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Abstract

This paper examines the effect of changes in capital on portfolio risk for a sample of publicly traded life insurance companies (LICs). We find that declines in capital lead LICs to increase portfolio risk. This result supports the hypothesis that a moral hazard problem exists for LICs. We also report that LICs financing part of their assets with guaranteed investment contracts face greater creditor and/or regulatory pressure which mitigates moral hazard. We also find that state guaranty fund systems in which taxpayers pay for the costs of resolving LIC insolvencies provide incentives for LICs to hold riskier portfolios. These findings support the view that government guarantees of the liabilities of financial firms exacerbate the moral hazard problem.

The Effect of Capital on Portfolio Risk at Life Insurance Companies

One of the consequences of the large number of failures at banks and savings and loan associations (S&Ls) in recent years has been a reassessment of the role of capital in financial intermediaries. Recent research has focused on the role that capital plays in affecting firm behavior, especially for managers of insured depository institutions. It has been demonstrated both theoretically and empirically that federal deposit insurance raises the incentive for insured institutions to bear additional risk.[1] Many researchers have argued that fixed-premium deposit insurance creates a moral hazard problem because depository institutions do not face the costs associated with increasing risk.

In this paper, we study the relationship between capital and asset risk for a sample of life insurance companies (LICs).[2] We are especially interested in identifying whether or not a moral hazard problem exists in the life insurance industry. Although there exists no federal program protecting life insurance policyholders from insolvencies, individual states have established guaranty funds. This paper seeks to answer three questions. First, do the state insurance guaranty funds, which by 1991 existed everywhere in the U.S except the District of Columbia, create incentives for LICs to pursue a high risk strategy? Second, how does the financial structure of the fund affect LIC risk-taking behavior? Third, what are the roles of creditor discipline and regulatory constraints in reducing the tendency of LICs to hold risky portfolios?

In light of the costly S&L bailout, which many observers have attributed in part to mispriced deposit insurance, one worries how state government guarantees of life insurance policies affect the riskiness of LICs. We address this issue by testing whether state guaranty funds induce firms to increase portfolio risk. Our strategy is to estimate the effect of changes in the firm's market asset-liability ratio on the optimal level of portfolio risk. According to the theory of moral hazard, lower asset-liability ratios raise the incentive to hold risky assets because the marginal benefit of raising risk increases as capital falls toward zero. Using a sample of publicly traded LICs, we find evidence supporting the moral hazard hypothesis: declines in capital lead LICs to increase portfolio risk.

In contrast to deposit insurance, the LIC guaranty funds differ across states with respect to the method used to pay for resolutions of failed LICs. Consequently, they provide an opportunity to assess how the financial structure of these funds affects firm behavior. This should be of interest to decision makers who must determine the best way to administer government guarantees of financial intermediary liabilities. Studies of state-administered deposit insurance systems of the nineteenth and early twentieth centuries have shown that their success depended on precisely how the member banks paid for the insurance. For example, Calomiris (1991) found that systems of mutual liability, self-regulating deposit insurance in the pre-Civil War era were entirely successful in dealing with financial panics. In these systems, surviving member banks were wholly responsible for paying depositors in failed institutions. Calomiris contrasts their success with the state deposit insurance systems of the 1914-1929 era, which led member banks to engage in excessive risk taking and rapid growth. These later systems failed because banks had little incentive to monitor the behavior of other member banks, while the deposit insurance gave each institution an incentive to increase risk.

A more recent use of mutual liability, self-regulating guaranty systems can be found in exchange clearinghouses. A clearinghouse serves as a guarantor to member firms' trades to mitigate credit risk exposure. Clearing associations have an incentive to monitor the insolvency risk of members because losses can be divided pro-rata among other clearinghouse members [Baer and Evanoff (1990) and Rutz (1989)]. However, by ceding the monitoring function to the clearinghouse, the individual firms do not have the same incentive to monitor as they would if there were no clearinghouse. Thus, even in a market with a clearinghouse overseeing activity, the sharing of insolvency costs tends to encourage risk-taking and provides incentives to use the system for subsidies or transfers between the members.

In a similar vein, we examine which methods used to finance state guaranty funds are most successful in promoting financially stable LICs. These funds are currently financed by *ex post* assessments made on surviving LICs operating in the individual states where a failure has occurred. The cost of an insurance bailout is prorated based on the proportion of total premiums collected within the state by the remaining LICs. However, in 39 states the incentive for the surviving institutions to monitor each other is typically quite weak because LICs may *credit* these assessments against their state premium taxes. In a study of 1990 life-health guaranty fund assessment costs, Barrese and Nelson (1992) found that over 80 percent of the present discounted value of these assessments were borne by taxpayers because of federal and state tax offsets. In the other states, companies are permitted to add a premium surcharge, so the resolution costs are shared by both existing policyholders and equity holders of surviving firms.

The cross-sectional variation in the financing of the funds allows us to estimate whether imposing costs on survivors leads to a more stable system. Our estimates indicate that the extent of risk-taking depends on whether or not surviving LICs pay for resolving life insurance failures. State guaranty funds in which taxpayers pay for the majority of costs of resolving failed firms induce LICs to hold significantly riskier portfolios. This finding is consistent with the performance of the early state deposit insurance funds.

Because LICs offer state insured liabilities, it is necessary for regulators to enforce constraints on firms. Capital requirements provide the first line of defense against losses. Also, the presence of non-insured debt instruments issued by LICs may help regulators by providing market assessments of the financial condition of LICs on a continuing basis. In the case of commercial banking, market prices of subordinated debt provide an early warning system to alert regulators of potential problems.

Both creditor discipline and regulatory pressure may depend on the types of liabilities LICs issue to finance their assets. Guaranteed investment contracts (GICs), widely used as funding instrument for defined contribution pension plans, typically obligate a life company to repay principal and interest accruing at a predetermined rate in a single payment at maturity. Thus, GICs have no insurance element. The effect of GICs on the stability of the life insurance industry has recently come under greater scrutiny. For example, Todd and Wallace (1992) argue that GICs were used by many LICs in the 1980s to facilitate rapid growth, similar to the way the S&Ls used brokered deposits. These liabilities, along with single premium deferred annuities

(SPDAs), have payoff characteristics similar to certificates of deposit. Thus, Todd and Wallace argue that LICs could use SPDAs and GICs to draw on savings previously held in other forms without the constraint imposed by the growth in the demand for insurance. On the other hand, Fenn and Cole (1992) stress creditor discipline as an important factor affecting LIC stock prices, particularly following problems at First Executive Corporation and The Travelers Insurance Corporation. LICs which have issued GICs may face more market discipline because most GICs are issued in large denominations to presumably sophisticated institutional investors. In fact, GIC holders began the liquidity run which brought down Mutual Benefit of New Jersey. Our empirical analysis helps settle this dispute. Firms using GICs to fund their assets respond less to the incentives presented by the state funds. We interpret this finding as evidence that these LICs face greater creditor and regulatory discipline, supporting the conclusions of Fenn and Cole (1992).

