The Capital Structure of Insurers: Theory and Evidence

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Abstract

This paper develops and tests a theory of insurers' choice of the mix of equity and liabilities. The role of equity in insurance markets (and in our model) is to back insurers' promises to pay claims when there is aggregate uncertainty, or dependence among risks. Depending on the nature of this aggregate uncertainty, the equity held by firms in a competitive insurance market may increase with rising uncertainty, or it may initially increase then decrease. The ratio of equity to revenue unambiguously increases with uncertainty. We test the model, as well as implications of recent models of insurance market dynamics, on a cross-section of U.S. property-liability insurers.

1. Introduction

In the simplest economic models of insurance markets, which ignore transactions costs of any kind, risks are priced at actuarially fair values. This prediction is supported by either of two sets of assumptions: the *pooling* theory of insurance assumes that insured risks are independently distributed and large in number; the *transfer* theory of insurance assumes that risks are independent of aggregate wealth in the economy and can be transferred through the issuance of equity to a perfect capital market (Marshall (1976)). Recent research in insurance economics has shown that the observed dynamics of insurance premiums and contracts can be explained only by a failure of both sets of assumptions. Aggregate uncertainty, and imperfections in the capital market transfer of risks to security holders, are required (e.g., Grn (1994), Winter (1988,1994)). This connection is not surprising, since imperfections of some sort are necessary to explain even the existence of insurance intermediaries. The empirical tests in this recent literature have focussed on time series implications of insurance pricing and capital flows.

This paper explores in more depth the cross-sectional variation in insurers' capital structures: the choice by stock insurers of the mix of equity and liability. As in the standard theory of optimal capital structure for financial corporations, predictions of the theory must rely on specific capital market imperfections. We focus here on the simplest one: that issuing and maintaining additional equity is costly. Our model yields testable implications with a focus (appropriate for an analysis of insurance markets) on the liability side of the market. On the empirical side, this paper uses for the first time, to our knowledge, a sample of 1155 U.S. property-liability stock insurance companies in a study of capital structure.

Section 2 of this paper develops the simplest model of an insurance market with costly equity, in a two-period setting. For equity to have any role in an insurance market there must be aggregate uncertainty, or dependence among insured risks; the absence of a law of large numbers means that equity is necessary to back up promises to pay claims in the event of adverse realizations of aggregate shocks. Accordingly, the key comparative static issue that we focus on is the impact of increasing aggregate uncertainty. We consider separately the cases of aggregate uncertainty in the *loss* incurred conditional upon an accident and uncertainty in the *probability* of an accident (i.e. dependence among the *events* of individual accidents). If the former case, the total equity issued by a competitive insurance market is increasing in the degree of uncertainty (and linear in a parameterized example). In the latter case, equity may be increasing then decreasing as a function of uncertainty. In both cases, the *ratio* of equity to revenue is increasing in uncertainty.

Section 3 tests the theory using cross-sectional data on U.S. property-liability insurers. While the theory is developed for competitive markets, by assuming that each insurer is operating in one or more competitive markets, we can use firm-level data in the tests. The focus is on tests of two hypotheses. The first is the implication of the static model developed in section 2, that leverage is decreasing in aggregate uncertainty. The second is an implication of previous dynamic models of competitive insurance markets (Grn (1994) and Winter (1994)) that external equity is more costly than internal equity – specifically that there is a positive cost to the "round-trip" of distributing an amount of cash then raising the same amount in external equity. Previous tests of this implication focus on insurance pricing, that the error in premiums as predictors of subsequent claims rather than being white noise should be correlated with the current stock of equity. These tests thus center on the dynamic behavior of insurance premiums. The empirical analysis here is complementary, based not on prices but directly on capital structure decisions. The paper also offers a link between the recent insurance market literature and corresponding empirical results in tests of capital structure for non-financial corporations: Titman and Wessels (1988) and Rajan and Zingales (1994) find negative relationships between leverage and past profitability; an explicit dynamic theory and tests are offered by Fischer, Heinkel and Zechner (1989).

2. The Optimal Capital Structure of Insurers

We describe the capital structure choice of an insurance firm in the simplest possible model. As stated in the introduction, a key assumption must be that risks are dependent, i.e. subject to aggregate uncertainty or common factors. We consider separately the cases of dependence in the *events* of accidents and dependence in the *size* of losses incurred.

