

## **DYNAMIC FINANCIAL MODELS OF LIFE INSURERS**

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## **ABSTRACT**

The Society of Actuaries seeks to provide actuaries of life insurance companies with a systematic approach for estimating the adverse effects of economic developments that could impede insurer performance. Toward that end, this study combines market and economic factors with insurer-specific data to form dynamic financial models of life insurers. Empirical analysis is based on annual data from 1985 through 1995 for 1,593 life insurers. By identifying important exogenous and insurer-specific factors related to life insurer performance, this study provides a basis for actuaries to build dynamic financial models for individual insurers. The study also identifies and describes several web sites that provide access to relevant economic and financial data.

## **Introduction**

The hallmark of life insurer operations, historically, was conservatism, with few exceptions. Life insurers tended to avoid speculative ventures, and instead enjoyed favorable gains in investments, mortality, and office productivity, which begat predominantly solid balance sheets. Given the relatively inelastic demand for life insurance products, companies seemed largely immune from external changes in markets or in the economy. Although market conditions affect firms to varying degrees, the overall economic environment's impact on life insurer performance (e.g., return on equity / surplus) is potentially significant. The issue is critical since life insurer performance is important to various stakeholders (e.g., policyholders, beneficiaries, investors), and capital markets. Recent experience in the savings and loan industry suggests that exogenous factors have serious implications for the viability of firms in financial services industries.

Given the push in the actuarial profession toward model building (particularly dynamic model building), it is important to identify the economic and firm-specific factors that have been important to the financial performance of life insurers in the past. Identifying these variables and the source of data for these factors are important first steps for actuaries who are charged with building dynamic financial models for their firms. Identifying and understanding those conditions both internal and external to the firm that may affect firm performance should aid actuaries in detecting, as early as possible, financial hardship for the insurer. Understanding the determinants of insurer performance also is important to regulators, insurers, managers of insurers, sales representatives, and consumers.

Previous academic studies and rating organizations generally identify bellwether financial variables and characteristics of insolvent insurers, as opposed to important economic and market conditions in which insurers operate (see Browne, Carson, and Hoyt, 1999). However, for dynamic modeling to be feasible, these economic and market variables must be identified. The goal of the present study is to investigate the importance of various economic and market factors as they relate to the financial performance of life insurers, while also accounting for firm-specific differences as captured by financial statement variables. This study also provides a source list for obtaining the important economic and market data series that would be utilized by actuaries in building dynamic financial models.

It is not the intent of this study that actuaries or other model builders would simply apply the models estimated here to their own insurers. Instead, we seek to identify those factors that have been important in the universe of insurers so that model builders for individual insurers will be alert to these factors. The web sites that we identify should serve as a valuable source for the variables

we identify and for a wide range of additional variables that modelers could incorporate when building insurer-specific models for their own insurers. Finally, the cross-sectional data that we utilize in our estimations allows us to provide insight to insurer-specific model builders that would not be available when working solely with single-firm data. Again, this final element serves to highlight insurer-specific factors that should not be overlooked in building dynamic financial models for individual insurers.

### **Literature on Life Insurer Performance**

As discussed above, the majority of research on life insurer performance has been in terms of identifying those insurer-specific variables that aid in identifying insurers that are more likely to become insolvent. Examining the life insurance industry, BarNiv and Hershbarger (1990) found insolvent insurers tend to be smaller in size than solvent insurers and changed their product mix more. Ambrose and Carroll (1994) found that financial variables combined with IRIS ratios in a logistic regression model outperformed A. M. Best's recommendations in distinguishing between insurers likely to remain solvent and those insurers likely to become insolvent. Combining all three types of predictors into one model provided the most accurate classification. Carson and Hoyt (1995) found that surplus and leverage measures are strong indicators of insurer financial strength, and also found a slightly higher risk of failure among stock insurers than mutual insurers. Carson and Scott (1996) examined the "run on the bank" risk, and found that prior to 1992 rating organizations generally did not appreciate the risks inherent in liabilities such as guaranteed investment contracts. Cummins et al. (1999) showed that cash flow simulation variables add explanatory power to solvency prediction models.

In a study of the relation between insurance market conditions and insolvencies, A. M. Best (1992) found that the number of insolvencies is correlated with the accident and health underwriting cycle (lagged one to three years). The increased number of insolvencies also is correlated with increases in interest rates and the life-health insurance industry's focus on investment-related products. The Best study did not examine the various economic factors in a multivariate framework, thus precluding the ability to identify the relative significance of the individual factors.

Prior studies of insurance company financial operations, including those by Outreville (1990), Cummins (1991), Browne and Hoyt (1995), Grace and Hotchkiss (1995), and Hodes et al. (1999) suggest that economic factors are significantly related to insurer financial performance. These factors are associated with disintermediation (interest rates, economic, and employment conditions), returns on insurer investments (bonds and stocks), and competition. D'Arcy (1990) provides a review of issues relating to dynamic financial analysis for property-casualty insurers.

In an earlier phase of this study, Browne et al. (1999) provided empirical evidence that life insurer insolvency was significantly related to several exogenous economic and market factors. The data and relatively long time period examined by Browne et al. (1999), quarterly data for 1972 to 1994, provides a more robust testing of the relevant economic and market variables than would be possible using shorter periods for which insurer-specific annual data are readily available. The combination of using this validated set of economic and market variables with the insurer-specific data (discussed below) provides a more rigorous evaluation of the relevant economic factors in a dynamic modeling framework. The remainder of the paper is organized as follows. The next section describes the methodology, sample, data, and variables for this study's examination of the dynamic relation between insurer-specific characteristics, exogenous economic factors, and life

insurer performance. Then the empirical results of the model estimations are discussed. The final two sections provide web site addresses where relevant economic and market data can be obtained and provide conclusions and implications.

**Methodology, Sample, Data, and Variables**

Although insurer insolvencies have received extensive study, there has not been a great deal of analysis in the academic literature on the economic conditions and insurer operating characteristics that are related to financial success. Defining a measure of success can be as problematic as identifying the factors that contribute to success.