The paper is divided into four sections. Section one develops both the theoretical model and the hypotheses to be tested. Section two presents estimates of the basic model along with a description of the data sources and variables used in the analysis. Section three presents empirical results estimated separately for LICs issuing GICs and those not issuing GICs. Section four concludes.

I. Theoretical Framework

To develop a set of hypotheses concerning LIC behavior, we use a model developed by Cummins (1988) in which he adapts Merton's (1977) option model of deposit insurance to the life insurance industry. Merton's approach implies that stockholder's equity can be represented as a call option on the value of the firm's assets with strike price equal to the (fixed) face value of liabilities. In Merton's model, the firm faces an audit at some pre-specified time in the future. If deemed solvent at that audit, the equity holders receive the difference between the value of the assets and the liabilities. Otherwise, the firm is either closed or recapitalized. Cummins (1988) used his adaptation of Merton's framework to determine the value of policyholder guarantees provided by the state funds. Cummins' model is similar to Merton's with one important exception: both assets and liabilities are recognized as risky. His assumptions continue to imply that common equity is equivalent to a call option on the firm's risky assets. The difference comes from the fact that the strike price, equal to the value of liabilities, is stochastic. One result of this more general specification is that the relevant risk parameter becomes the standard deviation of the return on the whole portfolio rather than just the return on assets. Analytically, the value of the equity may be expressed as a function of the following variables:

$$E = C(A, L, \sigma, T), \tag{1}$$

where A is the market value of assets; L is the market value of liabilities; σ is a risk parameter equal to the standard deviation of the instantaneous return on assets minus the cost of servicing liabilities; and T represents the time to the next audit, normalized to one year.[3]

To analyze the incentives faced by the firm, we assume that the owners maximize the difference between the value of their investment within the firm (E) and the value of that investment in an alternative security (K).[4] Analytically, the firm solves the following problem:

$$Max(E-K) = E-(A-L), \tag{2}$$

where K, the difference between the market value of assets and liabilities, represents the value of the owner's investment in the next best alternative outside the firm. In other words, K is the market value of the firm's capital in the absence of the put protection of the state guaranty funds. Substituting equation (1) into (2) and exploiting the fact that the option payoff is homogeneous of degree one in A and L, we have:

$$Max\; L\,C(A/L, \sigma) - (A-L). \tag{3}$$

Defining z to be equal to A/L, the firm's problem may be stated as follows:

$$Max\; V(z, \sigma, L) = L[C(z, \sigma) - (z-1)]. \tag{4}$$

In other words, the firm selects the asset-liability ratio (z), the level of portfolio risk (σ), and the size of its liabilities (L) to maximize firm value. Equation (4) as specified has no solution, however, because the marginal benefit of increasing z is always less than its marginal cost, and the marginal benefit of increasing portfolio risk is always positive while its cost is zero. To see why this is true, differentiate equation (4) with respect to z and σ:

$$\frac{\partial V}{\partial z} = L(C_z - 1) < 0 \; since \; C_z < 1. \quad (5)$$

$$\frac{\partial V}{\partial \sigma} = L C_\sigma > 0. \quad (6)$$

A one dollar increase in assets financed with equity capital always raises the value of the option by less than one dollar because the additional equity capital lowers the probability of bankruptcy. This increases the value of the other claims on the firm's assets at the expense of shareholders. In the absence of other constraints, shareholders would like to increase leverage as high as it possibly can since this would raise the value of the option. For the same reason, they would like to boost asset volatility as high as possible. Moreover, using the Black-Scholes model for the value of a European call option, Furlong and Keeley (1989) showed that the magnitude of these incentives grows as either the financial position of the firm deteriorates (z moves closer to one) or portfolio risk increases. This follows because the cross partial derivative of the objective function is negative:[5]

$$\frac{\partial^2 V}{\partial z \partial \sigma} = L C_{\sigma z} < 0 \; for\, all \, z > exp\left(\frac{\sigma^2}{2}\right) and \, \sigma. \quad (7)$$

Thus, the marginal benefit of increasing leverage (lowering z) is greater for firms holding riskier portfolios, and the marginal benefit of increasing risk is greater for firms that are more highly leveraged. This is the essence of the moral hazard hypothesis, which implies that the incentive to increase portfolio risk or leverage increases as a firm's asset-liability ratio gets closer to one. A firm perfectly immunized from market discipline by a government guarantee of its liabilities will have an incentive to increase both leverage and risk.

While this model shows that firms with insured liabilities have strong incentives to increase risk and leverage, firms almost never hold infinitely leveraged or risky portfolios because there are offsetting costs which weigh against these incentives. We therefore modify the theory by providing two hypotheses explaining why life insurance companies are not able to exploit fully the option-like payoff of equity.

The first offset to the preceding incentives may be the existence of regulatory pressure. LICs with weak balance sheets may face greater regulatory scrutiny, increased audit frequency and limitations on asset holding powers, all of which impose costs on the firm. In theory, this mechanism prevents banks and thrifts from exploiting the fixed-premium deposit insurance system. However, the degree of regulatory scrutiny may vary across institutions. Indeed, in the commercial banking industry it has been argued that the "too big to fail" doctrine implies that the largest institutions face less regulatory pressure than smaller institutions. For example, Ely and Weaver (1990) have shown that larger banks do, in fact, take advantage of the easier regulation by holding less capital.

As summarized in Cummins (1988), insurance companies are monitored by both state regulators as well as the National Association of Insurance Commissioners (NAIC). In general, site audits by state insurance examiners are performed once every three to five years. However, the NAIC does computerized audits of LICs on an annual basis, and companies that fail four or more of eleven audit ratio tests are subject to greater regulatory review. Nevertheless, the degree of regulatory scrutiny of life insurance companies varies widely across states. The quality of examinations can vary due to the size and sophistication of the state insurance departments and the amount of resources a state government wishes to allocate to the supervision of insurance companies.

In addition, the ability of life insurance companies to lobby successfully for less restrictive regulations or scrutiny may vary across states. If surviving companies do not receive tax credits for assessments, then they would have a greater incentive to monitor and may pressure regulators to minimize the likelihood that any life company will become insolvent. Our model suggests that the incentive to pursue a high risk strategy is unaffected by whether surviving firms or taxpayers pay for bailouts. However, when surviving LICs actually bear the cost of the insolvencies, they will be more concerned with the financial health of other LICs in the state.