2.1. Uncertainty in Accident Losses

2.1.1. Assumptions

We consider a competitive market for insurance. On the demand side of the market, a large number of individuals each face with a known probability p the loss of wealth. The size of the loss is itself random, taking on the value H with probability α and L with probability $(1-\alpha)$. If the risks faced by individuals were *independently* distributed then – given a large number of individuals – insurance would be provided at a fair premium with no need for equity. The optimal capital structure would have zero equity.[1] We introduce a role for equity by assuming that the random losses faced are dependent among individuals. In fact, for simplicity, losses are identical for those experiencing an accident. In short, each individual faces a two-stage lottery, with "accident - no accident" in the first stage and "L or H" in the second; across individuals the first stage outcomes are independently distributed and the second-stage outcomes are identical.

The individuals are expected utility maximizers and the gain from exchange in the insurance market arises because they are risk averse. We take the simple case of identical

[1]This can be shown with the law of large numbers on the continuum of consumers.

individuals, with initial wealth W and utility U.

Ex ante, a large number of stock insurers issue equity and then issue insurance policies. An insurance policy is assumed to be *non-participating.* That is, the contract with any individual specifies a payment that is contingent only on the individual's loss experience: I_L dollars if the individual experiences a loss of L, I_H dollars with a loss of H. The premium is denoted by P. We will constrain the insurance contracts and equity to satisfy a limited liability constraint, so that the contracts promised by the insurer must be credibly backed by the equity issued. We denote by E the equity per policy issued. A second constraint is that the promised payment in any accident state cannot exceed the accident loss in that state; this can be justified by a moral hazard assumption that an individual has the ability to cause an accident intentionally.

In a perfect capital market, the opportunity cost of issuing and maintaining equity would be zero; equityholders would be indifferent between investing through the insurance corporation and investing through their personal portfolios. It is evident that in reality equity cannot be issued by an insurer and maintained without limit at zero opportunity cost. The costs include agency costs of having corporate management intermediate between investment in assets and shareholders; the administrative costs of issuing equity; the signalling costs of issuing equity and the double-taxation of corporate income.[2] We do not identify these costs, but simply assume that equity cannot be raised at zero cost. We assume specifically that to raise E dollars of internal equity, an insurer must issue $(1 + c)E$ in shares, where cE represent these costs of equity.

Equityholders price equity according to the expected value of net payments that they are to receive; this reflects an assumption that the uncertainty in losses, while not diversifiable in the insurance market, is diversifiable in the stock market. Interest rates are zero. The supply of insurance is taken to be competitive, which means that any capital structure E and policy (P, I_L, I_H) consistent with zero expected return to equityholders will be supplied if it is demanded. On the demand side, the individuals choose the most preferred policy among policies offered by the market.

This model yields, as an equilibrium, the choice of an insurance policy that maximizes the expected utility of the individual among all the policies yielding zero expected return to

[2]It is evident that means of distributing cash to shareholders other than by dividends cannot be relied upon as costless alternatives.

stockholders. The issue of concern is how the equilibrium values of equity and the structure of liabilities vary with uncertainty in losses.

2.1.2. Remarks

This is the simplest model within which we can address the impact of dependence in risks and costly equity capital structure decisions. Several features of the simple model abstract from reality. First, we have taken the *form* of the insurance contract, the nonparticipating contract, as exogenous. This can be justified formally with an assumption that an individual can verify only his own accident experience. It includes the simplification that no mutual insurance is available. Second, in this static model we do not capture any distinction between the costs of maintaining equity, and the costs of adjusting equity. The evidence from the recent literature is that this distinction is important for explaining the dynamics of pricing and capital flows. This model represents a first step in analysing the tradeoffs between the costs and benefits of increased equity. In the empirical section, we shall in fact offer some evidence of the cost advantage of internal capital – and, implicitly, of the value of extending this model to a dynamic context.

2.1.3. Equilibrium

Consider first the payoffs to equityholders and individual demanders of insurance, under the contract $[E, P, I_L, I_H]$ when this contract is offered to all individuals.[3] The payoffs to an individual who does not experience an accident is $W - P$. The payoff to an individual who experiences an accident with loss X, for $X = L$ or H is $W - P - X + I_X$. The payoff to equityholders in the event that accident losses are X is $-(1+c)E+P-pX$ since a proportion p of individuals experience an accident.

