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Estimating the Cost of Equity Capital for Property-Liability Insurers

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Abstract

This article presents new evidence on the cost of equity capital by line of insurance for the property-liability insurance industry. To do so we obtain firm beta estimates and then use the full-information industry beta (FIB) methodology to decompose the cost of capital by line. We obtain full-information beta estimates using the standard one-factor capital asset pricing model and extend the FIB methodology to incorporate the Fama–French three-factor cost of capital model. The analysis suggests the cost of capital for insurers using the Fama–French model is significantly higher than the estimates based upon the CAPM. In addition, we find evidence of significant differences in the cost of equity capital across lines.

Introduction

Cost of capital estimation is becoming increasingly important for insurers. First introduced during the 1970s in regulatory proceedings, the application of financial methods in pricing, reserving, and other types of financial decision making has grown rapidly over the past two decades.[1] Recent developments include asset-liability management techniques (Panjer, 1998), methodologies to allocate equity capital by line of business (e.g., Myers and Read, 2001), market-based project evaluation techniques such as risk-adjusted return on capital (RAROC), and the projected introduction of fair value accounting for insurer liabilities (Girard, 2002; Dickinson, 2003). These and

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[1] Most of the important early financial pricing papers are collected in Cummins and Harrington (1987). More recent developments are reviewed in Cummins and Phillips (2000). Insurance pricing models that rely on estimates of the cost of capital are presented in Cummins (1990) and Taylor (1994).

other changes have intensified the need to find reliable methods to estimate the cost of capital for insurance firms.

The use of an incorrect cost of capital in capital budgeting, pricing, and other applications can have serious consequences, with the firm losing market share to competitors if the cost of capital is overestimated and losing market value if the cost of capital is underestimated. Essentially, using incorrect cost of capital estimates can lead to the firm's investing in negative net present value projects that destroy firm value. Choosing the appropriate cost of capital for specific projects is often a challenging task. The cost of capital varies significantly across industries, and cost of capital research has shown that there is a significant industry factor for insurance (Fama and French, 1997). Although insurance is a diverse industry, encompassing numerous lines of business with very different risk characteristics, little progress has been made in estimating costs of capital by line of business within the insurance industry. The objective of the present article is to remedy this deficiency in the existing literature by developing cost of capital models that reflect the line of business characteristics of firms in the property-liability insurance industry to assist insurers in making decisions that maximize firm value. In addition to providing valuable information for financial decision making, estimating the cost of capital by line also contributes to the literature on explaining cross-sectional price differences in the insurance industry (e.g., Sommer, 1996; Phillips, Cummins, and Allen, 1998; Froot, 2003).

The issue addressed in this article has been studied in the financial literature as the problem of estimating the cost of capital for divisions of conglomerate firms. Because the conglomerate firm itself rather than the division is traded in the capital market, market value data can be used to estimate the overall cost of capital for the conglomerate but not for the individual divisions comprising the firm. The classic approach for estimating the divisional cost of capital is the *pure-play approach* (Fuller and Kerr, 1981) that approximates the divisional cost of capital as the average cost of capital for publicly traded "pure-play" firms that specialize in the same product as the division under consideration.

The pure-play technique performs well when a relatively large number of pure-play firms of various sizes can be found. However, in many industries, there are only a few true specialist firms in some product lines and they often tend to be relatively small (Ibbotson Associates, 2002). Because small firms tend to have higher costs of capital than large firms, using pure-play cost of capital estimates from small specialist firms to determine the cost of capital of a much larger division of a conglomerate firm can lead to biased estimates of the divisional cost of capital. Property-liability insurance is an industry where the pure-play approach does not work very well because the vast majority of insurance premiums are written by multiple-line firms. In addition, relatively few insurers are publicly traded, with the majority of firms in the industry owned by insurance groups. Thus, development of an alternative to the pure-play method is particularly important in this industry.

