 100 − overall operating ratio. This is equal to 100 − (acquisition expenses / written premiums) − [(incurred losses + loss adjustment expenses)]/(earned premiums)] + (investment income/earned premiums), where written premiums are revenues on a cash basis, earned premiums are revenues on an accrual basis, and incurred losses are an undiscounted estimate of expected loss. Other liability includes all commercial- liability coverages (including product liability), except commercial automobile liability, medical malpractice, workers' compensation, and commercial multiple peril. Allied lines covers windstorm, riot, explosion, fire sprinkler leakage, and other perils. Catastrophe-reinsurance price index is based on 250–300 large insurers, making up about 50% of the market.

* Denotes the beginning of the market "crisis" or a large loss event in this year.

serves as a good proxy for price increases associated with the market disruption, both because demand for liability insurance is somewhat inelastic to price and because the market disruption was associated with lower policy limits and higher deductibles, indicating a decline in quantity. This suggests roughly 3 years of increasing prices following the beginning of the market disruption in liability insurance.

The next segment of table 2 provides price and quantity data for a particular type of commercial liability insurance, directors and officers (D&O) liability coverage. In this particular line, high prices and reduced quantity persisted for more than 3 years. Although the average premium reached a peak in 1988, the coverage index continued to decline until 1991, indicating continued quantity restrictions through the end of the decade (see Norton and Bastian 1996).

The last columns of table 2 present price information for catastrophe reinsurance before and after the market crisis beginning in 1992. Premium growth and profit measures are not available for catastrophe reinsurance because, as mentioned earlier, reinsurance is a global business and reinsurers do not report their revenue figures to U.S. regulators or any single body. We do, however, report a price index that increases by 60% from January 1992 to January 1993, the period that includes Hurricane Andrew in August 1992; by contrast, the increase over the previous 12 months was only 20%. By mid-1993, it appears that industry price increases were back to their historical levels and remained there, despite the 1994 Northridge earthquake, which was also a significant loss event.[19] Other data sources provide similar conclusions (see Froot and O'Connell 1996). Thus, the duration of the crisis was significantly shorter than that of the liability crisis.

IV. Relation to Adverse Selection

The prevailing explanation for the virtual disappearance of some lines of liability insurance during the liability crisis is adverse selection (see Priest 1987; Winter 1991). The idea is that large insurer losses accompanied by an increase in the overall risk of losses lead to increased adverse selection: good firms find it even more costly to be insured, so they are more likely to self-insure, increasing the proportion of bad firms in the insurance pool and eventually causing the pool to collapse. Priest (1987) argues that this problem is particularly severe in liability-insurance markets. For example, in the product-liability market, rising liability-insurance prices increase product prices. Higher product prices cause consumers who value the liability coverage less

19. Table A1 reports the only data that are similar to our other liability data and relevant to catastrophe reinsurance. It shows premium growth and profit for earthquake- and allied-lines insurance sold in the primary market, that is, sold by insurers to owners of property. These lines are not very reliable indicators of conditions in the reinsurance market, because of regulatory pressure on insurers not to make drastic changes in premiums or coverages. Both lines do, however, exhibit significant price increases following the loss events: the 1992 hurricane for allied lines and the 1994 earthquake.

(those who are less likely to have liability claims) to forgo purchases, making consumer pools deteriorate as well. This increases adverse selection: manufacturers know more than insurers about their potential product liability, because they not only have better information about their products but also have better information about their consumers. Increased risk along with asymmetric information between insurers and manufacturers and between manufacturers and consumers causes the market failure.

Although this theory does predict some features of the liability crisis, it has difficulty explaining others. Policy cancellations are a case in point: one would not expect adverse selection to affect policies purchased before the onset of the crisis, since the policy premium would reflect precrisis risk levels—yet such cancellations were widespread. In our model of overhang, policy cancellations correspond to the case where the overhang (q_A^0) is so high that insurers actually wish to have a negative volume of new policies; the only way to achieve this in any degree is to cancel policies currently in force.

The risk-overhang theory also provides clear predictions on the relative durations of crises, which this adverse-selection theory does not. Indeed, so long as the pool of potential policyholders is unchanged, a market failure caused by adverse selection might be expected to continue indefinitely or until insurers somehow become better at screening good risks from bad. By contrast, our overhang model suggests that the duration of a crisis is directly related to precrisis policy volumes and tail length in that line of insurance.

Although our model does not rely on adverse selection between existing insurers and insurance customers, incorporating slightly different dimensions of asymmetric information has the potential to strengthen our results. One potential objection to the overhang model is that insurers could always sell off their policies through the reinsurance market, removing the overhang. Such reinsurance would not overcome the loss of capital caused by expected losses on the old policies, but it would remove the problem caused by correlation between unexpected losses on old and new policies. The difficulty is that the insurers have better information about their potential risks and portfolio composition than the reinsurers, leading to adverse selection in the reinsurance market.