The contract offered in a competitive insurance market will maximize expected utility subject to three constraints. The first is a limited liability constraint, that the payment to accident victims in each event X must not exceed the sum of internal equity, $E + P$. That is, $pI_X \leq E + P$. The second is a participation constraint for insurers, that the expected profit be non-negative: $-(1 + c)E + P - p[\alpha H + (1 - \alpha)L] \geq 0$. The third is the constraint that $I_X \leq X$. The following results are easily proved.

[3]It is convenient to consider the equity E as one component of the contract; it backs the promise to pay the claims I_L and I_H.

Proposition 1: *If* $c = 0$, then the equilibrium insurance policy involves full coverage of each loss.

Lemma 1: *With* $c > 0$, the participation constraint is binding and:

(a) the constraint $I_L \leq L$ is binding: $I_L = L$.

(b) the limited liability constraint is binding in the event $H : pI_H = E + P$

(c) $I_H < H$

Proposition 1 is the standard perfect capital market benchmark. Lemma 1 is for the case of $c > 0$. Here, without the "moral hazard" constraint that $I_L \leq L$, low losses would actually be *more* than fully covered.[4] The lemma allows us to simplify the contract specification and payoffs: A contract can without loss of generality now be described as a pair (P, E). Individuals receive a net payoff of $W - P$ in any event except a high-loss accident, and $W - P - H + (P + E)/p = W - H + (\frac{1-p}{p})P + \frac{1}{p}E$ in the event of a high-loss accident. The *gross* return to shareholders is zero in the event of high accident losses (where the limited liability constraint is binding), so that the expected profit to shareholders from issuing a contract (P, E) is

$$\begin{aligned} &-(1 + c)E + (1 - \lambda)(P + E - pL) \\ &= -(\lambda + c)E + (1 - \lambda)[P - pL] \end{aligned}$$

In sum, we can characterize the equilibrium insurance contract as the solution to the following problem:

$$\max_{E,P} \quad (1 - p\lambda)U(W - P) + p\lambda U\left(W - H + (\frac{1-p}{p})P + \frac{1}{p}E\right) \tag{2.1}$$

subject to

$$-(\lambda + c)E + (1 - \lambda)[P - pL] \quad = \quad 0 \tag{2.2}$$

[4] This result follows because the events of an accident are independent across individuals, and therefore the market offers wealth transfers between the events of "accident" and "no accident" at an actuarially fair rate. The individual optimum therefore requires the equality of marginal utility in the event of no-accident and expected marginal utility conditional upon an accident. To achieve this equality, since high losses are not fully covered, low losses must be more than fully covered.

Letting the multiplier on the constraint be μ, the first order conditions with respect to E and P respectively are:

$$\lambda U'(\cdot) - (\lambda + c)\mu = 0$$

$$-(1 - p\lambda)U'(W - P) + \lambda(1 - p)U'(\cdot) + (1 - \lambda)\mu = 0$$

If we solve the first of these for μ and substitute into the second, we obtain

$$-(1 - p\lambda)(\lambda + c)U'(W - P) + \lambda[1 + c - p(\lambda + c)]U'\left(W - H + (\frac{1 - p}{p})P + \frac{1}{p}E\right) = 0 \quad (2.3)$$

Equations (2.2) and (2.3) characterize the optimal contract.[5] Our interest is in the impact on the equilibrium contract of an increase in aggregate uncertainty.

We represent an increase in uncertainty as a mean preserving spread in the conditional distribution of losses, but take as a simplifying restriction that λ remains constant in this increase. That is, $dH > 0$ with $dL = -\lambda/(1 - \lambda) \cdot dH$. Totally differentiating (2.3) and (2.2) with this substitution yields

$$\begin{matrix} dE/dH \\ dP/dH \end{matrix} = A^{-1} \begin{bmatrix} -\lambda[1 + c - p(\lambda + c)]U''(\cdot) \\ -p\lambda \end{bmatrix} \quad (2.4)$$

where A is given by

$$\begin{bmatrix} -\lambda/p \cdot [1 + c - p(\lambda + c)]U''(\cdot) & -(1 - p\lambda)(\lambda + c)U''(W - P) - \lambda[1 + c - p(\lambda + c)](\frac{1-p}{p})U''(\cdot) \\ -(\lambda + c) & 1 - \lambda \end{bmatrix}$$

Proposition 2: With aggregate uncertainty in the size of losses, an increase in uncertainty leads to

(a) an increase in both equity, E;

(b) an increase in the premium, P; and

(c) an increase in the equity-to-premium ratio, E/P.