This article utilizes a relatively new methodology, the *full-information industry beta (FIB) approach*, that overcomes the principal limitations of the pure-play methodology (Ehrhardt and Bhagwat, 1991; Kaplan and Peterson, 1998). Instead of discarding the cost of capital estimates for conglomerates, as is done in pure-play analysis, the FIB approach utilizes a sample of conglomerate and specialist firms to identify the impact of various lines of business on the cost of capital. The underlying insight is that the *observable* market-value beta for the conglomerate is a weighted average of the *unobservable* betas of the firm's underlying business segments. The approach is to conduct a cross-sectional regression for a sample of firms, where the dependent variable is the observable beta and the independent variables measure the firms' participation in various lines of business. The coefficients of the line of business participation variables are then interpreted as the full-information beta coefficients for the business lines. The resulting regression equation can be used to estimate costs of capital for individual lines of business, divisions of conglomerate firms, nontraded stock firms, and mutuals.

The betas used as the dependent variables in our FIB regressions come from the capital asset pricing model (CAPM) and the three-factor model developed by Fama and French (1992, 1993, 1997). The CAPM and Fama–French methods were chosen because they are used frequently in determining the cost of capital in practical applications (Graham and Harvey, 2001) and have been extensively tested in the academic literature. The Fama–French three-factor model (hereinafter the FF3F model) was developed in response to the criticism that the CAPM systematic market risk factor alone does not provide an adequate explanation of the cross-sectional variation of average stock returns. The FF3F model achieves significantly better explanatory power by adding risk factors to capture the effects of firm size (total market capitalization) and the ratio of the book value of equity (BE) to the market value of equity (ME). The former factor controls for the well-known inverse relationship between the cost of capital and firm size. The BE/ME ratio reflects the firm's growth prospects (relative financial distress), with firms with low growth prospects having higher values of this ratio than healthier firms.[2]

This article implements the FIB approach to cost of capital estimation using a sample consisting of all firms (insurance and noninsurance) listed in the Compustat data base for the period from 1997 through 2000. We utilize the FIB technique to estimate the cost of capital for personal and commercial lines of insurance and for regulated lines (automobile versus workers' compensation insurance). The FIB approach can easily be adapted to estimate costs of capital for other lines of business. We also estimate the overall CAPM and FF3F costs of capital for insurance and other types of financial services firms.

There have been several prior articles on cost of capital estimation for property-liability insurers. Cummins and Harrington (1985) utilize quarterly profit data to estimate the cost of capital for 14 property-liability insurers from 1970 to 1981. Cox and Griepentrog (1988) implemented the pure-play technique for a sample of 26–31 insurers (depending on the year) using data from the mid 1970s. Cummins and Lamm-Tennant (1994) estimate models showing that insurer costs of capital are related to leverage and find that commercial long-tail coverages have higher costs of capital than short-tail lines. Lee and Cummins (1998) estimate the cost of equity capital for property-liability

[2] The construction of the size and book-to-market factors are defined in more detail below. Cochrane (1999) reviews the empirical asset pricing literature and provides an intuitive discussion of the nondiversifiable risks proxied by the size and financial distress risk factors.

insurers using the CAPM, the arbitrage pricing theory (APT) model, and a unified CAPM–APT model developed by Wei (1988). They find that the APT and the Wei models perform better than the CAPM in forecasting the cost of capital for insurers. Except for Lee–Cummins, none of the prior research uses data after the 1980s, and none except Cummins and Lamm-Tennant estimates the cost of capital by line.

Our research contributes to the insurance cost of capital literature by providing the first comprehensive analysis of the cost of capital by line of business and by using a much larger sample of insurers. This article is the first to apply the FF3F model and the full-information beta technique to the insurance industry. We also innovate by conducting the first application in any industry of the FIB beta technique to explain the factors of the FF3F model.

The remainder of the article is organized as follows: Cost of capital models, estimation, and sample selection are discussed in the section "Cost of Capital Estimation Methodologies." The results are presented in the section "Empirical Results," and the final section concludes.

COST OF CAPITAL ESTIMATION METHODOLOGIES

This section outlines the cost of capital estimation methodologies utilized in this article. The discussion briefly summarizes each model and provides details on the estimation techniques.

The Capital Asset Pricing Model

The CAPM cost of capital is given by the following formula:

$$E(r_i) = r_f + \beta_{mi}[E(r_m) - r_f], \tag{1}$$

where

$E(r_i)$ = the CAPM cost of capital for firm i,
r_f = the expected return on a default risk-free asset,
$E(r_m)$ = the expected return on the market portfolio, and
β_{mi} = firm i's "beta coefficient" for systematic market risk = $\mathrm{Cov}(r_i, r_m)/\mathrm{Var}(r_m)$.

