Final Report of the CAS Research Project on Full Information Equity Betas for Property-Liability Insurance Including By-Line Estimates

The Risk Premium Project

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Submitted by

The Risk Premium Project (RPP)

Academic Investigators	Industry Investigators
J. David Cummins, Ph.D.	Richard A. Derrig, Ph.D.
University of Pennsylvania	Automobile Insurers Bureau of Massachusetts
Richard D. Phillips, Ph.D.	Robert P. Butsic, MBA, ASA, MAAA
Georgia State University	Fireman's Fund Insurance Company

Introduction and Statement of Purpose

The Risk Premium Project was organized in the Summer of 1999 to address the question of the equilibrium valuation of property and liability insurance risks as posed by the CAS's Committee on the Theory of Risk (COTOR). Phases I and II of the project were completed in April 2000 with a follow-up empirical Phase III. The goal of Phase III is to demonstrate the appropriateness of the pricing methodologies we discussed theoretically in Phases 1 and II and to develop procedures and parameterized models necessary to implement the methodologies empirically. A significant outcome of the research we propose will be the practical application of the results for use in the pricing and capital budgeting models currently being used by insurers.

This report is organized as follows: Section 1 provides a brief review of Phases I and II and highlights the theoretical conclusions. Further details can be found in the interim report published in the *Forum of the Casualty Actuarial Society* (Fall 2000) or on the CAS website at www.casact.org/cotor/rpp.htm. Sections 2 describes the empirical investigation on equity betas, including a statement regarding the importance and relevancy of the research, the data sources and the empirical methodologies we utilize.

1. The Risk Premium Project: A Review of Phases I and II

The goal of Phase I of the Risk Premium Project was to identify and review the actuarial and financial literature relating to the question of the equilibrium valuation of property-liability risks with a primary focus on research that has been published in the last 10-15 years. In all, over two hundred research papers and books were considered. The final bibliography contains 138 references from 37 different sources that in our view were deemed especially relevant to the valuation of insurance liabilities. All references were assigned to one of several thematic categories and the entire set of RPP references can be search online at www.casact.org/cotor. The references appear as an annotated bibliography searchable by author, subject, or keyword. Full PDF versions of many of the papers in the bibliography, with and without annotations, are also available on the web site via publisher links.

In Phase II of the project we attempted to synthesize the literature to provide a compact discussion of the theoretical conclusions that can be reached based upon the most recent evidence. Although we do not provide the details here, the five principal conclusions that have a direct bearing on the research question are shown below:

I.   The opinions of financial economists and actuaries regarding the role of systematic vs. non-systematic risks in determining equilibrium insurance prices are converging. Both see a role for non-systematic risk in pricing although an estimate of the non-systematic cost of risk is not yet well known.

II.   It is well known that a the systematic risk adjustment for the cash flows associated with a line of insurance should be included in the discount rate used to determine the fair value of the insurance premium.

However, it is not well know that in addition to the adjustment for common innovations between cash flows and market returns, the discount rate will also be a function of the maturity structure of the cash flows. This result suggests the equilibrium valuation of a line of insurance will require a charge for systematic risk even though the liability cash flows are triggered by events largely uncorrelated with market returns or other macroeconomic factors.

III.   The returns of financial assets cannot be adequately explained by the CAPM beta. Researchers have shown extensions of the CAPM which include additional factors significantly enhance the explanatory power of the models. In addition, although research using more sophisticated empirical tests has been published extending the CAPM, similar research focusing on insurance company returns does not currently exist.

IV.   A theoretically consistent way to allocate the costs of holding equity capital to individual lines of insurance has been identified. Thus, the costs associated with holding capital can now be charged to individual lines of insurance.

V.   The risk of insurer default to the policyholder should be recognized in pricing the risk transfer.

Research into some of the conclusions we list above is still ongoing and in some cases the reasons why some of the relationships exist have not been fully explained. In addition, empirical tests of many of the theoretical conclusions are either currently underway or have not yet been conducted. That being said, it is fair to say that a coherent approach to the valuation of insurance liabilities is emerging and much progress has been made that should be exploited to investigate the issues of equilibrium insurance pricing and insurance liability discounting. The empirical investigation we discuss below takes advantage of the recent research and should prove useful for both industry professionals seeking to more efficiently price their products as well as academics seeking to understand and evaluate the functioning of this important component of the financial services industry.