Proof: We can write (2.4) in shorthand as $\begin{bmatrix} dE/dH \\ dP/dH \end{bmatrix} = \begin{bmatrix} a & b \\ -g & d \end{bmatrix}^{-1} \begin{bmatrix} e \\ -f \end{bmatrix}$ with all of the lower-case letters on the right-hand side positive. (This can be shown using $U'' < 0$.)

[5] Note that if c equals zero, so that we have a perfect capital market, then (2.3) implies that the two marginal utilities are equal, which in turn implies full insurance. This equation shows also that if (2.3) is positive, then the coverage is less than full in the bad state.

Solving for dE/dH gives $dE/dH = [ad+bg]^{-1}[ed+bf] > 0$, proving (a). Solving for dP/dH yields $dP/dH = [ad+bg]^{-1}[ge-fa]$. Substituting back in the terms for $[ge-fa]$ yields $[ge-fa] = -[1-p\lambda+c(1-p)]U''(\cdot)(\lambda c) > 0$, hence $dP/dH > 0$, proving (b). To prove (c), re-write (2.2) as

$$\frac{P}{E} = \frac{\lambda + c}{1-\lambda} + p\frac{L}{E}$$

from which we have

$$\frac{d\left(\frac{P}{E}\right)}{dH} = \frac{p}{E^2}\left[E\frac{dL}{dH} - L\frac{dE}{dH}\right] = \frac{p}{E^2}\left[-E\frac{\lambda}{1-\lambda} - L\frac{dE}{dH}\right]$$

which is negative since $dE/dH > 0$ by (b). It follows that $d(E/P)/dH > 0$.

2.2. Uncertainty in Accident Probabilities

2.2.1. Assumptions

The alternative structure is one in which common factors are in the events of accidents. We assume now that the loss from an accident is known, and equal to L, but, because of dependence in the events of accidents, the frequency of accidents is random. This frequency, p, is assumed to take on two possible values, a and b, with $b > a$. The term λ now represents the probability of the frequency b of accidents. The *ex ante* probability of an accident for any individual is $\bar{p} = (1-\lambda)a + \lambda b$.

A contract now involves the promise of a payment I in the event of an individual accident in exchange for the premium P. In contrast to the case of uncertain losses that are identical across individuals, where contractual promises for cash flows are always met, we must introduce here the notion of bankruptcy. An insurer with equity-per-contract E is bankrupt if $P + E - pI < 0$. We allow for the possibility that bankruptcy involves the loss of specific assets, interpreted as a reputation for prudence, or other bankruptcy costs. As before, issuing equity requires a transaction cost of c per unit.

As before, we consider the contract offered by a competitive market to identical, risk-averse consumers. This is the contract that maximizes individual expected utility subject to a zero-profit constraint.

2.2.2. Equilibrium

Depending on the market parameters, especially the size of bankruptcy costs and λ, the equilibrium may or may not involve bankruptcy in the event that the accident frequency is b. In the case where bankruptcy costs are sufficiently large, the equilibrium contract in this model will satisfy the solvency constraint in both states. We consider this a reasonable approximation, in light of the regulatory solvency constraints faced by firms. These constraints do not, evidently, reduce the probability of bankruptcy to zero; but the rate of bankruptcy is very small with less than one percent of policies defaulted on in any year. In understanding the costs and benefits in the choice of an equity ratio by a firm facing existing solvency regulation, and generating testable implications regarding this choice, approximating the regulation as a complete constraint against bankruptcy is useful.[6]

When the firm is subject to a no-bankruptcy condition for both events, a and b, the gross return to shareholders in the event b is zero, since (it is easily shown) excess equity will not be issued. The expected return to shareholders from the policy (P, I) with equity E is

$$-(1+c)E + (1-\lambda)[E + P - aI] = -(c+\lambda)E + (1-\lambda)(P - aI) \tag{2.5}$$

The amount of equity, E, will be chosen given the contract (P, I) to meet minimally the no-bankruptcy constraint in event b: $E + P \geq bI$ or $E = bI - P$.

We can solve the no-bankruptcy constraint for I and use this to express the payoffs to both shareholders and policyholders as functions of E and P, i.e from the contract that results from P and the efficient use of E. This is convenient for empirical testing, since equity and revenue for insurers are observable, whereas the average coverage per policy is not a meaningful concept. Solving $E = bI - P$ for I and substituting into (2.5) yields $(b - \bar{p})P - (bc + \bar{p})E = 0$ where $\bar{p} = (1-\lambda)a + \lambda b$ is the ex ante probability of an accident.