CAPM cost of capital estimation is conducted using the usual two-stage approach. In the first stage, returns on specific stocks in the sample are regressed on a market risk factor to obtain the beta coefficient for each firm.[3] In the second stage, the beta coefficients are inserted into Equation (1) along with the estimated market risk-premium to obtain the cost of capital estimate for each firm. The expected market

[3] The market excess return factor ($r_{mt} - r_{ft}$) in the first-stage CAPM regression is defined as the value-weighted return on a broad market index consisting of all stocks traded on the New York Stock Exchange (NYSE), the American Stock Exchanges (AMEX), and Nasdaq less the 30-day U.S. Treasury-bill rate lagged 1 month. The regression sample periods consist of 60 months of data. The market excess factor and estimation period are standard choices in the cost of capital literature (e.g., Fama and French, 1992).

premium for systematic risk, $E(r_m) - r_f$, is the average value-weighted excess return on NYSE/AMEX/Nasdaq stocks relative to the 30-day Treasury-bill rate from 1926–present.[4]

To control for potential biases caused by infrequent trading, the CAPM beta is also estimated using the widely accepted *sum-beta approach* (Scholes and Williams, 1977; Dimson, 1979), based on the following augmented regression:

$$r_{it} - r_{ft} = \alpha_i + \beta_{mi0}(r_{mt} - r_{ft}) + \beta_{mi1}(r_{m,t-1} - r_{f,t-1}) + \varepsilon_{it}. \quad (2)$$

The estimated sum-beta coefficient is obtained by adding the contemporaneous and lagged beta estimates from Equation (2), i.e., $\hat{\beta}_{mi} = \hat{\beta}_{mi0} + \hat{\beta}_{mi1}$.[5]

The Fama–French Three-Factor Model

Fama and French (1992, 1993, 1996) provide evidence that the CAPM does not provide an adequate explanation of the cross-sectional variation in average stock returns. They find that a three-factor model, which retains the CAPM risk-premium for systematic market risk but adds risk-premia for two additional factors to capture the effects of firm size and book-to-market equity (BE/ME) ratio, provides a much better explanation of the cross-sectional variation in stock returns.[6] The implication of their results is that reliance on the CAPM overlooks significant common risk factors that play a role in determining expected stock returns and thus is likely to lead to inaccurate cost of capital estimates. Accordingly, we also estimate the cost of capital using the FF3F model.[7]

The FF3F formula for the cost of capital is the following:

$$E(r_i) = r_f + \beta_{mi}[E(r_m) - r_f] + \beta_{si}\pi_s + \beta_{hi}\pi_h, \quad (3)$$

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[4] This approach to estimating the market risk premium is standard in the literature, and 1926-present is the most common averaging period. Derrig and Orr (2003) provide a review of alternative estimation periods and methods for estimating the market risk premium. In practical applications, the interest rate and the expected market risk premium often are varied to match the time horizon of the project under consideration (see Ibbotson Associates, 2002, p. 53). This distinction is not made here to focus attention on the impact of the beta coefficients, rather than the project horizon or interest rates, on the cost of capital. However, the approach could easily be adapted in practice to allow for differing time horizons.

[5] Scholes and Williams (1977) and Dimson (1979) include lead terms in addition to the lagged terms in adjusting for non-synchronous trading. However, these lead terms are not necessary under the assumption that the market return is not contaminated by stale prices.

[6] The Fama–French findings have been extensively tested and have been corroborated by other researchers (e.g., Barber and Lyon, 1997; Wang, 2003).

[7] We also considered estimating multi-factor models based upon arbitrage pricing theory (APT) as developed by Ross (1976). Although APT is an important model, we do not estimate APT costs of capital in this article. The APT places heavier demands on the data than the CAPM or FF3F methods and thus is more difficult to implement for industries such as insurance where the number of traded stocks is relatively low. In addition, the factors that comprise empirical versions of the APT model are often difficult to interpret economically, and the generalization of the methodology to incorporate industry factors is not straightforward. Further information on APT, see Campbell, Lo, and MacKinlay (1997).

where

β_{si} = firm i's beta coefficient for the size factor,
π_s = the expected market risk-premium for firm size,
β_{hi} = firm i's beta coefficient for the book-to-market (BE/ME) equity factor, and
π_h = the expected market risk-premium for the book-to-market (BE/ME) equity factor.