Creditor discipline provides a second offset to the moral hazard problem. If creditors face costs when the firm increases leverage and/or risk, they will monitor the firm's finances carefully rather than ceding the responsibility to the regulator. These costs stem from two sources: (1) lack of full confidence in or knowledge of the state guarantees by policyholders; and (2) less than perfect protection for policyholders from the guaranty funds. Guaranty fund coverage does in fact vary from state to state. In most states, policyholders are protected up to $300,000 in death benefits, $100,000 in cash or withdrawal value for life insurance, $100,000 in present value of annuity benefits and $100,000 in health benefits. Some states also cover unallocated annuities such as GICs up to a certain amount (usually $5 million). Even if policyholders are fully protected by the fund the state can take several years to liquidate a failed company; hence, they may not have full access to their funds immediately. Policyholders can impose market discipline by taking out policy loans or surrendering the policies for their cash value. As a result, the LIC has an incentive not only to keep risk and leverage at acceptable levels but also to maintain sufficient liquidity to meet potential cash demands from its customers. Market discipline of insurance companies would induce firms holding less capital to compensate creditors by holding safer, more liquid portfolios. In section four we analyze the impact of the GIC market on the strength of both regulatory pressure and creditor discipline.

II. The Impact of Moral Hazard on LIC Behavior

A. Model Specification

This section develops the empirical framework used to test whether management's selection of portfolio risk is affected by the incentives presented by the existence of policyholder guarantees and by other variables. Because we only have complete data for a five year period from 1986 to 1990, we focus only on the choice of risk as a function of several explanatory variables. LIC capital adjustment proceeds very slowly due to costs associated with changing dividends, issuing new securities, or increasing liabilities rapidly. Without a long time series, we are unable to model adequately the adjustment process determining observed levels of the asset-liability ratio. From the theory we know that the firm's choice of both its asset-liability ratio and portfolio risk are jointly determined [see equations (2) and (3)]. However, there are other factors outside management's control influencing these variables. For example, the value of assets and liabilities may vary exogenously in response to macroeconomic shocks such as changes in the level of interest rates. Thus, we focus on the effects of exogenous changes in the asset-liability ratio on the firm's choice of risk.

Since management may not costlessly vary its level of portfolio risk, we employ a partial adjustment model.[6] Each period, changes in risk equal a fraction of the difference between last period's value and the optimum. Specifically,

$$\Delta\sigma_{i,t} = \sigma_{i,t} - \sigma_{i,t-1} = \gamma(\sigma^*_{i,t} - \sigma_{i,t-1}) + \nu_{i,t}, \tag{8}$$

where $\sigma_{i,t}$ is the actual level of portfolio risk (as measured by the standard deviation of the ith LIC's portfolio return during period t); starred variables refer to their optimal levels; γ is an adjustment parameter; $\nu_{i,t}$ is a stochastic error term.

In order to estimate equation (8), we specify a set of exogenous and predetermined variables that affect the firm's optimal choice of risk (σ^*). To control for the effects of both market discipline and explicit regulatory pressure, we model the firm's optimal choice of risk as a function of the beginning period market asset-liability ratio (z_{t-1}). In the absence of the guarantees, this measures the compensation creditors would receive if the firm failed, so the market discipline hypothesis predicts a positive relation between risk and capital. Similarly, regulators presumably allow firms with more capital to hold riskier portfolios.

To test for the effects of the way the state guaranty funds are financed, we include the proportion of premium income from states which do not permit LICs to credit guaranty fund assessments against state premium taxes (NOCST) as an explanatory variable. We expect that a higher value of NOCST will lower the optimal level of risk. In the absence of the tax credits, surviving firms will pay more of the cost of bailouts, providing these companies with a greater incentive to pressure regulators to minimize the likelihood of any failures.

The optimal level of portfolio risk may also depend on firm size (SIZE). Differences in both regulatory pressure and the agency conflict between management and shareholders may vary with firm size. Also, larger firms may be better equipped to diversify the non-systematic risk component of their portfolios. If the diversification hypothesis is correct, then the coefficient on this variable should be less than zero.

Finally, the optimal level of portfolio risk is modelled as a function of the change in the asset-liability ratio (Δz). As shown in the previous section, the moral hazard hypothesis predicts that decreases in capital will increase the incentive for the firm to hold risky assets and liabilities. In order to test this notion, we include exogenous changes in the asset-liability ratio in the specification of the optimal level of risk. Since the current level of the asset-liability ratio is jointly determined with portfolio risk, via equations (5) and (6), we use the lagged value of Δz in our primary specification. Combining all these relationships, σ^* may be expressed analytically as follows:

$$\sigma^* = G(\Delta z_{-1}, z_{-1}, SIZE_{-1}, NOCST_{-1}), \tag{9}$$

with expected signs for the partial derivatives as follows:

$$G_1 < 0; G_2 > 0; G_3 < 0; G_4 < 0.$$

Substituting a linearized version of σ^* into equation (8) yields the following equation:

$$\Delta RISK_{i,t} = \beta_0 + \beta_1 ALR_{i,t-1} + \beta_2 RISK_{i,t-1} + \beta_3 SIZE_{i,t-1} + \beta_4 NOCST_{i,t-1} + \beta_5 \Delta ALR_{i,t-1} + \nu_{i,t}. \tag{10}$$

where $ALR_{i,t} = z_{i,t}$ and $RISK_{i,t} = \sigma_{i,t}$.

B. Data Sources and Variable Definitions

The model was estimated using ordinary least squares on a panel of 44 publicly traded insurance companies specializing in life insurance (greater than 60% of their assets) for each quarter from the end of 1986 to the end of 1990.[7] Stock market data for the 44 companies are from Interactive Data Services, Inc. A list of the corporations used in this study is presented in Table 1. For multiple LIC holding companies, the assets and liabilities of individual subsidiaries are consolidated using the Statutory Reports of Condition that insurance companies are required to file with state regulators at the end of each year. To generate accounting data for intermediate quarters, we used a linear interpolation of the year-end values with an adjustment based on the Federal Reserve's quarterly Flow of Funds data for the industry as a whole. For instance, if total assets in the industry during the second quarter of 1988 based on the actual data from the Flow of Funds Accounts were 0.5% greater than the interpolated value between the fourth quarter of 1987 and the fourth quarter of 1988, we increased the interpolated value of total assets in that quarter for each LIC by 0.5%. A similar approach was used for the other balance sheet and income statement variables taken from the Statutory Reports of Condition.