The optimal contract incorporating the no-bankruptcy constraint, and the zero-profit constraint solves the following problem:

$$\max_{(P,E)} \quad (1-\bar{p})U(W - P) + \bar{p}U(W - P - L + \frac{P+E}{b}) \tag{2.6}$$

subject to

$$(b - \bar{p})P - (bc + \bar{p})E = 0 \tag{2.7}$$

[6] We have elsewhere considered in more detail the effect of actual solvency regulation on insurance markets (Winter (1991)).

Proposition 3: In the case of uncertain probabilities with a no-bankruptcy constraint,

(a) an increase in uncertainty leads to an increase in E if uncertainty is sufficiently small. That is, $dE/db > 0$ if $b - a$ is sufficiently small.

(b) For larger levels of uncertainty, dE/db may be positive or negative.

(c) In the case of constant absolute risk aversion, the value of b for which E is maximal is increasing in the coefficient of absolute risk aversion.

proof:

Let $A(b) \equiv \frac{bc+p}{b-p}$ and $B(b) \equiv \frac{(1+c)-(bc+p)}{b-p}$. Note that $A'(b) = -\frac{(1+c)p}{(b-p)^2} < 0$ and $B'(b) = -\frac{(1+c)(1-p)}{(b-p)^2} < 0$. Solving (2.7) for P, substituting into (2.6) and differentiating yields the following first-order condition for (2.6).

$$-(1-p)AU'(W-AE) + pBU'(W-L+BE) = 0 \tag{2.8}$$

Now $(1-p)A - pB = (1-p)\frac{bc+p}{b-p} - p\frac{(1+c)-(bc+p)}{b-p} = c$, hence $(1-p)A > pB$. This, plus $U'' < 0$, plus (2.8) implies

$$W - L + BE < W - AE \tag{2.9}$$

That is, there is less that full insurance. Next, totally differentiating (2.8) with respect to E and b yields

$$\begin{gathered}\{(1-p)A^2U''(W-AE) + pB^2U''(W-L+BE)\}dE \\ +\{-(1-p)A'(b)\left[U'(W-AE) - AEU''(W-AE)\right] + \\ pB'(b)\left[U'(W-L+BE) + BEU''(W-L+BE)\right]\}db = 0\end{gathered} \tag{2.10}$$

From risk aversion, the term inside the coefficient of dE in (2.10) is negative. Hence the sign of dE/db is the same as the sign of the coefficient of db. The first line of this expression in (2.10) is positive. To consider the sign of the second line for $b - a$ sufficiently small, we evaluate it as b approaches p from above. $B \to \infty$ as $b \to p^+$ and the other terms in $[\cdot]$ of this line are bounded. Hence the terms inside $[\cdot]$ are negative in this limit and, since $B'(b) < 0$, the coefficient of db is positive in the limit. This proves the first part of the proposition.

To prove the second part, a parametric example suffices. Taking the case of constant absolute risk aversion, $U(W) = -e^{-aW}$ and solving (2.8) yields

$$E = \left(\frac{b-p}{1+c}\right)\left[\frac{1}{a}\ln\left((\frac{p}{1-p})(\frac{1+c-bc-p}{bc+p})\right) + L\right]$$

for an interior solution with

$$a(1+c)\frac{dE}{db} = \ln\left((\frac{p}{1-p})(\frac{1+c-bc-p}{bc+p})\right) + aL - \tag{2.11}$$

$$\frac{(b-p)(1-p)(bc+p)}{p(1+c-bc-p)} \cdot \frac{(1+c)(1-p)}{(b-p)^2} \tag{2.12}$$

It is easy to find parametric examples for which dE/db is negative for sufficiently large b. For example, if $(p, c; L, a) = (.1, .1; .25, 1)$ then E is initially increasing in b, reaching a maximum of .25 at $b = .0998$, then E is decreasing in b.

Part (c) of the proposition follows from total differentiation of the right hand side of (2.11).