In practice the management of a life insurance company must choose from among a variety of alternative risks. That is, management chooses among competing projects that present the possibility of profit or loss to the insurer. Those risks that are believed most likely to result in payoffs consistent with the company's objectives are chosen. The risks that are picked will depend on characteristics of the insurer including experience with particular product lines, its financial structure, and its asset mix. Whether the risks result in gains or losses for an insurer will depend both upon internal factors, such as management expertise, and external factors, such as changes in interest rates and asset prices.

The set of alternative risks from which management chooses consists of two major types-- asset risks and underwriting risks. Asset risks relate to the financial investment decisions of the firm. These decisions include such aspects as how much real estate to invest in, the types of bonds chosen for the investment portfolio, and the stocks picked for the company portfolio. Underwriting risks pertain to the lines of insurance the insurer chooses to write and the underwriting policies that are used. To analyze the financial success of life insurers we decompose their operations by the types of risks they undertook during the period of analysis.

In contrast to Browne et al. (1999), this phase of the study combines economic and market variables with firm-level data to provide insight on the interaction of insurer operations with general

economic conditions. An important difference here is that, rather than examine such an extreme measure of financial performance as insolvency, this study utilizes going-concern measures such as return on equity, return on assets, and the percentage change in capital and surplus. Such measures are more relevant for established, going-concern insurers that are very unlikely to face the threat of insolvency. However, the various stakeholders still are concerned with the overall financial performance of their insurer.

### **Methodology**

An analytic model of life insurer financial performance is posited with the following general form:

$$\text{financial performance} = f(\text{asset structure/mix, liability structure/product mix, disintermediation, economic and market variables}), \quad (1)$$

where the various right-hand side factors are proxied by a number of individual variables. The variables reflecting these firm-specific and exogenous economic factors are described and motivated in the following section. The dependent variable, financial performance, is measured by return on equity, return on assets, and the percentage change in capital and surplus from year to year. Both risk-adjusted and unadjusted financial performance measures are considered.

The analytic model presented in equation (1) leads to an empirical model of the following form that relates insurer financial performance to the specific proxies for firm-specific characteristics and exogenous economic factors. The empirical model can be represented as:

$$Y_{it} = \mathbf{a} + \sum_j \mathbf{b}_j X_{ijt} + \mathbf{e}_{it}, \quad (2)$$

where  $i$  is the number of insurers,  $t$  is the number of time periods, and  $j$  is the number of predictor variables.



**Sample and Data**

Annual financial statement data were obtained for 1,593 life insurers from 1985 through 1995 from the National Association of Insurance Commissioners (NAIC) data tapes. The firm-specific variables used in the analysis are selected based on previous research on insurer performance and solvency (see BarNiv and Hershbarger, 1990, and Carson and Hoyt, 1995). The firm-specific variables fall into four broad categories: solvency ratios (IRIS); asset structure/mix; liability structure / product mix; and disintermediation. These firm-specific variables and the motivation for their inclusion in the model are discussed below.

Annual economic and market data for the same time period also were obtained, including such variables as investment returns, inflation, disposable personal income, the slope of the yield curve, unemployment, and returns on real estate. Thus, the external economic and market factors vary across time, while all the other variables vary both across time and across insurers. Table 1 reports summary statistics for each of the firm-specific and economic variables examined. The Appendix reports the primary sources of the economic and market data used in the analysis. In a later section we identify and describe several web sites that provide ready access to relevant economic and market data. We also indicate explicitly which of the web sites contain the data used in this study.

**[INSERT TABLE 1 ABOUT HERE]**

**Financial Performance Variables**

Three different dependent variables are employed in the analysis: return on equity (ROE), return on assets (ROA), and the percentage change in capital and surplus (PCS). ROE is defined

as net income to capital and surplus, ROA is defined as net income to total assets, and PCS is self-explanatory.<sup>1</sup>

Financial statement variables, as well as economic and market factors, are examined jointly. Given the numerous possible independent variables available from financial statements, this study relied on guidance from previous research on insurer performance and insolvency in the selection of appropriate explanatory variables (see Carson and Hoyt, 1995). Important financial statement variables examined here relate to firm size, leverage, surplus, interest rate exposure, asset risk, and liquidity risk. The variables chosen reflect the sources of solvency or financial performance risk characterized by the Society of Actuaries as contingency risks. These contingency risk categories are C-1 risk (asset risk), C-2 risk (pricing risk uncertainty regarding future operating results), C-3 risk (asset/liability matching or interest rate risk), and C-4 risk (miscellaneous risks beyond the control of insurers to manage). Several of the Insurance Regulatory Information System (IRIS) ratios also are examined. The lower portion of Table 1 provides a listing of the financial statement-based independent variables.

### ***Economic and Market Variables***

The economic environment may to a large degree determine whether or not the investment and underwriting strategies a company chooses are successful. The exogenous economic factors examined here are associated with disintermediation (interest rates, economic, and employment conditions), and returns on insurer investments (bonds, stocks, and real estate). Each of the economic variables used in the study is described below along with the motivation for its inclusion.

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<sup>1</sup> Note that the NAIC data are based on statutory accounting principles (SAP) and not on GAAP. Thus, changes in the market value of assets will not have an immediate or dramatic effect on the value (surplus) of an insurer. Similarly, the drain on surplus due to new business is a feature of SAP but not necessarily of GAAP.

*Unemployment.* Recessionary periods are likely to affect life insurer cash flow in that life insurance purchases are more discretionary than auto and homeowners insurance purchases. In addition, Linton's Emergency Fund Hypothesis (1937) suggests that policy surrenders are likely to increase during periods of economic duress. Dar and Dodds (1989) and Hoyt (1994) provide evidence that disintermediation in the form of policy surrender activity was directly related to unemployment. Widespread increases in surrender activity also may be accompanied by a decrease in new sales, thereby exacerbating the decrease in insurer liquidity. Thus, high unemployment is likely to be negatively associated with life insurer performance.