We use Cummins' (1988) model to compute the market value of the asset-liability ratio (z) and the standard deviation of the return on LIC portfolios (σ). His specification assumes that all LICs face an audit one period in the future to determine their solvency. If deemed solvent, the equity holders receive the difference between the market value of assets and liabilities. Otherwise, the firm must recapitalize or is closed by the regulatory authority. In addition, LICs are assumed to hold a portfolio of marketable assets (A) and marketable liabilities (L) which obey the following Itô processes:

$$dA = \mu_A A\,dt + \sigma_A A\,dz_A, \tag{11}$$

$$dL = \mu_L L\,dt + \sigma_L L\,dz_L, \tag{12}$$

where dz_A and dz_L are Wiener processes related as follows:

$$dz_A dz_L = \rho_{AL}\,dt, \tag{13}$$

ρ_{AL} may be interpreted as the instantaneous correlation between the return on assets and the return on liabilities.

Under these assumptions, common equity is equivalent to a call on the firm's risky assets with strike price equal to the value of its risky liabilities.[8] Cummins showed that the differential equation satisfied by this derivative security equals the Black-Scholes differential equation in which the relevant risk parameter equals the risk on the overall portfolio (denoted as σ^2) as follows:

$$\sigma^2 = \sigma_A^2 + \sigma_L^2 + 2\rho_{AL}\sigma_A\sigma_L. \tag{14}$$

Since the boundary conditions remain unchanged, the value of equity may be written as follows:

$$\frac{E}{L} = z\Phi(x) - \Phi(x-\sigma), \tag{15}$$

where z is the asset-liability ratio; Φ(.) represents the cumulative, standard normal distribution function; and $x = (\log(z) + \sigma^2/2)/\sigma$. Moreover, since equity is a derivative security, this model implies that the standard deviation on the equity must be proportional to the standard deviation of the firm's portfolio:

$$\sigma_{E/L} = \left(\frac{A}{E}\Phi(x)\right)\sigma. \tag{16}$$

Recognizing that A/E = z (L/E) and substituting yields:

$$\sigma_{E/L} = \left(z\frac{L}{E}\Phi(x)\right)\sigma. \tag{17}$$

We use this model to infer the standard deviation of the firm's portfolio (σ), and the market value of the asset-liability ratio (z). In order to do so, we assume that the book value of liabilities equals the unobserved market value. Consequently, E/L may be constructed from market data on stock prices and book values of liabilities. For $\sigma_{E/L}$, we use the sample standard deviation of the LIC's weekly stock return over the quarter.[9] Given estimates of E/L and $\sigma_{E/L}$, equations (15) and (17) comprise a system of two equations and two unknowns that we solve for the market values of z and σ. These are used as the variables in the empirical model.

The risk equation contains two exogenous variables believed to influence the optimal ratio of assets to liabilities: (1) the proportion of premium income from states which do not allow LICs to credit guaranty fund assessments against taxes (NOCST); and (2) total assets (SIZE). A description of the guaranty funds by state appears in Table 2. We use this information to construct NOCST. SIZE is measured as the log of total book value assets at the end of t-1.

Table 3 contains summary statistics of the variables for the sample of firms used in the estimation.

We also estimate equation (10) using time fixed effects to control for the effects on risk of changes in time-specific factors that are not captured by our independent variables.[10] As a further check on the robustness of our estimation procedure, we also estimated equation (10) using the standard deviation of the equity return times the market capitalization-asset ratio (STDRET) as an alternative measure of risk and the ratio of market value of assets to book value liabilities as a proxy for ALR. We computed the value of assets as the sum of the book value of liabilities plus the stock market capitalization. This approach is less desirable than our methodology because the value of equity includes the put protection of the state guarantee funds.

C. Results

The results of estimating equation (10) appear in Table 4. The first two columns of Table 4 show the results of tests in which the dependent variable is ΔRISK. The last two columns of Table 4 present the results with the change in the standard deviation of stock returns (ΔSTDRET) as the dependent variable. The results of estimating equation (10) with time fixed effects for each measure of risk are presented in columns two and four. In each of the four specifications, the results appear consistent with the partial adjustment model. The coefficient on the lagged level of risk ($RISK_{-1}$ or $STDRET_{-1}$) lies in the interval from -1 to 0. The point estimate of the adjustment parameter indicates that LICs move realized risk approximately 70 percent of the way toward the optimal level in one quarter.

In accord with the moral hazard hypothesis, a *ceteris paribus* decrease in ΔALR in period t-1 leads to a rise in the optimal level of portfolio risk in period t. Indeed, this effect is statistically significant in every specification. The coefficient on the lagged level of the asset-liability ratio is significantly positive, indicating that LICs with more capital tend to hold riskier portfolios. We interpret this result as consistent with both market discipline as well as regulatory pressure. The coefficient on SIZE is negative and statistically significant, indicating that large LICs tend to hold less risky portfolios. Firm size might serve as a proxy for LIC asset diversification since large LICs can diversify their assets better than smaller firms.

The coefficient on NOCST, the proportion of premiums from states in which taxpayers do not fund the policyholder guarantees, is negative and significant in all four specifications. LICs hold less risky portfolios when they face some of the costs associated with insolvencies. Evidently, in states without tax offsets for the cost of bailouts, healthy LICs encourage stricter regulation of their competitors. This conclusion follows because the incentive for individual LICs to engage in high risk behavior is the same regardless of whether taxpayers or surviving firms pay for the bailout. Moreover, the point estimate on this coefficient indicates that the effect of the financing of these state funds has a large impact on the long-run viability of these systems. For instance, our results indicate that an LIC operating strictly in states with no tax offset would hold a portfolio less than half as risky as the typical life insurance corporation operating nationwide.

The results in column 2, which include time fixed effects, as well as columns 3 and 4, which use an alternative measure of risk, are qualitatively similar to the results reported in column 1 for all the explanatory variables. Thus, we believe these results to be robust to both changes in model specification and the way in which risk is measured.

III. The Effects of the GIC Market on Creditor Discipline

The effects of LIC issuance of guaranteed investment contracts and other liabilities devoid of any insurance characteristics are currently under scrutiny. Todd and Wallace (1992) compare GICs and SPDAs with brokered deposits as a mechanism used by LICs to finance excessive growth. They argue that these instruments exacerbate the moral hazard problem. However, GIC holders typically are sophisticated institutional investors who may be better equipped to impose discipline on LICs. Thus, they may provide timely information to regulators which acts as a brake on excessive risk-taking by any LICs choosing to issue these securities. Thus, LICs issuing GICs may respond less to the incentives to increase risk (moral hazard) than firms specializing in traditional life insurance products.

To further analyze the relation between LIC risk and capital, the sample was divided into two categories: LICs which issue GICs and LICs which do not. Life companies in each category are ordered according to their book capital-asset ratios and divided into high capital and low capital firms. The high capital LICs consist of those firms in each category with a capital-asset ratio in excess of 9 percent. The low capital group is comprised of the remaining LICs. Table 5 presents growth rates of several balance sheet items from 1987 to 1990 for high and low capital LICs which issue GICs and LICs which do not, respectively. The results in Table 5 indicate that low capital LICs which do not issue GICs tend to grow faster than low capital capital firms which do issue GICs. Low capital LICs which do not issue GICs also grew faster than both types of high capital life companies. Moreover, junk bond holdings rose more at low capital LICs which do not issue GICs.