Such asymmetric information between incumbent insurers and outsiders also motivates barriers to capital and to entry, which are crucial to the overall theory of insurance cycles. Outside investors will be most reluctant to contribute more capital in settings where adverse selection in insurer quality is severe (see Myers and Majluf 1984). Similarly, outside insurers will be most reluctant to enter in settings where incumbents have a high information advantage, since they know that their pool of potential policyholders will be weighted toward the incumbents' rejects. D'Arcy and Doherty (1990) find evidence of this type of asymmetric information in the personal automobile–insurance market, where "public" information on buyers, such as drivers' records from state departments of motor vehicles, might be considered more prevalent.

Finally, we should note that adverse selection can also be a concern on the part of potential policyholders; after all, policyholders want an insurer that is likely to be around to meet its obligations when claims come due. Our discussion of overhang has presumed that the insurer fears financial distress, leading to an effectively risk-averse (concave) objective function for the insurer. This makes sense for insurers who still have enough "going-concern" value to make financial distress costly to shareholders and managers alike. On the other hand, it is well known that once a firm's net worth is sufficiently low, both shareholders and managers may have incentive to gamble on risky, negative-expected-value projects: shareholders because the upside goes to them while the downside is shared with creditors, and managers because it is the only way to have a chance of avoiding bankruptcy and job loss.[20] Alternatively, this can be viewed as an example of the Myers (1977) underinvestment problem, where an overhang of liabilities (in the present case, insurance policies) causes the firm to eschew decisions that enhance safety.

Now consider an insurance market where a negative shock has occurred and overhang is a concern. Those insurers with the worst capital positions (including the impact of expected losses from their overhang of old policies) will be the ones most inclined to offer additional policies in this line—in effect, they can "double up" on their existing policies, reaping the benefit of high premiums if no more losses occur, defaulting otherwise. By contrast, insurers whose positions are relatively better will be concerned about preserving going-concern value and avoiding distress, so they will be most reluctant to issue additional policies. To the extent that insurers have better information about their financial positions (including potential losses from overhang), potential policyholders will be concerned that the insurers most actively seeking new business are "lemons" that cannot make good on their obligations. Thus, demand for insurance policies will be dampened. Once again, overhang contributes to market disruption.

V. Applications to Other Financial Intermediaries

In our model, insurers are financial intermediaries who offer contracts to customers, exposing the insurers to risk; thus, portfolio considerations are a critical variable in determining the supply of insurance, and an overhang of existing policies can exacerbate the market disruption that follows a large insured shock. As we now discuss, the same intuition applies to other financial intermediaries as well.

A. Lending Institutions

Banks and other institutions that lend to firms with limited access to public capital markets provide these firms with a form of insurance against shocks to their internal capital; when the firm needs external financing, a lender that

20. See Jensen and Meckling (1976).

has a relationship with the firm may not only be the cheapest but the only source of financing available. Such lending institutions may face risk-overhang problems because loan default rates exhibit high correlation within a given sector or geographic region. In the event of a sector downturn, expected loan losses increase, depleting lenders' net worth and increasing their effective risk aversion; even without overhang, this should cause a relative reluctance to lend or "credit crunch." The overhang of risky loans also means that lenders will be most averse to making loans in those sectors where they already have large exposures.

Since lending is an information-intensive business, the asymmetric information factors we discussed for insurance will play a role here as well. Heightened asymmetric information between established lenders and other institutions will make it especially costly for incumbent lenders to reduce exposures or raise additional capital.[21] Indeed, if overhang is very severe, established lenders may be forced to call or refuse to renew loans as a way of reducing exposure (though the distress this causes for borrowers will make this a costly risk-reduction method). Similarly, lack of expertise and "winners' curse" concerns will inhibit entry by lenders that do not already have significant presence in the distressed sectors.[22] Both problems will persist as long as the overhang of bad loans is significant.

The upshot is that risk overhang from old loans may exacerbate credit crunches in a sector-specific way. Moreover, since the model requires only that overhang be difficult to unload or hedge and that external finance be costly, even unregulated lenders will be affected. This is certainly consistent with the 1989–92 credit crunch; problems were most severe in the commercial real estate and business-lending sectors, and the crunch also affected nonbank lenders, such as life insurers and finance companies.[23]

B. Securities Firms

By underwriting security issues and making markets in these securities after they are issued, securities firms help give firms that need external financing access to active public capital markets. At first glance, securities firms would seem unlikely to suffer from the overhang problem discussed in this article; faced with a capital shock, they should be able to sell off any securities that they hold, removing any further exposure to the risk of these securities. Nevertheless, recent events suggest that this is not always the case; the securities these firms deal in may face potentially great informational concerns, exposing them to an illiquid inventory of securities in the event of a market crisis. If so, the overhang of risk emanating from these inventories will make securities firms especially averse to further exposure in that market sector.