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**Phase III, Project 1: Full Information Equity Betas for
Property-Liability Insurance Including By Line Estimates**

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Importance of the Research

Modern financial theory suggests the identification of systematic risk is an important prerequisite to determine the equilibrium prices of securities issued by corporations, the valuation of privately held companies, and, more generally, in the pricing of goods and services offered by firms in regulated industries. The application of this theory to insurance pricing (e.g., Myers and Cohn 1987) has required an estimate of the insurer's equity CAPM beta which can then be used to price the insurer's liabilities as a residual.

Unfortunately prior research investigating the equity cost of capital for insurers, and therefore estimates of the systematic risk of the insurer's liabilities, suffers from two distinct problems. First, recent research documents a number of empirical anomalies that can not be reconciled within the assumptions that underlie the Capital Asset Pricing Model. Most notably, Fama and French (1992) show investments in small-cap stocks appear to earn average returns *higher* than would otherwise be predicted by the CAPM even after controlling for beta. In addition, assets with high book-to-market equity ratios (value stocks) have *higher* average returns after accounting for market beta. Although other factors have been studied (including leverage, dividend yield, earnings/price ratio, etc.) the dominant multifactor model to date is the Fama-French three-factor model. Although the failures of the CAPM are well documented in the literature, the implications for the cost of capital estimates in the insurance have not been identified. Thus, the first goal of this project is to provide estimates of the cost of capital for the insurance industry recognizing the weaknesses of the traditional application of the CAPM.

The second primary limitation of the application of modern capital budgeting model to price insurance risks is the general lack of reliable information regarding differences in the systematic risk across the various lines of insurance. Prior research seeking to estimate liability betas by line of insurance has met with little success.

Cummins and Harrington (1985) adopted an accounting based approach and estimated underwriting betas using based upon accounting data. They report the estimates were highly unstable – a result entirely consistent with other papers in this literature that report accounting betas are typically not highly correlated with market betas. Cox and Griepentrog (1988) adapted the pure-play approach of Fuller and Kerr (1981) to estimate divisional costs of capital for insurers but report the resulting cost of capital estimates were also unreliable. In addition, the estimates the authors do report are likely biased upwards since the pure-play approach requires the elimination for firms conducting business in more than one line of insurance. This requirement leaves insurers that write in only one line insurance who tend to be relatively low-market-capitalization firms whose costs of capital are known to be higher due to the small cap stock effect documented by Fama and French.

Completed Research

In this project we overcame the limitations of both the pure play and accounting based approaches and estimate full information equity betas, with autocorrelation adjustments (sum betas), for a typical property-liability insurer in a manner similar to Kaplan and Peterson (1997). The full information approach assumes the systematic risk of a conglomerate firm is a weighted average divisions of the firm and has gained widespread attention as it is a market based approach that allows the one to estimate industry costs of capital without eliminating so many firms from the analysis.

The estimation technique extends the Kaplan and Petersen approach in two important ways. First, we estimate the firm specific betas using the three-factor model proposed by Fama and French (1992, 1997). Thus, our estimates will more closely reflect the state-of-the-art in cost of capital estimation techniques. Second, we propose to extend their analysis beyond industry estimates of the cost of capital to estimate the equity cost of capital by line or groups of lines of insurance. Thus, the results on relative risk will be useful for actuaries pricing various lines of insurance and should also shed light on the role the duration of the liability cash flows has in determining the systematic risk of the line of insurance. Estimation for individual lines of insurance proved to be unstable due primarily to data limitations. Consequently, final estimates are made for portfolios of lines of insurance: short-tail and long-tail, personal and commercial, and auto, workers' compensation and all other lines.

The principal document constituting our report is the enclosed academic style paper by Cummins and Phillips: Estimating the Cost of Equity Capital for Property-Liability Insurers, dated June 23, 2003. This paper has been submitted to the Journal of Risk and Insurance for peer review and, when published will cite the CAS as the financial sponsor. All members of the RPP acknowledge the generous commitment of time by the members of the Committee on the Theory of Risk. We look forward to the completion of the companion IRC Phase III project on allocation of capital.