Using a dummy variable, GICDUM, the coefficients in equation (10) were estimated separately for both categories of LICs. GICDUM is equal to one for an GIC issuing life insurance company and zero otherwise. Table 6 reports the results using ΔRISK as the risk measure and Table 7 presents the results using ΔSTDRET as the risk measure. In both Table 6 and Table 7, the first and third columns show the parameter estimates from estimation of a version of equation (1) in which each independent variable is interacted with the binary dummy variable GICDUM. Columns (2) and (4) present the parameter estimates for GIC issuing life insurance companies.

The results in Table 6 indicate that two of the exogenous variables, SIZE and ΔALR, affect the firm's optimal choice of RISK differently depending on whether or not the LIC chooses to issue GICs. The impact of lagged ΔALR on risk provides support for the notion that GIC issuing firms face sufficient market and/or regulatory pressures to prevent moral hazard (columns (1) and (2) of Table 6). A unit decline in ALR leads non-GIC issuing firms to *increase* the optimal choice of risk by 0.14 while inducing GIC firms to *decrease* risk by 0.001, although this latter effect is not significantly different from zero. Thus, in contrast to non-GIC firms, the LICs which offer GICs respond to adverse movements in capital by lowering portfolio risk, as predicted by the view that creditor and/or regulatory discipline controls the moral hazard problem. The results in Table 6 also show a statistically significant negative association between asset size and changes in portfolio risk for non-GIC issuing life insurance companies. Our results suggest that these LICs may have chosen to take advantage of scale in some way so as to reduce risk. In Table 7, there is little evidence of a statistically significant association between SIZE and portfolio risk for GIC issuing firms. For both GIC issuing and non-GIC issuing firms, the coefficient on the NOCST variable is negative and significant, suggesting that firms in states without premium tax credits have less of an incentive to engage in high risk behavior regardless of whether they issue GICs.

The results in columns (3) and (4) of Table 6, which include the time dummy variables, are consistent wtih those reported in columns (1) and (2). In particular, non-GIC issuing life companies respond to adverse movements in capital by raising portfolio risk. There is no evidence of an association between LIC risk and lagged ΔALR for GIC issuing firms. When ΔSTDRET is used as the risk measure, the results including time fixed effects in Table 7 for GIC issuing life companies indicate a significant negative correlation between risk and lagged ΔALR. However, this negative relation is smaller in absolute value than for non-GIC issuing firms. In all specifications in Table 7, SIZE and NOCST have the same qualitative effects as those found in Table 6.

Overall, these results lend support to the notion that regulators ought to encourage LICs to diversify into the GIC market. Our results indicate that LICs issuing GICs pose less of a moral hazard problem on the state guarantee funds. This may occur either because large GIC-holders such as pension funds impose direct creditor discipline on firms or because the presence of these securities provides information to regulators.

IV. Conclusions

State guarantees of life insurance policies present LICs with the incentive to hold highly leveraged portfolios composed of risky assets and liabilities. Stockholder wealth may be increased indefinitely by raising risk because of the asymmetric payoff: all upside gains accrue to shareholders while, particularly for poorly capitalized institutions, little is at risk on the downside. Our empirical results demonstrate that these incentives are manifested in the behavior of LICs. We have shown that regulatory pressure and market discipline can control the LICs' tendency to take risk, since we find a direct relationship between the asset-liability ratio and portfolio risk. Consistent with the moral hazard hypothesis, however, exogenous declines in capital lead LICs to increase portfolio risk.

Our findings lead us to two main policy conclusions. First, the empirical results indicate that the way the state guaranty funds are financed affects the behavior of LICs. The use of premium tax credits for guaranty fund assessments encourages LICs to increase portfolio risk. By eliminating these tax credits, the surviving LICs have a stronger incentive to pressure regulators to decrease the likelihood of failures. This finding should be of great interest to policymakers concerned with the long run viability of the state guarantee funds.

Second, LICs should be encouraged to hold uninsured or partially insured liabilities both to increase the presence of creditor discipline and to assist regulators in collecting accurate and timely information on market conditions. This is the rationale for suggesting that banking organizations supplement their capital structure with subordinated debt instruments. LICs which use GICs to finance their portfolios appear to respond more to the pressures of creditors and/or regulators than to incentives created by the state guarantee funds. We base this conclusion on the effects of lagged changes in capital on the optimal choice of risk: LICs that do not issue GICs respond to exogenous declines in capital by raising portfolio risk; LICs active in the GIC market do not.

FOOTNOTES

[1]Merton (1977) was the first to demonstrate this result by modelling deposit insurance as a put option. For empirical evidence on the incentive effects of deposit insurance at S&Ls, see Brickley and James (1986), Kane (1985, 1989) and Brewer and Mondschean (1992).

[2]The term life insurance companies (LICs) is used throughout to refer to firms that are classified as life and/or life-health insurance companies.

[3]See Cox and Rubinstein (1985). By market value, we assume that there exist markets in which these assets and liabilities can be sold or transferred to third parties. For analytic convenience, we assume that there are no other intangible assets (for example, franchise value) except the value of the guarantee.

[4]A similar modelling strategy is used by Gennotte and Pyle (1990).

[5]Applying the Black-Scholes option model, the call option can be written as follows:

$$C = z\,\Phi\left([ln(z) + \sigma^2/2]/\sigma\right) - \Phi\left([ln(z) - \sigma^2/2]/\sigma\right). \qquad (F1)$$

The cross partial derivative of this function can be written as:

$$C_{\sigma z} = \Phi'\left(\frac{-ln(z)}{\sigma^2} + \frac{1}{2}\right). \qquad (F2)$$

The term $\exp(\sigma^2/2)$ is close to one unless the option maturity is very long. For example, in our sample the mean value for σ is 0.053, which implies that $\exp(\sigma^2/2)$ equals 1.0014.

[6]See Shrieves and Dahl (1992) for an application of the partial adjustment framework to model bank capital decisions.

[7]We included one company, the Travelers Corporation, that had less than 60 percent of their consolidated assets in life insurance because it is one of the largest firms in the insurance industry. Also, data for two companies, Financial Benefit Group and Unum Corporation, were not available in the fourth quarter of 1986.

[8]We do not adjust for dividend payout over the life of the option. In effect, we assume that dividend disbursements follow the same stochastic process as the firm's assets and are paid only at the expiration of the option.