*Disposable Personal Income Per Capita.* Life insurance sales are positively related to personal income, and policy surrenders are negatively related to personal income. Therefore, when personal income is relatively high, cash flows to insurers are likely to increase and disintermediation is likely to be relatively low. Thus, personal income is expected to be positively related to insurer performance. On the other hand, increased sales result in greater leverage and a drain on surplus, and an alternative hypothesis is that personal income is negatively related to insurer performance.

*Stock Returns.* Life insurer investment portfolios typically contain a relatively small proportion of stocks. Thus, as stock returns increase, the return on insurer's portfolios may increase, and the insurer's performance also may increase. An alternative hypothesis is based on the fact that holders of life insurance policies have the option to take policy loans or surrender their policies. As returns from alternative investments become more attractive, disintermediation in the form of policy surrenders (see Outreville, 1990) or policy loans (see Carson and Hoyt, 1992) increases. The negative correlation between rates on alternative investments and insurer cash flows

represents a liquidity risk for life insurers. Thus, due to disintermediation, stock returns may be negatively related to life insurer performance. The popularity of variable life insurance in the mid-1980s could serve to mitigate such disintermediation.

*Changes in interest rates.* Changes in interest rates have a direct impact on the value of insurers. As interest rates decline, the value of bonds in an insurer's portfolio rises, and vice versa. Staking and Babbel (1995) note that one way insurers incur risk with their financial portfolio is by holding assets with a longer duration than their liabilities. This mismatch creates an interest rate risk since the magnitude of the change in the value of assets will be greater than that of liabilities when interest rates move. When interest rates decrease, insurers with this duration mismatch experience an increase in surplus. On the other hand, an increase in interest rates leads to a larger decline in the value of assets than liabilities, and thus a decrease in surplus. Colquitt and Hoyt (1997) document a positive asset/liability maturity mismatch for the majority of life insurers in their sample. The asset/liability mismatch results in increased leverage and a greater risk of poor performance for the insurer (see Carson and Hoyt, 1995). Changes in interest rates are expected to be negatively related to insurer performance.

Differences in asset and liability durations should be interpreted as only a possible indication of exposure to interest rate risk since insurers can cover current obligations as they become due by using cash, including premium income and other assets. If insurers have sufficient funds from current operations (investment earnings, investment turnover, and premiums collected) to offset current obligations, then the effect of an interest rate change on financial performance may be relatively insignificant.

*Unanticipated inflation.* Unanticipated inflation may impair life insurer performance. Inflation has an important effect on administrative expenses and on health insurance claims (but little or no effect on life claims or annuity payments). Real returns on fixed-rate bonds are lower than expected when unanticipated inflation is high, and profit margins are lower than expected. This will place a financial strain on insurers that will decrease insurer performance. Thus, unanticipated inflation is likely to be negatively related to insurer performance. The measure of unanticipated inflation is set equal to the nominal rate of inflation over the past three years minus the three-year Treasury yield at the beginning of the three-year period. This measure is based on the assumption that the risk-free rate incorporates expectations of inflation over the upcoming period. A similar measure is discussed in Kandel et al. (1991) and Browne and Hoyt (1995).

*Bond portfolio returns.* Life insurers invest a large proportion of their investment portfolios in corporate and government bonds, and thus, the absolute level of interest rates may be related to insurer performance. Since interest earnings are a significant source of revenue for insurers, companies are more likely to perform well when interest earnings are high. High interest earnings are generally indicative of favorable investment experience for insurers. Thus, the level of interest rates is a proxy for investment earnings for insurers. Higher investment earnings will facilitate insurers in meeting their obligations to policyholders. In this case, interest rates are hypothesized to be positively related to insurer performance. To the extent that interest earnings are credited back to insureds through lower premiums or higher policy returns, the effect of interest earnings on performance will be reduced.<sup>2</sup>

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<sup>2</sup> Fairley (1979) and Cummins (1991) discuss the implications of interest earnings on insurance ratemaking.

Alternatively, high market interest rates likely result in greater disintermediation for life insurers, in the form of policy loans (see Carson and Hoyt, 1992) and guaranteed investment contract withdrawals (see Carson and Scott, 1996). In addition, the Interest Rate Hypothesis suggests that higher interest rates are likely to be related to policy surrenders (see Cummins, 1973 and Outreville, 1990). That is, when the value of insurers' assets is decreased due to higher interest rates, disintermediation also may increase, thus leading to risk of liquidity crisis for life insurers. In this case, interest rates may be negatively related to insurer performance.

To provide a proxy for the earnings on insurers' investment portfolios, an interest rate variable, which equals the three-year arithmetic average yield on Aaa corporate bonds during the current year and the two preceding years is used. The Aaa bond yield is chosen because it is highly correlated with overall yields on insurers' investment assets which are heavily weighted toward investment-grade bonds.

*Slope of the yield curve.* Estrella and Hardouvelis (1991) and Dueker (1997) provide empirical evidence that the slope of the yield curve may contain useful information about the future prospects of the economy. The expectations hypothesis suggests that long-term interest rates decline before an anticipated recession in order to equalize holding-period returns. Inasmuch as the performance of life insurers may be related to the state of the economy, important predictors of the economy may be related to insurer performance. If insurer performance is likely to decline during recessionary periods (when the yield curve is flatter or inverted), then the slope of the yield curve is expected to be positively related to insurer performance. Further, since life insurers tend to have a positive duration mismatch between their assets and liabilities, their returns should be reduced by

a flatter or negatively-sloped yield curve. The slope of the yield curve is measured by  $\log((1 + \text{twenty-yr. T-bond}) / (1 + \text{three-mo. T-bill}))$ .