Thus, the critical ingredients are that the securities have potentially high

21. See, e.g., Lucas and McDonald (1987, 1992), Stein (1998), and Winton (1999*b*).
22. See Dell'Ariccia, Friedman, and Marquez (1999); Shaffer (1998); and Winton (1999*a*).
23. See Federal Reserve Bank of New York (1994).

risk and information sensitivity and that the securities' risk be highly correlated within a given sector of the market. Examples of such securities include bonds issued by low-credit-quality borrowers, where information about borrower quality can lead to great swings in the market value of the bonds, and complex mortgage-backed securities, where information about precise prepayment rates can have a radical effect on the securities' value and sensitivity to interest-rate changes. Note that, in both cases, the risk has a high systematic component; as mentioned previously, credit or default risk is correlated across firms in a given sector or economy, and interest-rate changes also have a large systematic component.

A large negative shock in one of these market sectors increases the risk of these securities and thus the relative magnitude of any lemons concerns, making the securities less liquid.[24] Inventories that securities firms have been holding as part of their underwriting and market-making activities are suddenly both riskier and more difficult to unload, leading to a large overhang of risk. Thus, incumbent securities firms will be reluctant to do more underwriting or market-making in this sector. To the extent that pricing and trading these risky securities tends to require more specialized expertise, entry by unaffected securities firms will be difficult. Once again, the market disruption may persist for some time.

These patterns can be seen in the crisis in the U.S. "junk-bond" (below-investment-grade–bond) market in 1989–90, the crisis in mortgage-backed-securities markets in 1994, and the emerging-markets bond crises of 1997 and 1998.[25] Disruptions lasted a few years in most cases; for example, junk bond underwriting volumes took until 1992 to recover.

VI. Conclusion

In this article, we extend the portfolio model of corporate risk management introduced in Froot et al. (1993) to include an overhang of risk emanating from past business decisions. We show that when those past risks cannot be easily diversified or hedged, they will reduce the firm's willingness to engage in correlated business activities. Our discussion focuses on the nonlife-insurance industry, where our model predicts that market disruptions will last longer in lines with greater overhang. Our model also predicts that sufficiently large risk overhang accompanied by a high correlation with future business opportunities can result in sellers withdrawing from the market and trying to shed past exposure. We find supportive evidence for both of these predictions

24. For low-credit-quality bonds, large negative credit shocks increase the chance that the debt will not be paid in full, leading to higher variance; for mortgage-backed securities, large shocks can affect the risk of the prepayment options built into the security. Empirically, the result that market volatility tends to increase following large negative shocks is fairly general.

25. For U.S. junk bonds, see U.S. Senate Committee on Banking, Housing, and Urban Affairs (1990) and Benveniste, Singh, and Wilhelm (1993); for mortgage-backed securities, see *Economist* (1994*a*, 1994*b*); for emerging markets, see Lee (1997) and Zuckerman and Ip (1998).

by comparing market outcomes during the liability insurance crisis and the catastrophe-reinsurance crisis. The crisis in liability lines, with significantly longer times between events and claims (and thus overhang), persisted longer than that in the catastrophe-reinsurance market, where claims are resolved relatively quickly after a loss event. In addition, in both cases insurers refused to sell new policies in certain areas or lines and canceled existing policies in order to reduce exposure.

Although our analysis focuses mostly on the insurance industry, our model of risk overhang applies to other industries as well; the critical features are that past business decisions produce continuing exposure to risk and that these risks are difficult to hedge and are correlated with risk from new transactions in the firm's line of business. Both lenders and certain securities firms share these features, and key features of both "credit crunches" and securities-market crises are consistent with the predictions of the risk-overhang model. Similar considerations should apply to nonfinancial firms: to the extent that these firms face noninsured exposures from past transactions in one of their major business lines, they will be reluctant to undertake additional business in this line—even if this additional business seems profitable in isolation.

Appendix

TABLE A1 Premium Growth and Profitability: Earthquake and Allied Lines

	Earthquake		Allied Lines	
Year	Premium Growth (%)	Profit Measure	Premium Growth (%)	Profit Measure
1985				−3.1
1986			16.58	19.1
1987			11.74	21.5
1988			−7.62	16.8
1989	22.58	−36.00	1.17	−19.6
1990	27.40	49.40	2.05	−.3
1991	23.49	58.70	5.04	2.1
1992	10.46	65.10	−.41	−39.6
1993	9.90	70.80	13.10	−11.5
1994	−10.32	−778.90	14.49	−7.5
1995	43.93	35.50	7.79	−14.0
1996	31.74	15.10	8.57	−10.1
1997	−15.53	47.00	6.69	4.6

SOURCE.—A. M. Best (1995, 1998).

NOTE.—Premium growth is measured as the percent annual change in earned premiums. In the case of earthquake insurance, there was no following crisis event, although reports indicate that the Northridge earthquake in 1994 did prolong the market disruption in catastrophe reinsurance. The profit measure is equal to 100 − overall operating ratio (as reported in Best's *Aggregates and Averages, Property Casualty Edition*). This equals 100 − (acquisition expenses / written premiums) − [(incurred losses + loss adjustment expenses)]/(earned premiums)] + (investment income/earned premiums), where written premiums are revenues on a cash basis, earned premiums are revenues on an accrual basis, and incurred losses are an undiscounted estimate of expected loss. Allied lines covers windstorm, riot, explosion, fire-sprinkler leakage, and other perils.

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