The size factor controls for the "small stock effect"—the tendency of stocks with small market capitalization to have higher costs of capital than large capitalization stocks. The book-to-market equity factor is usually interpreted as a "value factor" or measure of a firm's growth prospects. Firms with high growth prospects tend to have relatively low BE/ME ratios and lower costs of capital than firms with relatively low growth prospects. The BE/ME factor also is often interpreted as providing a market risk-premium for financial distress (Fama and French, 1995).

The first-stage regression in the Fama–French (FF3F) methodology is the following:

$$r_{it} - r_{ft} = \alpha_i + \beta_{mi}(r_{mt} - r_{ft}) + \beta_{si}\pi_{st} + \beta_{hi}\pi_{ht} + \varepsilon_{it}, \tag{4}$$

where

π_{st} = return differential between small and large stocks in period t, and
π_{ht} = return differential between high BE/ME stocks and low BE/ME stocks in period t.

The model augments the CAPM regression to include variables representing market excess returns for size and financial distress, based on the differential returns between "small" and "large" stocks and "high" and "low" BE/ME stocks, respectively. These return series are derived using the procedures described in Fama and French (1993, 1997).

As in the case of the CAPM, it is also important to correct for infrequent trading bias when estimating the FF3F model. Accordingly, we also calculate FF3F beta estimates using a sum-beta regression that includes contemporaneous and lagged values of each of the Fama–French return series.[8] Analogously to Equation (2), sum-beta estimates are then obtained by summing the betas of the contemporaneous and lagged returns for each of the three factors.

In the second stage of the FF3F methodology, we insert either the betas from Equation (4) or the corresponding sum-beta estimates into Equation (3). The risk-premium for systematic market risk, $E(r_m) - r_f$, in the FF3F model is the same estimate

[8] The importance of using the sum beta adjustment for all three FF3F factors is demonstrated in our empirical results, where a substantial proportion of the coefficients of the lagged risk factor terms in the sum beta version of Equation (4) is statistically significant.

used for the CAPM. Also used in this stage are estimates of the long-term average market risk-premia π_s and π_v for size and financial distress. The averaging period for the size and financial distress premia is from 1926 through 2000.[9]

The Full-Information Industry Beta Method

The FIB methodology produces cost of capital estimates that reflect the line of business composition of the firm.[10] Such estimates can be used to estimate costs of capital by line of insurance, for divisions or subsidiaries of conglomerate firms, and for nontraded stock insurers and mutuals. The underlying premise is that the firm can be envisioned as a portfolio of assets, where the assets represent divisions or individual lines of business. The rationale for the FIB decomposition is the value-additivity property of arbitrage-free capital markets, which holds that the arbitrage-free market value of the firm is the sum of the values of its individual projects (e.g., Brealey and Myers, 2002). This conceptualization implies that the firm's overall market beta coefficient is a weighted average of the beta coefficients of the separate divisions or business lines. In theory, the weight on each divisional or line of business beta is the market value of the division divided by the market value of the firm as a whole. However, because individual business units are not publicly traded, market value weights cannot be used. Instead, we follow Kaplan and Peterson (1998) in using sales data to represent business participation.

We seek to decompose the overall market beta coefficient (for the CAPM) or coefficients (for the FF3F model) into separate beta coefficients for each industry in which firms participate. There are two steps in the decomposition: (1) Estimate the overall market beta coefficients for a sample of firms using the CAPM or FF3F methods, as discussed above. (2) Obtain full-information betas for each industry by performing cross-sectional regressions with the overall market betas as dependent variables and a series of weights proxying for the firm's participation in various industries or lines of business as explanatory variables. The regression equation for the CAPM beta, estimated with the constant term suppressed, is

$$\beta_{mi} = \sum_{j=1}^{J} \beta_{fmj}\omega_{ij} + \nu_{mi}, \tag{5}$$

[9] Excess return data for market systematic risk, size, and financial distress were obtained from Kenneth French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french.