*Real estate returns.* Life insurers generally hold a portion of their investment portfolios in real estate. As witnessed by events in the early part of the 1990s, real estate can have a debilitating effect on the financial soundness of an insurer as real estate values decline. Conversely, a strong real estate market can produce high returns for insurers. Thus, the proportion of an insurer's investment portfolio that is invested in real estate is expected to be positively related to returns on real estate, and it is an empirical question whether investments in real estate have been generally positive or negative for life insurers. The upper portion of Table 1 provides a listing of economic and market-based independent variables.

### ***Firm-Specific Variables***

To control for differences across companies that may affect both the types of risks they undertook during the period of analysis and their success with those risks we include a series of variables representing the insurers' operating characteristics. The firm-specific variables are logically divided into one of four categories. The four categories are proxies for asset structure/mix, liability structure / product mix, disintermediation, and solvency ratios.

*Asset structure/mix.* Six different variables are used as proxies for an insurer's asset structure. These variables are mortgages to total assets, liquid assets to total assets (where liquid assets consist of cash on hand and short-term investments), real estate to total assets, separate accounts to total assets, the natural log of total assets, and the log of capital and surplus. Only one of the last two variables is included in the model at a time. The choice between these two variables is based on which measure of financial performance is being used. As an example, if the measure

of financial performance is return on equity which contains capital and surplus in the denominator, then the log of total assets is used as the size proxy. It is expected that the proportions of mortgages, real estate, and separate accounts would be negatively related to firm performance, while the size of the firm and its proportion of liquid assets would be positively related to its financial performance.

*Liability structure / product mix.* Seven variables serve as proxies for liability structure. These variables are ordinary life reserves to total reserves, annuity reserves to total reserves, accident and health premiums to total premiums, annuity premiums and considerations to total premiums, premiums to surplus, reserves to capital and surplus, and reinsurance to total assets. The first four variables reflect differences in product mix while the last three reflect the level of insurance and financial leverage utilized in the insurer's capital structure. We hypothesize that the insurance and financial leverage measures would be negatively related to firm performance. We have no prior expectation on the direction of the relation between the product mix variables and firm performance.

*Disintermediation.* Policy lapses are costly to insurers and are a form of disintermediation. Carson and Dumm (1999) provide evidence that insurer lapse rates are negatively related to life insurance policy performance. Three variables measure the level of disintermediation risk for the insurer. These variables are the ordinary life lapse rate, policy loans to total assets, and a proxy for the insurer's mismatch between asset duration and liability duration. This final proxy is the difference between long-term assets and long-term liabilities to total assets. It is expected that these disintermediation proxies would be negatively related to firm performance.



*Solvency ratios.* The final category of firm-specific variables consists of six of the NAIC's IRIS ratios. These ratios are selected as those that do not duplicate proxies already contained in the other three categories. The six variables (ratios) chosen are nonadmitted assets to admitted assets (IRIS 5), investments in affiliates to capital and surplus (IRIS 7), surplus relief (IRIS 8), change in premium (IRIS 9), change in product mix (IRIS 10), and change in asset mix (IRIS 11). Although these ratios are categorized as solvency ratios, each is reflective of some of the characteristics described in the other three categories. As an example, IRIS 10 reflects changes in the firm's product mix, while IRIS 11 represents changes in the insurer's asset structure. It is expected that these solvency ratios would be negatively related to firm performance. The lower portion of Table 1 provides a listing of the firm-specific independent variables in each of the categories.

### **Empirical Results and Discussion**

In the first phase of this research, Browne et al. (1999) modeled life insurer insolvency rates for the period 1972 through 1994 in order to identify important economic and market variables related to insurer bankruptcy. This analysis indicated that long-term interest rates, personal income, unemployment, the stock market, and the overall number of insurers were positively related to insurer failure rates (an adverse measure of insurer financial performance), and negatively related to real estate returns. As discussed above, in this phase of the study we combine economic and market variables with firm-specific variables and use going-concern measures of financial performance. First, the analysis models financial performance without adjustment for return risk. Second, the financial performance measures are modeled on firm-specific characteristics after adjusting for return risk.

#### ***Unadjusted Returns***

The data set combines time series and cross sections. In other words, we have data for multiple insurers over a period of years. Data that pool time series and cross sections are referred to as longitudinal or panel data. A specific set of regression analysis methods have arisen to deal with the estimation of models using panel data. The two main approaches are fixed-effects models, where a unique intercept is estimated for each insurer (cross section), and random-effects models, where the insurer-specific intercept term is viewed as randomly distributed across the insurers. Greene (1993, pp. 464-480) provides a detailed discussion of these methods.

Based on panel data methods, Table 2 reports the estimated parameters of equation (2) for the three dependent variables: PCS (percentage change in capital and surplus), ROA (return on assets), and ROE (return on equity). In terms of interpretation, the results in Table 2 can be viewed

in a way similar to ordinary least squares. We report results of Hausman tests<sup>3</sup> for the choice of specification between the fixed- and random-effects models. The results are largely consistent between the last two dependent variables (ROA and ROE), but are somewhat less consistent with the results for the PCS variable, especially regarding the economic and market variables. The effect of the economic and market variables on life insurer financial performance is discussed first. The discussion is then followed by discussion of the firm-specific variables.

**[INSERT TABLE 2 ABOUT HERE]**

Given the interrelated nature of the economic data, multicollinearity could be a potential problem in the estimation of the three financial performance models. In spite of some relatively high correlations between the various economic variables, these cross correlations do not appear to be adversely affecting our inferences in the empirical models. For the results of the three performance models presented in Table 2, the highest variance inflation factor (VIF)<sup>4</sup> value in each of the three models was 13.79. The variable with this VIF was the proxy for the slope of the yield curve. Since this variable is fixed across all insurers within a given year it had the same VIF value for each of the three measures of financial performance. Omitting this variable reduced the highest VIF value to 3.66. However, omitting this variable did not alter the empirical results on the other variables in any qualitatively significant way. As a result, although the VIF value warns of potential multicollinearity problems associated with the inclusion of the yield curve variable, the empirical results do not appear to be adversely affected.

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<sup>3</sup> Small values of the Hausman statistic argue in favor of the random-effects model over the fixed-effects model. See Greene (1998, p. 321) for a discussion of the Hausman test.