[9]Although the theory calls for the volatility of the return on the ratio of equity to liabilities, we use an estimate of the volatility of the return on equity only since we can only observe the value of liabilities annually. Since these firms are highly leveraged, however, the amount of volatility contributed by the risky liabilities in this ratio is likely to be very small. This assumption may seem implausible to some. However, our procedure yields the same output for z and σ that one would estimate using Merton's original model for deposit insurance in which the value of liabilities is taken to be non-stochastic. The only difference is in the interpretation of the risk parameter, σ. Since both assets and liabilities are indeed risky for life insurance companies, we interpret the risk parameter coming out of the Black-Scholes model as the risk of the firm's whole portfolio rather than just the risk associated with its choice of assets.

[10]For a discussion of the existence of "other effects" in time series, cross sectional analysis, see Balestra and Nerlove (1966).

REFERENCES

Baer, Herbert and Douglas D. Evanoff. "Payment System Issues in Financial Markets That Never Sleep." Federal Reserve Bank of Chicago, *Economic Perspectives*, November/December, 1990, pp. 2-15.

Balestra, Pietro and Marc Nerlove. "Pooling Cross-Section and Time-Series Data in Estimation of a Dynamic Model: The Demand for Natural Gas." *Econometrica* 34 (July 1966), pp. 585-612.

Barrese, James and Jack M. Nelson. "Distributing the Cost of Protecting Life-Health Insurance Consumers," Testimony to US Senate Judiciary Committee, Subcommittee on Antitrust, Monopolies, and Business Rights, April 28, 1992.

A. M. Best. *Best's Insolvency Study of Life/Health Insurers: 1976-1991*, 1992.

Black, Fischer and Myron Scholes. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy* 81 (May/June 1973), pp. 637-659.

Brewer, Elijah III and Thomas H. Mondschean. "An Empirical Test of the Incentive Effects of Deposit Insurance: The Case of Junk Bonds at Savings and Loan Associations." *Journal of Money, Credit, and Banking* (1993, forthcoming).

Brickley, James A. and Christopher M. James. "Access to Deposit Insurance, Insolvency Rules, and the Stock Returns of Financial Institutions." *Journal of Financial Economics* 16 (July 1986), pp. 345-371.

Calomiris, Charles W. "Deposit Insurance: Lessons from the Record." Federal Reserve Bank of Chicago, *Economic Perspectives*, May/June 1989, pp. 10-30.

Cox, John C. and Mark Rubenstein. *Options Markets*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1985.

Cummins, J. David. "Risk-Based Premiums for Insurance Guaranty Funds." *Journal of Finance* 43 (September 1988), pp. 823-839.

Ely, David P. and Richard R. Weaver. "The Shifting Value of Federal Deposit Insurance: Implications for Reform." *Journal of Financial Services Research* 5 (October 1991), pp. 111-130.

Fenn, George and Rebel Cole. "Announcements of Asset-Quality Problems and Stock Returns: The Case of Life Insurance Companies." *Proceedings of a Conference on Bank Structure and Competition*, Federal Reserve Bank of Chicago, May 1992, pp. 818-842.

Furlong, Fred and Michael Keeley. "Capital Regulation and Bank Risk-Taking: A Note." *Journal of Banking and Finance* 13 (December 1989), pp. 883-891.

Gennotte Gerard and David Pyle. "Capital Controls and Bank Risk." Finance Working Paper No. 197, Institute of Business and Economic Research, University of California at Berkeley, December 1990.

Kane, Edward J. *The Gathering Crisis in Deposit Insurance*. Cambridge, MA: MIT Press, 1985.

Kane, Edward J. *The S&L Insurance Mess.* Washington, D.C.: Urban Institute Press, 1989.

Merton, Robert C. "Analytical Derivation of the Cost of Deposit Insurance and Loan Guarantees: An Application of Modern Option Pricing Theory." *Journal of Banking and Finance* 1 (June 1977), pp. 3-11.

Rutz, Roger D. *Clearance, Payment, and Settlement Systems in the Futures, Options, and Stock Markets."* Board of Trade Clearing Corporation, February 24, 1989.

Shrieves, Ronald E. and Drew Dahl. "The Relationship between Risk and Capital in Commercial Banks." *Journal of Banking and Finance* 16 (April 1992), pp. 439-457.

Todd, Richard M and Neil Wallace. "SPDAs and GICs: Like Money in the Bank?" Federal Reserve Bank of Minneapolis, *Quarterly Review*, Spring 1992, pp. 2-17.

United States General Accounting Office. *Insurer Failures: Life/Health Insolvencies and Limitations of State Guaranty Funds*, (Washington, DC: US Government Printing Office) March 1992.

Table 1
Publicly-traded life insurance holding companies, December 31, 1990

Life insurance company	Total assets	Market capitalization ratio
	(millions of dollars)	(percent)
Academy Insurance Group	333.1	23.9
Acceleration International Corporation	112.8	33.9
Aetna Life & Casualty Corporation	47,301.6	9.2
American Bankers Insurance Group	524.9	24.1
American General Corporation	24,367.5	15.0
American Heritage	669.2	18.6
American National	4,247.5	17.8
Amvestors Financial Corporation	1,536.3	1.1
AON Corporation	8,202.4	27.2
Capital Holding Corporation	13,101.8	13.5
Central Reserve Life Corporation	59.0	31.0
CIGNA Corporation	28,859.8	10.2
Conseco Group	10,973.9	1.4
Cotton States Life & Health	80.4	26.3
Durham Corporation	690.7	34.3
Equitable of Iowa Corporation	3,210.5	3.1
Financial Benefit Group	568.5	1.2
First Capital Holding Corporation	8,103.9	0.9
First Centennial Corporation	17.0	21.8
First Executive Corporation	14,100.0	0.2
Home Beneficial Corporation	1,091.7	17.8
ICH Corporation	6,030.3	2.6
Independent Insurance Group	1,031.2	10.0
Intercontinental Life	953.7	3.3
Kansas City Life	1,899.3	10.8
Kentucky Central Life	1,322.9	7.1
Laurentian Capital Corporation	718.0	3.1
Liberty Corporation	1,047.3	30.8
Lincoln National	17,990.2	9.9
MCM Corporation	290.4	6.4
Monarch Capital Corporation	1,133.2	0.4
National Western Life Corporation	1,889.5	1.0

Table 1 (continued)
Publicly-traded life insurance holding companies, December 31, 1990

Life insurance company	Total assets	Market capitalization ratio
	(millions of dollars)	(percent)
Presidential Life Corporation	2,326.6	4.2
Protective Life Corporation	1,932.3	10.3
Reliable Life Corporation	390.6	12.6
Statesman Group	2,372.7	0.8
Transamerica Corporation	16,893.3	14.7
Travelers Corporation	34,253.4	4.9
United Insurance Cos. Inc.	251.9	24.4
Universal Holding Corporation	55.1	3.8
Unum Corporation	8,595.4	18.3
USLICO Corporation	1,926.0	8.9
USLIFE Corporation	3,884.3	11.1
Washington National Corporation	1,855.2	6.0