[10] Consistent with Kaplan and Peterson (1998), we estimate full-information equity betas rather than asset betas. The use of equity betas incorporates the assumption that all firms in an industry have an optimal capital structure and that the firms in the industry are operating at or close to the optimum. Although it would be possible to unlever the estimated equity betas, this approach has the limitation of assuming that all industry segments for a given firm have the same leverage (debt capital to equity capital) ratio. Unlevering beta also would require information on the rate of return on debt capital for insurers, which is difficult to obtain due to lack of market data on insurance liabilities. For these reasons, and because equity betas are useful in a variety of contexts, we focus on equity betas in this article.

where

β_{mi} = firm i's overall market systematic risk beta coefficient,
β_{fmj} = the full-information market systematic risk beta for industry, line, or division j,
ω_{ij} = firm i's industry-participation weight for industry, line, or division j, and
ν_{mi} = random error term for firm i.

The ω_{ij}, $j = 1, 2, \ldots, J$, for firm i, which sum to 1.0, measure the firm's participation in each line of business. Revenues by industry are used to calculate ω_{ij}, i.e., ω_{ij} = revenues of firm i in industry j divided by total revenues of firm i. The β_{fmj}, which vary by industry but not by firm, capture the impact that any particular line of business is expected to have on the overall riskiness and hence the beta coefficient of the firm. Equation (5) then is used "out of sample" to estimate the overall beta coefficients β_{mi} for individual divisions or lines of business by inserting the ω_{ij} weights for the division or business line.

Using Equation (5) would not be appropriate to decompose the FF3F size and book-to-market betas because these betas tend to vary systematically with firm size and book-to-market ratio, respectively. Specifically, the size betas are inversely related to firm size, and the BE/ME betas are directly related to firm BE/ME ratios.[11] Accordingly, regressions analogous to (5) for the size and book-to-market betas would be likely to suffer from omitted variables bias. To address this problem, we conduct the following regressions for the size and BE/ME betas:

$$\beta_{si} = \sum_{j=1}^{J} \beta_{f1sj}\omega_{ij} + \beta_{f2s} \ln(\text{ME}_i) + \nu_{si} \tag{6}$$

$$\beta_{hi} = \sum_{j=1}^{J} \beta_{f1hj}\omega_{ij} + \beta_{f2h} \ln(\text{BE}_i/\text{ME}_i) + \nu_{hi}, \tag{7}$$

where

β_{si}, β_{hi} = overall size and BE/ME beta estimates firm i, s = size, h = BE/ME,
$\beta_{f1sj}, \beta_{f1hj}$ = full-information size and BE/ME beta intercept coefficients for industry j,
β_{f2s}, β_{f2h} = full-information size and BE/ME beta slope coefficients,
BE_i, ME_i = book value of equity and market value of equity for firm i,
ν_{ji} = random error term for firm i, equation j, $j = s, h$.

[11] See Fama and French (1996, p. 59). There is no apparent pattern of market systematic risk factors in the FF3F model by either size or BE/ME ratio; and, likewise, the size betas have no apparent relationship with the BE/ME ratios, and the BE/ME betas are not systematically related to firm size.

Equations (6) and (7) allow for different intercept coefficients for each industry and also allow the slope coefficients to vary by the log of market equity and the log of the BE/ME ratio, respectively.[12] The full-information beta estimates for the size factor are obtained using the estimated coefficients $\hat{\beta}_{f1sj}$ and $\hat{\beta}_{f2s}$ by inserting the industry-participation weights (ω_{ij}) and ln(ME$_i$) for a given firm into Equation (6), and the full-information beta for the BE/ME factor is obtained similarly using Equation (7).

Equations (5)–(7) are estimated using two techniques—unweighted least squares (UWLS) and weighted least squares (WLS). In the WLS estimations, the weight for each firm in a specified cross-sectional regression is the ratio of its market capitalization to the total market capitalization of the firms in the sample.[13] For both the UWLS and WLS cases, we estimate the three FF3F regressions using the seemingly unrelated regressions procedure to improve estimation efficiency. The weighted and unweighted FIB regressions for the CAPM are conducted using ordinary least squares.