<sup>4</sup> The primary diagnostic statistic that we used for detecting the presence of collinearity in the regression models is the variance inflation factor (VIF). Neter, Wasserman and Kutner (1990) indicate that VIF values greater than 10 may create a serious multicollinearity problem.

We also performed Granger causality tests to assess whether we have statistical support for the direction of causation in our models. Greene (1993, p. 553) provides a discussion of Granger causality tests. The results of these tests generally support the relationship presented in our models. The few exceptions relate to the log of total assets in the PCS model and when we measure financial performance by return on assets (ROA), our tests suggest that three variables, nonadmitted assets to admitted assets (IRIS5), annuity reserves to total reserves, and policy loans to total assets, are Granger caused by ROA (opposite to our model specification). These results should not be viewed as invalidating our model results. However, rather than considering these particular factors as determining financial performance, it might be more appropriate to consider them solely as important control variables.

F-tests for the overall statistical goodness-of-fit of our models are presented at the bottom of Table 2. All three models are significant at the .0001 level. Although the adjusted- $R^2$  values are relatively low (.047 to .085), it is important to recall that the primary focus of this study is on identifying the most significant firm-specific and exogenous economic factors that are related to firm financial performance. Also, the models are being fit to a large number of insurers (well over 1,000) which makes a somewhat lower  $R^2$  value more likely.

Three exogenous variables are significant in the ROA and ROE models: disposable personal income per capita, unanticipated inflation, and portfolio returns for bonds. Only the real estate returns variable is significant among the exogenous variables in the PCS model.

Thus, for the ROA and ROE models, the findings indicate that life insurer financial performance has been enhanced by increases in personal income, which is consistent with the disintermediation/emergency fund hypothesis. This finding is in contrast to the findings in Browne

et al. (1999) which suggested that insurer insolvency rates have increased with increases in personal income. This apparently conflicting result may suggest a reallocation of insurance funds within the insurance industry as personal income has increased (e.g., funds moved from smaller insurers to larger insurers, causing higher levels of financial distress for some insurers). Second, while there is a tradeoff between the average bond yield and the “new money” marginal bond yield, life insurer performance is significantly improved during periods of high long-term interest earnings, as measured by the average bond returns variable. Third, periods of higher unanticipated inflation produce reduced financial performance for life insurers. Based on the PCS model, some evidence exists that insurers’ financial performance is bolstered by higher real estate investment returns. This result is consistent with the findings of Browne et al. (1999).

Browne et al. (1999) found a strong statistically significant relation between insurer insolvency rates and both stock market returns and the unemployment rate. Neither of these economic variables was significant in any of the models presented in Table 2. One possible explanation for the absence of these variables as predictors in the current models is the fact that both variables exhibited relatively limited variation during the sample period (1985 to 1995). The prior insolvency rate study, on the other hand, covered the period from 1972 to 1994, over which the two variables experienced far greater variation. Hence, the reader is cautioned against concluding that stock market returns and the unemployment rate would be unimportant in dynamic modeling of insurer performance.

With respect to the firm-specific variables, all three measures of financial performance suggest that larger insurers with less in separate accounts and with lower levels of financial and insurance leverage produced superior financial performance over the sample period. The remaining

results were not consistent across all three measures of financial performance. The models produce some evidence that greater business mix in ordinary life insurance yielded lower returns (ROA and ROE models), that higher investment in mortgages resulted in lower returns (PCS and ROA models), and that greater assets committed to real estate and policy loans lowered insurer returns (ROA model). The results for the various solvency ratios were inconsistent across the three models.

***Risk-Adjusted Returns***

The second portion of the analysis is based on risk-adjusted measures of financial performance. We would expect that if a firm adopts an operating strategy that produces more volatile financial performance its average returns would be higher than a firm that has less volatility in its returns. Grace (1990) contends that, other things equal, greater variation in earnings over time results in a lower market valuation of the firm. The second portion of our empirical analysis seeks to model risk-adjusted returns by dividing the average of each of the three return measures by the standard deviation of its respective returns. These calculations are conducted over the full sample period (1985 to 1995) and include those firms for which at least 10 years of operating data were available.

The analysis is divided into three parts. First, we plotted the mean return against the standard deviation of return for each insurer. The standard deviation effectively represents a total risk measure. The plot for each of the three return measures is presented in Figure 1, Figure 2, and Figure 3, respectively. Generally, the plots reveal the expected positive relation between risk and return. Second, for each of the three return measures we form two groups. The first group consists of those insurers who reported a mean return during the sample period above the median for all insurers and a standard deviation of returns that was below the median. This group constitutes those

firms that produced a “favorable” risk/return result. The second group consists of those insurers with a mean return below the median for all insurers and standard deviation of returns above the median. This group represents those firms with “unfavorable” risk/return results. Third, we construct a risk-adjusted return for each of the three measures which is the mean return divided by the standard deviation. We then estimate regression models for these three measures using firm-specific characteristics. The economic data cannot be included in this portion of the analysis since they only vary across time. Thus, computing average values for these measures would result in no variation in these variables.

As previously noted, the general relation between risk and return for the sample companies is observable in Figures 1 through 3. In the second portion of the risk-adjusted analysis, we compared the median values of the various firm-specific values for the “favorable” group to the median values for the “unfavorable” group in a univariate setting using the Wilcoxon nonparametric test for differences. These results suggest that the firms in the “favorable” group were larger, had lower levels of liquid assets, were less mismatched in their assets and liabilities, relied less on reinsurance, had more business in separate accounts, and had lower levels of change in their product mix and asset mix. However, it is important to recognize that this comparison was done on a univariate basis, that is, without controlling simultaneously for the various factors. As a result, some of these variables may be serving as proxies for other factors. For example, separate accounts, liquid assets, and reinsurance are highly related to the size of the insurer and may simply be measuring size differences.