At the heart of the comparative statics in proposition 3 are two off-setting effects of an increase in uncertainty on equity. Holding constant the amount of coverage issued, I, an increase uncertainty b implies an increase in the value of equity, E, that is necessary to cover the claims at a given premium. This is the *input effect.* The amount of coverage will drop, however, as a consequence of the higher cost of offering any amount of coverage; this feeds back to a decrease in E: an *output effect.* When uncertainty is sufficiently low, the input effect dominates and when uncertainty is high, the output effect may dominate. The two effects can be seen in the total differentiation of the no-bankruptcy condition, which yields $dE/db = I + b(dI/db) - dP/db$. The first two terms of this are, respectively, the input effect and the output effect. Endogenizing the change in P through total differentiation of (2.5) yields

$$\frac{dE}{db} = \frac{1-\lambda}{(1+c)}\left[I + b\frac{dI}{db}\right]$$

again showing a decomposition into the input and the output effects.

Proposition 4: In the case of uncertain probabilities with high bankruptcy costs, an increase in uncertainty leads to an increase in the equity ratio E/P.

proof: Solve (2.7) for $E/P = (b-\bar{p})/(bc+\bar{p})$, from which $d(E/P)/db = \bar{p}(1+c)/(bc+\bar{p})^2 > 0$.

3. Evidence

3.1. Introduction

Cross-sectional data on a sample of U.S. property-liability insurers allows us in this section to provide evidence on two aspects of insurers' capital structure decisions. The first is the implication from our model that insurers' leverage should be decreasing in the uncertainty faced in predicting average risks. While the equilibrium equity in our model is for particular cases non-monotonic in uncertainty, leverage – as measured by the ratio of insurance revenue to equity – is unambiguously decreasing in uncertainty.

The second aspect of capital structure that we offer evidence on is the relative costs of internal and external equity. Recent theory on the economic dynamics of insurance markets relies on the assumption that internal capital is less costly than external equity. By a cost advantage to internal capital, we mean simply that there is a positive cost to the round-trip of distributing an amount of cash to equityholders, then raising the same amount through the issuance of new equity. (The basis for such a cost is well-developed in the literature, e.g. Myers and Majluf (1984)). Up to now, this assumption has been tested for insurance markets using the time series of insurance market pricing. The implication of this assumption for the cross-section is that leverage should be decreasing in recent profitability, since this profitability leads to greater accumulation of internal equity.[7]

3.2. Empirical Proxies and Estimation

The firm specific data are collected from both OneSource and Best's Aggregates and Averages annual reports on consolidated property-casualty insurance companies. These statutory financial information are filed by insurance companies to National Association of Insurance Commissioners (NAIC) to assist insurance commissioners in regulating and monitoring insurance companies licensed in their respective state. The selected sample covers 1155 property-casualty stock insurance companies, from 1990 to 1995. To our knowledge, it is the first time that cross-sectional data on a sample of 1155 U.S. property-liability stock insurance companies is used to study the capital structure of insurers.

[7]The tests of both hypotheses for insurance markets are parallel to tests of capital structure hypotheses for general corporations that have been offered in the financial economics literature (e.g., Bradley, Jarrell and Kim (1984), Titman and Wessels (1988)).

The cross-sectional regressions of firm capital structure (leverage) on four hypothesized determinants— uncertainty of insurance loss, claim-paying ability rating, firm size, and past profitability, are specified as

$$\log(NPW/E) = \alpha + \beta \cdot \log(SD) + \gamma \cdot RATING + \delta \cdot \log(SIZE) + \eta \cdot PROFIT + \varepsilon_t \quad (3.1)$$

where *NPW* is the Net Premiums Written, *E* is the Policyholders Surplus, *SD* is the uncertainty of the insurance loss, *SIZE* is the firm size, *PROFIT* is past profitability, *RATING* is the insurance claim-paying ability rated by Standard & Poor's . These empirical proxies are defined as follows.

• Policyholders' Surplus *E*: the equity of a property-casualty insurance firm.

• Net Premium Written *NPW*: the total insurance policy revenue issued at a given business year.

• Loss Ratio: the ratio of incurred losses and loss adjustment expenses to net premium earned.

• Capital Structure (NPW/E): is measured as the ratio of Net Premium Written (*NPW*) to Policyholders' Surplus (*E*) in 1995. This reflects the relationship between the current volume of net insurance liability and the equity.

• Uncertainty of the insurance loss SD: is represented by the standard deviation of the loss ratio from 1990 to 1994. The theoretical model predicts an inverse relationship between the capital structure and the uncertainty in insurance market.

• Insurance Rating *RATING*: the default risk of the insurer affects negatively the demand for insurance policies. As a proxy for default risk we employ Standard & Poor's Insurance Company Ratings for property-casualty firms. A Standard & Poor's insurance claims-paying ability rating is an assessment of an operating insurance company's financial capacity to meet the obligations of its insurance policies in accordance with their terms. We assign a value of seven for companies with a rating of AAA, six for AA, five for A, four for BBB, three for BB, two for B, and one for CCC. We assign a value of zero for those firms with no rating.