When UWLS is used to estimate Equations (5)–(7), the β_{fjk} are interpreted as equally weighted average industry specific betas. When WLS is used, the β_{fjk} represent market value weighted industry betas (Kaplan and Peterson, 1998). The equally weighted results are useful in obtaining an indication of the betas for the average firm in an industry, whereas the market value weighted (WLS) results are a more useful indicator of the overall cost of capital for an industry.

Data and Sample Selection

To estimate the CAPM, FF3F, and full-information costs of capital, we need data on stock returns and revenues by line of business for a sample of firms. This section describes the data sources, sample selection procedures, and data screens employed to construct our sample.

In this article, we estimate full-information costs of capital for property-liability insurers over the period from 1997 through 2000.[14] Stock return data were obtained

[12] The logged variables are used as regressors to be consistent with Fama and French (1997). They do not estimate full-information betas, but they do allow the slope coefficients to vary by the logs of market equity and the BE/ME ratio in some of their cost of capital regressions. We also conducted sensitivity analysis where we also interacted the slope coefficients with the ω_{ij} variables in regressions analogous to (6) and (7). The cost of capital estimates from the interacted regressions were very similar to those based on Equations (6) and (7).

[13] Kaplan and Peterson (1998) suggest using instrumental variables estimation (IV) rather than WLS. WLS rather than IV is used here because IV estimation is based on the assumption that the error terms in Equations (5)–(7) are homoskedastic, whereas we consider the assumption of heteroskedasticity to be more appropriate. However, WLS and IV give the same point estimates of the coefficients so the choice only affects the standard errors.

[14] Prior full-information cost of capital papers (Kaplan and Peterson, 1998; Ehrhardt and Bhagwat, 1991) base their analysis on only 1 year of data. The rationale for the choice of estimation period is that the objective in this article is to illustrate the estimation of divisional costs of capital by line for property-liability insurers rather than to study asset pricing anomalies or to develop and test a multi-factor asset pricing model. The CAPM and FF3F models we use here have been thoroughly tested by other authors and are widely accepted in the literature. Because the objective is to apply rather than test the models, it is not necessary to utilize a lengthy estimation period such as 20 or 25 years as in Fama and French (1992, 1996).

from the University of Chicago's Center for Research in Security Prices (CRSP). Data were obtained for the period from 1992 through 2000, permitting us to estimate costs of capital for the period from 1997 through 2000, because we follow the standard procedure of using 60 monthly observations to estimate our cost of capital models.[15]

To obtain revenues by line of business, we utilize Compustat's Business Information File and data from the National Association of Insurance Commissioners (NAIC). Compustat includes revenue data for firms in various industries, categorized using the North American Industry Classification System (NAICS). Insurance is included in the finance sector, which has two-digit NAICS code of 52. Within the finance sector, there are several insurance subcategories including property/casualty insurance (NAICS code 524126), property/casualty reinsurance (NAICS code 52413 or 524130), life insurance (NAICS code 524113), and health insurance (NAICS code 524114), and we utilize Compustat revenue data for these insurance lines of business in estimating our models. Because the NAICS system does not further categorize revenues by line of insurance, we obtained data on insurance revenues by line from the NAIC annual statement CD-ROMs to supplement the Compustat data.

EMPIRICAL RESULTS

This section begins by discussing summary statistics on the industry-participation ratios of property-liability (P&L) insurers. The overall beta and cost of capital estimation results are then presented, followed by cost of capital estimates by line. We illustrate the methodology using two lines of business categorizations: (1) personal versus commercial lines and (2) automobile insurance versus workers' compensation versus all other lines. The FIB approach could be applied similarly to other line categories.

Summary Statistics

Table 1 presents the industry-participation statistics for publicly traded firms writing property-liability insurance at year-end 2000. The three primary insurance industry categories are presented at the top of the table, followed by noninsurance industries. There are 117 firms in our sample of publicly traded firms that report writing property-liability insurance in 2000. Seventy-five of these firms are identified being primarily property-liability insurers by Compustat, and 42 firms are identified as primarily participating in other industries. The table shows that firms participating in the property-liability insurance market are represented in a variety of other industries. The most common industry is "finance excluding insurance," which includes mutual fund management, financial planning, securities brokerage, and consumer lending. Thirty-four of the firms that list their primary industry as property-liability insurance participate in the finance excluding insurance category, and 22 of the firms in the sample that are not primarily property-liability insurers participate in the finance excluding insurance segment. Only a few firms in the sample earn significant revenues from nonfinancial industries.