**[INSERT FIGURES 1, 2 AND 3 ABOUT HERE]**

The third stage of the risk-adjusted returns analysis controls simultaneously for firm-specific factors by utilizing a multivariate model. As described above, the data in this estimation are averages of insurer-specific data over the period of the study. As a result, the data vary only across insurers. In other words, the data are cross sectional only. Hence, the three models of risk-adjusted financial performance can be estimated by ordinary least squares instead of panel data methods. A regression model is estimated for each of the three risk-adjusted return measures and the results are presented in Table 3. Correlation analysis and variance inflation factors suggest that multicollinearity is not a problem in the estimation of these three models. The highest VIF was 3.02.

**[INSERT TABLE 3 ABOUT HERE]**

Larger insurers with less in separate accounts, more in liquid assets, fewer assets in policy loans, and lower insurance and financial leverage produced superior returns on a risk-adjusted basis. The results are generally consistent with the results for the unadjusted return measures presented in Table 2. However, the solvency ratios are uniformly more significant in explaining lower risk-adjusted returns than unadjusted returns. Also, contrary to the findings in the unadjusted models, higher investment in mortgages produced superior risk-adjusted returns during the sample period. The relation was negative and significant in the unadjusted return models. Additionally, once the returns are adjusted for risk, the importance of adequate levels of liquid assets becomes much more apparent.

**Access to Economic and Financial Data**

In the past one of the greatest challenges to researchers doing economic modeling was the lack of a convenient source for economic data. Although several publications such as the *Federal*



*Reserve Bulletin* provided a compilation of a wide variety of economic and financial data, collection of these data was only possible by accessing several issues per year over the entire sample period.

In addition, the data were only available in printed format instead of computer-readable format.

The dramatic expansion of the World Wide Web (WWW) over the past several years has led to the establishment of several web sites that provide ready access to a wide array of economic and financial data. By design these sites not only provide user-friendly access to many data series, but also enable the researcher to extract the desired data in computer-readable format.

Below we discuss some of the more useful web sites that we were able to identify. For each site we provide information on the uniform resource locator (URL), an overview of the available data, whether the data are freely available and to whom the data are available, the frequency of the data, and the time period for which the data are available.

The Federal Reserve Board Statistics: Releases and Historical Data site contains information on the following <http://www.bog.frb.fed.us/releases/>:

*Commercial Paper*  
*Selected Interest Rates*  
*Aggregate Reserves of Depository Institutions and the Monetary Base*  
*Factors Affecting Reserve Balances*  
*Money Stock and Debt Measures*  
*Assets and Liabilities of Commercial Banks in the United States*  
*Foreign Exchange Rates*  
*Industrial Production and Capacity Utilization*  
*Consumer Credit*  
*Flow of Funds Accounts of the United States*

The information on this site that we found to be most useful was contained on the *Selected Interest Rates* page <http://www.bog.frb.fed.us/releases/H15/data.htm>. Many of the items listed on this page are available for each business day as well as weekly, biweekly, and monthly. All of the series are available at least weekly. The time period for which these data are available is given in brackets. The categories available include:

*Federal funds*  
*Commercial Paper (financial and non-financial for 1, 2 and 3 months)*  
*Commercial Paper (historical 1, 3, and 6 months) [since 1970]*  
*Finance paper placed directly (historical 1, 3 and 6 months) [since the late 1950s]*  
*Bankers acceptances (top rated 3 and 6 months)*  
*CDs (secondary market 1, 3 and 6 months)*  
*Eurodollar Deposits (London 1, 3 and 6 months) [since 1971]*  
*Bank Prime Loan [since 1955]*  
*Discount Window Borrowing [since 1955]*  
*U.S. Government Securities*  
*Treasury Bills*  
*Auction average (3 and 6 months and 1 year) [since 1980]*  
*Secondary Market (3 and 6 months and 1 year) [since mid 1950s]*  
*Treasury constant maturities (3 and 6 month and 1, 2, 3, 5, 7, 10, 20, and 30 year)*  
*[various, with many going back into the 1960s]*  
*Composite (over 10 years (long-term)) [since 1977]*  
*Corporate Bonds*  
*Moody's seasoned (Aaa and Baa) [since mid 1980s]*  
*State and local Bonds*  
*Conventional Mortgages*

This site provides the data used for computing the average yield on Aaa corporate bonds, the slope of the yield curve, and the change in the three-month T-bill rate.

The Foreign Exchange Rates (weekly) site <http://www.bog.frb.fed.us/releases/H10/hist/> provides exchange rates for 33 national currencies and the Euro. Most data are available going back into the 1980s.

The White House web site offers two pages containing statistical data. The one more closely related to the type of data used in this study is the Economic Statistics Briefing Room (ESBR). The URL is <http://www.whitehouse.gov/fsbr/esbr.html>. The major headings on the site include:

*Production, Sales, Orders and Inventories*  
*Output*  
*Income, Expenditures, and Wealth*  
*Employment, Unemployment, and Earnings*  
*Prices*  
*Money, Credit, and Interest Rates*  
*Transportation*  
*International Statistics*

This site provides the data used to compute disposable personal income per capita, the unemployment rate, and the inflation rate (CPI).

The Bureau of Economic Analysis (BEA) Data Page also offers links to national, international, and regional data <http://www.bea.doc.gov/>. This site links back to some of the sites referenced above. The materials on this page are taken from BEA's monthly journal, the *Survey of Current Business*. A more comprehensive set of this information is available from STAT-USA/Internet. STAT-USA is a members-only site. The homepage is <http://www.stat-usa.gov/>. Order forms for licenses are available on the site.

The Casualty Actuarial Society offers the CAS Dynamic Financial Analysis (DFA) Web Site. The goal of the CAS is to create a web site that will eventually evolve into a full-scale distribution mechanism for a permanent and widely accessible research database. The web site currently lists a number of very useful databases of financial and economic information that are available for free <http://www.casact.org/research/dfa/free.htm>. The web site arose from the first stage of the CAS DFA Project that is described in Garven (1996). Data for the Standard and Poor 500 stock index variable are available from this site.