• Firm Size *SIZE*: the costly external equity suggests that it is more difficult for smaller firms to issue equity in time of increasing of aggregate uncertainty and big catastrophe event; therefore, smaller insurance firms tend to keep a higher equity-liability ratio. Warner (1977), Ang, Chua, and McConnel (1982) and Titman and Wessels (1988) provide evidence for non-financial firms that capital structure is related to firm size. One explanation for this is that transaction costs are decreasing in the size of the firm. Smith (1977) finds that small firms incur substantially more costs to issue equity than large firms. [8] In regression, the natural logarithm of total admitted assets is used as a proxy for firm size. The predicted sign in the regression is positive.

- Past Profitability *PROFIT*: A positive cost of issuing equity, or a positive cost of distributing cash to shareholders implies a negative relationship between the capital structure and past profitability. This is because this positive cost of equity implies that the internally generated funds are low-cost source of equtiy capital for the insurance firm. The sample average of the profit/surplus ratios from 1990 to 1994 is used as a proxy of firm's past profitability.

3.3. Empirical Results

Table I reports descriptive statistics for variables in the regressions. Table II reports the results of the cross-sectional OLS regressions of firm capital structure on four hypothesized determinants— uncertainty of insurance loss, firm size, past profitability, and rating on claim-paying ability. The regression are conducted on a subsample of 200 largest firms (ranked by admitted assets) and a whole sample of 1155 firms. In the regression, the t-statistics are calculated using the method of White (1980). The regression results reported in Table II provide strong evidence to support the hypothesis that there is a inverse relationship between the capital structure and insurance uncertainty. For both the samples of the largest 200 firms and 1155 firms, the estimates of coefficient for $\log(SD)$ are negative and statistically significant. The parameter estimates for β is -0.129 in the sample of 200 firms (regression (1)) and -0.207 in the sample of 1155 firms (regression(5)), with t_β-statistics of -1.94 and -5.444, respectively.

The estimated coefficient for *RATING* provides further evidence on the relationship between capital structure and insurance uncertainty. It suggests that the capital structure is negatively related to firm's rating, i.e. default risk. The parameter estimate for γ is -0.101, with a t_γ-statistic of -3.506 for the sample of 1155 firms (regression (8)).

[8] The transaction costs of issuing securities are defined as flotation costs and costs encountered in trying to secure the highest price for the firm's securities. Smith (1977) identified flotation costs as: (1) compensation paid to investment bankers, (2) legal fees, (3) accounting fees, (4) engineering fees, (5) trustee's fee, (6) listing fees, (7) printing and engraving fees, (9) federal revenue stamps, and (10) state taxes. Smith went on to provide evidence which showed that firms enjoy economies of scale when issuing securities.

The parameter estimate for firm size *SIZE*, $\hat{\delta}$, is 0.071 with t_{δ}-statistic of 3.821 in the sample of 1155 firms (regression (8)). This "size" effect could reflect higher transaction costs faced by smaller firms in issuing equity. Consequently, the "size" effect is not significant in the sample of the largest two hundred insurance firms.

The estimated coefficients for *PROFIT* imply that the capital structure is negatively related to firms' past profitability. The estimated coefficient of *PROFIT* , $\widehat{\eta}$, is negative and statistically significant across 1155 insurance firms. The parameter estimate for η is $-.0497$, with a t_{η} - statistic of -2.0. The evidence on costly external equity in this cross-section study is consistent with the evidence on the dynamics of insurance markets, in which the explanations of "cycles" in the insurance markets rely on costly external capital.

In general, the restricted and unrestricted regressions confirm that insurers' leverage should be decreasing in the uncertainty faced in predicting average risks. However, insurance uncertainty is not the sole determinant of the capital structure of insurance firms. A combination of *SD, PROFIT, SIZE, RATING* provides higher explanatory powers. For the sample of 200 firms, the Likelihood Ratio test statistic is 8.192 (between regression (1) and (4)); for the sample of 1155 firms, it is 35 (between regression (5) and (8)), which are all significant at 1% level. These results parallel the results of Titman and Wessels (1988) on nonfinancial firms. [9].