Table 2
Basic provisions of state life/health guaranty funds

State	Coverage	GIC's	Effective date	Max annual assessments	Premium tax offset
Alabama	0	S	1/1/83	2%	none
Alaska	1	Y	5/16/90	2%	20% for 5 years
Arizona	1	S	8/27/77	2%	20% for five years
Arkansas	1	Y	3/9/89	1%	recoup from policy surcharge
California	1	N	1/1/91	1%	none
Colorado	1	N	6/1/91	1%	20% for 3 yrs., 7.5% for 2 yrs. for life and annuity, for health recoup from policy surcharge
Connecticut	1	Y	10/1/72	2%	20% for 5 years
Delaware	1	Y	7/23/82	2%	20% for 5 years
Florida	1	S	10/1/79	1%	.1% per year
Georgia	1	Y	7/1/81	2%	20% for 5 years
Hawaii	1	N	7/1/88	2%	20% for 5 years
Idaho	1	N	6/1/77	2%	100% in 1 of the following 5 years
Illinois	1	Y	1/1/86	2%	20% for 5 years
Indiana	1	Y	7/1/78	2%	20% per year or recoup from policy surcharge
Iowa	1	Y	7/1/87	2%	20% for 5 years
Kansas	1	N	7/1/82	2%	20% for 5 years
Kentucky	1	N	6/17/78	2%	20% for 5 years
Louisiana	1	N	9/30/91	2%	20% for 5 years

Table 2 (continued)
Basic provisions of state life/health guaranty funds

State	Coverage	GIC's	Effective date	Max annual assessments	Premium tax offset
Maine	1	S	7/25/84	2%	recoup from policy surcharge
Maryland	1	S	7/1/71	2%	none
Massachusetts	1	N	4/3/86	2%	10% for 5 years
Michigan	1	Y	5/1/82	2%	amount varies according to a formula
Minnesota	1	Y	5/27/77	2%	none
Mississippi	1	Y	4/9/85	2%	25% for 2 years
Missouri	1	N	8/13/88	2%	20% for 5 years
Montana	1	S	7/1/74	2%	20% for five years
Nebraska	1	S	8/24/75	2%	20% for 5 years
Nevada	1	N	7/1/73	2%	20% for 5 years
New Hampshire	0	S	6/25/79	4%	--
New Jersey	1	Y	1/1/91	2%	10% for 5 years
New Mexico	0	S	4/9/75	2%	none
New York	1	Y	8/2/85	2%	80% when aggregate assessments for all insurers exceeds 100 million
North Carolina	1	Y	4/13/74	2%	20% for 5 years
North Dakota	1	Y	7/1/83	2%	20% for 5 years
Ohio	1	Y	9/14/88	2%	20% for 5 years
Oklahoma	1	N	9/1/81	2%	20% for 5 years
Oregon	1	N	9/13/75	2%	20% for 5 years

Table 2 (continued)
Basic provisions of state life/health guaranty funds

State	Coverage	GIC's	Effective date	Max annual assessments	Premium tax offset
Pennsylvania	0	S	1/25/79	2%	20% for 5 years
Rhode Island	1	S	6/20/85	3%	10% for 5 years
South Carolina	0	S	7/14/72	4%	20% for 5 years
South Dakota	1	N	7/1/89	2%	20% for 5 years
Tennessee	1	N	7/1/89	2%	10% for 10 yrs. or .1% of premium written, whichever is less
Texas	1	Y	9/27/73	1%	10% for 10 years
Utah	1	Y	7/1/86	2%	20% for 5 years
Vermont	0	S	4/27/72	2%	20% for 5 years
Virginia	1	N	7/1/76	2%	.05% for 5 years
Washington	1	Y	5/21/71	2%	20% for 5 years
West Virginia	1	S	6/21/77	2%	none
Wisconsin	1	S	8/22/69	2%	20% for 5 yrs., if can't recoup through policy rates
Wyoming	1	S	7/1/90	2%	10% for 10 years

0=All policy holders
1=Residents only

S=SILENT N=NO
Y=YES

Table 3
Summary statistics for data in LIC regression analysis

Variables	Description	Mean	Standard Deviation
ALR_A	Market value of assets divided by book value liabilities.	1.222	0.177
ALR_B	Book value of liabilities plus market value of common stock divided by book value of liabilities.	1.222	0.172
RISK	Standard deviation of return of LIC Portfolio.	0.053	0.052
STDRET	Adjusted standard deviation of common stock return.	0.051	0.048
SIZE	Total book-value of assets (millions of dollars).	5,392	
NOCST	Proportion of life insurance premium income from states with no tax-offset during the sample period.	0.164	0.125

Table 4
A pooled cross-section time series examination of the relationship between LIC portfolio risk and capital structure

	ΔRISK		ΔSTDRET	
	OLS	OLS With Time Effects	OLS	OLS With Time Effects
	(1)	(2)	(3)	(4)
Intercept	0.009	0.023	-0.018	-0.005
	(0.030)	(0.028)	(0.023)	(0.023)
ALR_{-1}	0.109	0.100	0.112	0.102
	(0.016)***	(0.016)***	(0.013)***	(0.014)***
$RISK_{-1}$	-0.734	-0.717	--	--
	(0.053)	(0.055)***		
$STDRET_{-1}$	--	--	-0.723	-0.702
			(0.050)***	(0.053)***
SIZE	-0.005	-0.005	-0.004	-0.004
	(0.001)***	(0.001)***	(-0.001)***	(0.001)***
NOCST	-0.036	-0.037	-0.028	-0.029
	(0.008)***	(0.008)***	(-0.007)***	(0.007)***
ΔALR_{-1}	-0.111	-0.128	-0.121	-0.134
	(0.026)***	(0.028)***	(0.023)***	(0.025)***
$\bar{R}^2$	0.463	0.503	0.489	0.531
F	114.413	36.000	126.858	40.101
N	658	658	658	658