### **Conclusions and Implications**

Studies of life insurer performance traditionally have focused on identifying important predictor variables for identifying insurers at higher risk of insolvency. Rather than focus solely on these variables, this study tests whether there is a relationship between various broader measures of life insurer performance (not just financial distress), financial statement variables, and temporal economic and market conditions. Browne et al. (1999), in an earlier phase of this research, found that life insurer insolvencies were positively related to the number of insurers, long-term interest rates (bond returns), the unemployment rate, personal income, and stock market returns, and negatively related to returns on real estate investments. The present study finds that, after

accounting for differences across insurers, life insurer performance is positively related to portfolio returns on bonds and disposable personal income per capita, and negatively related to unanticipated inflation.

Over the sample period, larger insurers with fewer assets in separate accounts and lower levels of insurance and financial and leverage produced higher nominal and risk-adjusted returns. The results of the study also document the importance of controlling for risk in the modeling process. Higher investment in mortgages and liquid assets and favorable solvency ratios correlated with higher risk-adjusted returns, but these relations were masked in the models based on nominal returns.

***Implications for Financial Modeling by Insurers***

Insurance executives are becoming increasingly aware of the interrelated nature of the financial decisions that they must make in managing their firms. Product line mix, asset allocation, and capital structure decisions interact with one another and with economic and market factors to determine the ultimate financial performance of the insurer. The economic and market factors identified in this study are likely to be important to insurer managers, even of large, relatively stable insurers, in the building of dynamic financial models for their own firms. Additionally, the web sites described in the study provide managers, actuaries, and other model builders with ready access to the economic and market data necessary in the building of dynamic financial models.

Too often dynamic financial analysis models are built based on the model builder's judgment regarding the interdependencies of various firm-specific and exogenous economic variables. The focus of this study has been on attempting to identify in a statistical framework the most significant factors affecting life insurer financial performance. The analysis was carried out

on a sample approaching the universe of U.S. life insurers in existence during the period 1985 to 1995. This analysis serves to emphasize firm-specific and economic factors that model builders should not ignore.

Secondly, we have explicitly demonstrated the process by which these factors can be identified. This is valuable to actuaries and other insurer model builders since if they wish to apply dynamic financial analysis to their own companies they must build insurer-specific models. These model builders will have the likely advantage over us of having more frequent data points for the financial operations of their own insurers. The regression methods that we describe can be applied to these more frequent data points to estimate insurer-specific models.

Lastly, the information that we provide on web sites that contain economic and market data should facilitate the estimation of models with more frequent data points. Although data constraints limited our analysis to annual data, most of the data available from these web sites are provided on at least a monthly basis. These data would enable model builders to fully utilize their insurer-specific data in the model building process. This study and the companion study by Browne et al. (1999) should be viewed as only the first step in the process of implementing integrated dynamic financial analysis for life insurers.

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## APPENDIX

### Data Sources

<b>Variable Description</b>	<b>Data Sources</b>
Average yield on Aaa corporate bonds	<i>Federal Reserve Bulletin</i>
Slope of the yield curve	underlying data from <i>Federal Reserve Bulletin</i>
Change in the three-month T-bill rate	underlying data from <i>Federal Reserve Bulletin</i>
Returns on real estate	National Association of Real Estate Investment Trusts
Disposable personal income per capita	<i>Federal Reserve Bulletin</i>
Unemployment rate	<i>Employment and Earnings</i> , U.S. Dept. of Labor
Standard and Poor 500 stock index	<i>Federal Reserve Bulletin</i>
Inflation rate (CPI)	underlying data from <i>Federal Reserve Bulletin</i>

Note: Please see the section entitled "Access to Economic and Financial Data" in the text.

**Table 1**

<b>Variable Description</b>	<b>Mean</b>	<b>Standard Deviation</b>
<b>Financial Performance Measures</b>		
<b>% change in surplus</b>	0.14	0.72
<b>Return on assets</b>	0.03	0.08
<b>Return on equity</b>	0.08	0.30
<b>Economic and Market Variables</b>		
<b>Unemployment</b>	6.18	0.76
<b>Disposable Personal Inc.</b>	4075.90	858.43
<b>Stock returns (S&amp;P 500)</b>	364.60	122.22
<b>Change in Int. Rates</b>	-0.26	1.57
<b>Unanticipated inflation</b>	-1.09	3.97
<b>Portfolio returns (Aaa)</b>	9.06	1.23
<b>Yield curve</b>	0.02	0.01
<b>Real estate returns (REIT)</b>	8.38	15.10
<b>Asset structure/mix</b>		
<b>Mortgages/Total Assets</b>	0.07	0.11
<b>Liquid Assets/TA</b>	0.12	0.18
<b>Real Estate/TA</b>	0.02	0.03
<b>Separate Accounts/TA</b>	0.03	0.10
<b>log(Total Assets)</b>	18.38	2.21
<b>log(Capital and Surplus)</b>	16.68	1.66
<b>Liability structure</b>		
<b>Ord.lifeRes/Total Reserves</b>	0.49	0.38
<b>Annuity Reserves/TR</b>	0.26	0.33
<b>A&amp;Hprem/Total Premium</b>	0.30	0.41
<b>Annuity premiums/TP</b>	0.16	0.55
<b>Premiums Written/S</b>	2.01	2.81
<b>Reserves/CS</b>	5.12	7.66
<b>Reinsurance/TA</b>	0.04	0.17

**Table 1 (continued)**

<b>Variable Description</b>	<b>Mean</b>	<b>Standard Deviation</b>
<b>Disintermediation</b>		
<b>Lapse (percent)</b>	11.55	50.00
<b>Policy loans/TA</b>	0.03	0.06
<b>Asset/liability mismatch</b>	0.42	103.10
<b>Solvency Ratios</b>		
<b>IRIS5(Nonadmitted assets)</b>	3.48	42.19
<b>IRIS7(Affiliate invest.)</b>	15.45	96.56
<b>IRIS8(Surplus Relief)</b>	2.47	70.49
<b>IRIS9(Premium change)</b>	14.10	265.32
<b>IRIS10(Product mix)</b>	2.97	19.12
<b>IRIS11(Asset mix)</b>	2.95	67.04