4. Conclusion

This paper explores the capital structure of insurers. The focus is on the impact of aggregate uncertainty, or dependence among risks, since this is the source of an insurer's incentive to issue equity. Insurance firms respond to the shocks of increased risks by taking all or some of the following actions: placing limits on the number or coverage of contracts that they offer; raising premium for the policies that they issue; and raising more equity. We analyze the equilibrium mixture of these responses in a competitive insurance market, and find that the impact of increasing uncertainty on the equity decision depends on the nature of aggregate uncertainty. Where this uncertainty is in the size of losses, equity increases with uncertainty; where the risk dependence is in the events of losses, equity first increases then decreases with uncertainty, providing that individuals are not too risk averse. The latter result follows from

[9] The attributes used in their paper are asset structure, non-debt tax shields, growth, uniquenesses, size, earning volatility, profitability and industry classification

a tradeoff between two effects, which we label the input effect of uncertainty, and the output effect. In both cases, however, the ratio of equity to insurance revenue increases.

The paper tests this prediction and others on insurers' capital structure decisions. The cross–sectional tests over major property–casualty firms support the predicted negative relationship between capital structure and insurance uncertainty. The tests also find that past profitability and firm size (transaction costs) are an important determinants of the capital structure of insurers. Collectively, the importance of profitability and transaction costs provides cross–sectional evidence for "capacity–constrained hypothesis" of Grn (1994) and Winter (1994).

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Table I
Descriptive Statistics

This table reports the descriptive statistics of capital structure and its determinants. *NPW* is the Net Premium Written for each firm, *E* is the Policyholders' Surplus for each firm, the capital structure is measured as the ratio of Net Premium Written (*NPW*) to Policyholders' Surplus (*E*). *SD* is the standard deviation of Loss Ratio over the period from 1990 to 1994. *RATING* is the Standard and Poor's insurance rating on claim-paying ability (from 0 to 7). *PROFIT* is the average of profit/surplus ratios from 1990 to 1994. In total, there are 1155 firms in the sample. (Mean for SIZE (admitted asset) is in thousands of U.S. Dollars.)

	Mean	Std. Dev.	Minimum	Maximum
NPW/E	1.24	0.87	0.01	11.79
SD	0.114	0.145	0.002	1.674
SIZE	450,561	1,671,136	5,660	32,558,521
RATING	4.03	1.59	0	7
PROFIT	0.078	0.1423	-0.946	2.32

Table II
Regression Analysis of Capital Structure on Determinants

This table reports the results for cross-sectional regression of liability-to-equity ratio on its determinants: uncertainty of insurance loss, rating, firm size, and past profitability
$\log(NPW/E) = \alpha + \beta \cdot \log(SD) + \gamma \cdot RATING + \delta \cdot \log(SIZE) + \eta \cdot PROFIT + \varepsilon_t$
where *NPW* is the New Premiums Written, *E* is the Policyholders Surplus, *SD* is the insurance loss uncertainty, *SIZE* is the firm size, and *PROFIT* is the past profitability. *RATING* is the Standard & Poor's rating for property-casualty insurance companies. *N* is the number of firms in the sample. t-statistics of parameter estimates are reported in parentheses, it is calculated by the method of White (1980).

N	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$	η	R^2	Log. Likelihood	Regression
200	-0.376	-0.129				0.0186	-225.89	(1)
	(-1.95)	(-1.94)						
200	0.887	-0.171		-0.091	-1.118	0.0476	-222.89	(2)
	(0.914)	(-2.64)		(-1.325)	(-2.797)			
200	1.497		-0.046	-0.087	-0.483	0.0254	-225.19	(3)
	(1.549)		(-0.775)	(-1.218)	(-1.111)			
200	0.875	-0.185	-0.06	-0.072	-0.946	0.058	-221.79	(4)
	(0.911)	(-2.771)	(-1.026)	(-1.014)	(-2.16)			
1155	-0.648	-0.207				0.0361	-1592.81	(5)
	(-5.972)	(-5.444)						
1155	-0.975	-0.216		0.031	-0.617	0.0455	-1587.16	(6)
	(-4.43)	(-5.445)		(1.709)	(-2.223)			
1155	-0.711		-0.06	0.076	-0.285	0.0163	-1604.55	(7)
	(-3.432)		(-2.134)	(4.105)	(-1.425)			
1155	-1.133	-0.257	-0.101	0.071	-0.497	0.0649	-1575.31	(8)
	(-5.361)	(-6.363)	(-3.506)	(3.821)	(-1.993)			