Estimated Equations:

$$\Delta RISK_{i,t} = \beta_0 + \beta_1 ALR_{i,t-1} + \beta_2 RISK_{i,t-1} + \beta_3 SIZE_{i,t-1} + \beta_4 NOCST_{i,t-1} + \beta_5 \Delta ALR_{i,t-1} + \nu_{i,t},$$

$$\Delta STDRET_{i,t} = \beta_0 + \beta_1 ALR_{i,t-1} + \beta_2 STDRET_{i,t-1} + \beta_3 SIZE_{i,t-1} + \beta_4 NOCST_{i,t-1} + \beta_5 \Delta ALR_{i,t-1} + \nu_{i,t},$$

where $\Delta RISK_{i,t}$ is the change in portfolio risk of the ith LIC in quarter t; $\Delta STDRET_{i,t}$ is the change in adjusted standard deviation of common stock returns of the ith LIC in quarter t; $ALR_{i,t-1}$ is the asset-liability ratio for the ith LIC in quarter t-1; $RISK_{i,t-1}$ is the portfolio risk for the ith LIC at the end of quarter t-1; $STDRET_{i,t-1}$ is the adjusted standard deviation of common stock returns for the ith LIC at the end of quarter t-1; $SIZE_{i,t-1}$ is the natural logarithm of total assets; $NOCST_{i,t-1}$ is the proportion of premium income from states which do not permit LICs to credit guaranty fund assessments against state taxes; $\Delta ALR_{i,t-1}$ is the change in the asset-liability ratio in quarter t-1; and $\nu_{i,t}$ is an error term. Figures in parentheses are heteroskedastically consistent standard errors. Starred coefficients are significantly different from zero at the 10(*), 5(**), and 1(***) levels, respectively.

Table 5
Growth in selected balance sheet items for the groups of low-and high-capital LICs
Part A
Life companies with GICs

Variable	Assets	Mortgage loans	Direct real estate investment	Stock	Junk bonds	Other bonds	Guaranteed investments contracts
			Low capital				
1987	10.2	7.0	35.0	-6.1	23.0	9.5	11.4
1988	9.6	6.1	12.7	20.1	-11.2	19.5	13.1
1989	3.1	1.3	4.8	29.1	9.8	7.5	-1.8
1990	0.9	-0.0[1]	13.8	-3.8	-7.3	0.1	-1.5
Average	5.9	3.6	16.6	9.8	3.6	9.1	5.3
			High capital				
1987	12.5	9.8	14.0	9.3	54.0	16.5	77.1
1988	8.5	3.6	13.1	9.8	-13.9	13.2	4.3
1989	24.7	15.8	18.0	12.2	11.8	31.1	65.8
1990	9.1	5.2	1.1	-13.4	5.7	16.2	14.8
Average	13.7	8.6	11.5	4.5	14.4	19.2	40.5

Part B
Life companies without GICs

Variable	Assets	Mortgage loans	Direct real estate investment	Stock	Junk bonds	Other bonds
			Low capital			
1987	14.4	7.2	6.3	10.0	83.9	16.8
1988	13.9	3.5	9.1	-6.2	13.8	24.7
1989	14.0	7.9	0.3	-29.8	32.6	17.4
1990	10.8	5.8	-0.0[1]	8.8	13.1	11.6
Average	13.3	6.1	3.9	-4.3	35.8	17.6
			High capital			
1987	10.9	8.6	13.0	3.4	28.1	16.4
1988	11.3	0.5	14.4	-1.8	-2.5	18.6
1989	7.9	3.7	0.4	16.4	-3.7	10.5
1990	6.4	0.8	9.6	-2.6	7.7	11.9
Average	9.1	3.4	9.3	3.8	7.4	14.3

[1] Rounded to zero.

Table 6
The relationship between portfolio risk and capital structure for non-GIC and GIC issuing life insurance companies

Dependent Variable: Change in asset volatility (ΔRISK)

	OLS		OLS With Time Effects	
	Parameter estimates	Parameter estimates: GIC issuing firms	Parameter estimates	Parameter estimates: GIC issuing firms
Intercept	0.047	--	0.065	--
	(0.042)		(0.041)	
ALR_{-1}	0.109	--	0.100	--
	(0.019)***		(0.019)***	
$RISK_{-1}$	-0.729	--	-0.721	--
	(0.060)***		(0.061)***	
SIZE	-0.007	--	-0.007	--
	(0.001)***		(0.001)***	
NOCST	-0.021	--	-0.025	--
	(0.011)*		(0.012)**	
ΔALR_{-1}	-0.138	--	-0.150	--
	(0.028)***		(0.020)***	
GICDUM	-0.071	-0.024	-0.077	-0.012
	(0.073)	(0.061)	(0.071)	(0.057)
$DALR_{-1}$	-0.013	0.096	-0.015	0.085
	(0.029)	(0.021)***	(0.028)	(0.020)***
$DRISK_{-1}$	-0.049	-0.779	-0.040	-0.761
	(0.121)	(0.105)***	(0.116)	(0.103)***
DSIZE	0.004	-0.002	0.005	-0.002
	(0.002)**	(0.002)	(0.002)***	(0.002)***
DNOCST	-0.012	-0.033	-0.006	-0.030
	(0.016)	(0.012)***	(0.015)	(0.010)***
$D\Delta ALR_{-1}$	0.137	-0.001	0.133	-0.017
	(0.046)***	(0.036)	(0.045)***	(0.035)
$\bar{R}^2$	0.476		0.516	
F	55.371***		29.061***	
N	658		658	

Figures in parentheses are standard errors.

Table 7
The relationship between portfolio risk and capital structure for non-GIC and GIC issuing life insurance companies

Dependent Variable: Change in the adjusted standard deviation of common stock return (ΔSTDRET)

	OLS		OLS With Time Effects	
	Parameter estimates	Parameter estimates: GIC issuing firms	Parameter estimates	Parameter estimates: GIC issuing firms
Intercept	0.0013 (0.033)	--	0.029 (0.032)	--
ALR_{-1}	0.118 (0.017)***	--	0.110 (0.017)***	--
$STDRET_{-1}$	-0.750 (0.061)***	--	-0.742 (0.061)***	--
SIZE	-0.006 (0.001)***	--	-0.006 (0.001)***	--
NOCST	-0.014 (0.009)	--	-0.017 (0.010)*	--
ΔALR_{-1}	-0.126 (0.026)***	--	-0.134 (0.030)***	--
GICDUM	-0.066 (0.054)	-0.053 (0.042)	-0.066 (0.052)	-0.038 (0.040)
$DALR_{-1}$	-0.016 (0.026)	0.102 (0.020)***	-0.024 (0.024)	0.086 (0.019)***
$DSTDRET_{-1}$	0.023 (0.111)	-0.727 (0.092)***	0.049 (0.105)	-0.693 (0.092)***
DSIZE	0.004 (0.002)**	-0.002 (0.001)	0.005 (0.002)***	-0.002 (0.001)
DNOCST	-0.015 (0.015)	-0.029*** (0.012)	-0.008 (0.014)	-0.025 (0.010)***
$D\Delta ALR_{-1}$	0.055 (0.050)	-0.070 (0.043)	0.038 (0.047)	-0.096 (0.040)**
$\bar{R}^2$	0.496		0.538	
F	59.769***		31.568***	
N	658		658	

Figures in parentheses are standard errors.