**Table 2**  
**Unadjusted Returns**

		% Change in Surplus (PCS)	Return on Assets (ROA)	Return on Equity (ROE)
Variable	Expected Sign	Coefficient	Coefficient	Coefficient
Intercept		n/a	-.06305**	-.82591***
<b>Economic and Market Variables</b>				
Unemployment	-	-.006996	.001088	-.009770
Disposable Personal Inc.	+/-	-.000058	.000018***	.000084***
Stock returns (S&P 500)	+/-	-.000058	-.000055	-.000187
Change in Int. Rates	-	-.003289	-.001146	-.003100
Unanticipated inflation	-	-.006733	-.000729*	-.004855***
Portfolio returns (Aaa)	+/-	.021981	.003720*	.031263***
Yield curve	+	-.19457	-.11442	-.11827
Real estate returns (REIT)	+	.001208*	.000012	.000044
<b>Asset structure/mix</b>				
Mortgages/Total Assets	-	-.12861*	-.01229*	.008601
Liquid Assets/TA	+	.068225	.01810***	-.001569
Real Estate/TA	-	.24470	-.09064***	-.11866
Separate Accounts/TA	-	-.53317***	-.04019***	-.15787***
Log(Total Assets)	+	.20244***		.02858***
Log(Capital and Surplus)	+		.001008*	
<b>Liability structure</b>				
Ord.lifeRes/Total Reserves		-.001631	-.01253***	-.032885***
Annuity Reserves/TR		.020275	-.01399***	-.015163
A&Hprem/Total Premium		.035712	.001577	.005197
Annuity premiums/TP		-.004494	-.001433	.001686
Premiums Written/S	-	-.022415***	-.002285***	-.023082***
Reserves/CS	-	-.010689***	-.0007413***	-.009446***
Reinsurance/TA	-	.050864	.008630	.013393

**Table 2 (continued)**

		% Change in Surplus (PCS)	Return on Assets (ROA)	Return on Equity (ROE)
Variable	Expected Sign	Coefficient	Coefficient	Coefficient
<b>Disintermediation</b>				
Lapse	-	-.000118	-.000004	-.000040
Policy loans/TA	-	.16584	-.02308*	.084264
Asset/liability mismatch	-	-.000024	.000004	.000004
<b>Solvency Ratios</b>				
IRIS5(Nonadmitted assets)	-	.000108	.00004**	.000123*
IRIS7(Affiliate invest.)	-	-.000148*	.000003	.000003
IRIS8(Surplus Relief)	-	-.000343**	.00001	-.000368***
IRIS9(Premium change)	-	.000140***	-.000008***	-.000044***
IRIS10(Product mix)	-	-.000092	.000005	-.000021
IRIS11(Asset mix)	-	.000049	.00002	.000015
	Adjusted-R <sup>2</sup>	.04840	.04735	.08470
	F-test (significance level)	.0001	.0001	.0001

\*\*\* statistically significant at 0.01, \*\* statistically significant at 0.05, and \* statistically significant at 0.10. Tests are one-tailed if the sign is predicted and two-tailed otherwise. The model for PCS is a one-way fixed effects model while the models for ROA and ROE are one-way random effects models. Large values of the LM statistic argued in favor of the panel data models against the classical regression model. In the case of ROA and ROE small values of the Hausman statistic argued in favor of the random effects model (see Greene, 1998, p. 321, for details).

**Table 3**  
**Risk-Adjusted Returns**  
**mean(return) / std.dev.(return)**

		% Change in Surplus (risk-adjusted)	Return on Assets (risk-adjusted)	Return on Equity (risk-adjusted)
Variable	Expected Sign	Coefficient	Coefficient	Coefficient
intercept		-1.4542***	-4.2839***	-4.9626***
<b>Asset structure/mix</b>				
Mortgages/Total Assets	-	.1200	2.1611***	2.2596**
Liquid Assets/TA	+	1.7137***	2.0273**	2.3721**
Real Estate/TA	-	-.0449	-4.2102**	-3.0436
Separate Accounts/TA	-	-.4055	-1.6811**	-2.3513***
log(Total Assets)	+	.1111***		.3570***
log(Capital and Surplus)	+		.3506***	
<b>Liability structure</b>				
Ord.lifeRes/Total Reserves		.4566**	.2681	.2204
Annuity Reserves/TR		.6055**	.3012	.7888
A&Hprem/Total Premium		.1401	-.2541	-.2910
Annuity premiums/TP		.2789	.3786	.3408
Premiums Written/S	-	-.0390*	-.0763*	-.1132**
Reserves/CS	-	-.0168**	-.0538***	-.0954***
Reinsurance/TA	-	-.5259	-1.0717	-1.2528
<b>Disintermediation</b>				
Lapse	-	-.0037	.0166	.0245**
Policy loans/TA	-	-.9817	-4.5201**	-4.0553*
Asset/liability mismatch	-	-.0003	-.0016	-.0006
<b>Solvency Ratios</b>				
IRIS5(Nonadmitted assets)	-	.0000	.0009	.0012
IRIS7(Affiliate invest.)	-	-.0035***	-.0037**	-.0049**
IRIS8(Surplus Relief)	-	-.0007	-.0052**	-.0049*
IRIS9(Premium change)	-	-.00001	-.0029**	-.0030**
IRIS10(Product mix)	-	-.0111*	-.0287**	-.0319**
IRIS11(Asset mix)	-	-.1697***	-.1055*	-.1076
	<b>Adjusted-R<sup>2</sup></b>	.1727	.2356	.2275
	<b>F-test (significance level)</b>	.0001	.0001	.0001
*** statistically significant at 0.01, ** statistically significant at 0.05, and * statistically significant at 0.10.				