[15] In selecting the stock returns, we employed screening rules that also are standard in the cost of capital estimation literature (e.g., Fama and French, 1992, 1997). For example, we eliminated firms with estimated CAPM beta coefficients greater than 5 in absolute value and also eliminated firms that did not have at least 36 consecutive months of return information prior to June of each year of the estimation period.

TABLE 1

Sources of Revenue Across Industries for Firms Writing Property-Liability Insurance: 2000

Table displays the total revenue across industries for all firms writing property-liability (P&L) insurance during 2000. Industry classifications were based on the North American Industry Classification System (NAICS). The firm's primary NAICS code was used to classify the firms as either predominantly P&L insurers or as firms whose primary business line was something else. Revenue amounts are reported in $millions. The number of firms with positive revenues in a given industry segment are reported in parantheses. Source: COMPUSTAT Business Information File.

2-Digit NAICS	Industry Description	Primarily Non-P&L Insurer		Primarily P&L Insurer	
–	Property/liability ins. and reinsurance	$71,639.26	(42)	$134,218.70	(75)
–	Health insurance	4,050.54	(5)	9,283.92	(2)
–	Life insurance	93,430.59	(10)	16,664.25	(17)
72	Accommodation and food services	–	–	351.06	(1)
71	Arts, entertainment, and recreation	–	–	32.68	(1)
62	Health care and social assistance	4.96	(1)	–	–
61	Education services	1,856.83	(1)	–	–
56	Administrative support, waste management, and remediation	626.64	(2)	–	–
54	Professional, scientific, and technical services	488.09	(3)	350.29	(2)
53	Real estate and rental and leasing	5,078.98	(4)	8.20	(1)
52	Finance excluding insurance	26,456.14	(22)	5,518.24	(34)
51	Information	326.12	(4)	3.55	(1)
48	Transportation and warehousing	99.50	(1)	31.52	(1)
45	Retail trade 2	332.43	(1)	–	–
44	Retail trade 1	1,402.19	(1)	–	–
42	Wholesale trade	–	–	378.60	(3)
33	Manufacturing - heavy ind., machinery, electronic, & computer	2,750.82	(2)	–	(1)
32	Manufacturing - light commercial products	1,607.42	(1)	63.98	(1)
31	Manufacturing - consumer items	803.50	(1)	4,302.81	(2)
23	Construction	13.15	(1)	155.68	(2)
22	Mining	–	–	1,054.52	(2)

Note: Property-liability insurers and reinsurers have NAICS codes 524126 and 52413, respectively. Life insurers have NAICS code 524113. Health insurers have NAICS code 524114. All other NAICS codes under the "Finance and Insurance" heading (2 Digit NAICS code 52) are classified as "Finance Excluding Insurance."

TABLE 2
CAPM Betas and Costs of Capital for Property-Liability Insurers

Table shows average CAPM beta for firms which are identified as property-liability (P&L) insurers based on having overall NAICS codes 524126 or 52413. Both beta and sum beta regressions are conducted for each firm (Equations (2) and (3)). The beta regression is:

$$(r_{it} - r_{ft}) = \alpha_i + \beta_{mi}(r_{mt} - r_{ft}) + \varepsilon_{it}$$

where r_{it} is the return on firm i, r_{ft} is the 30 day Treasury bill rate observed at the beginning of the month, and r_{mt} is the value-weighted market return on all NYSE, AMEX, and Nasdaq stocks. The "Sum β" model adjusts for nonsynchronous trading by adding to the regression the excess market return variable lagged one time period. The reported sum betas equal the sum of the contemporaneous and lagged beta estimates. The data period for each year ends on June 30. Estimates are calculated using the previous 60-months of returns. The risk-free rate of interest used to estimate the cost of equity capital was the average 30 day T-bill rate over the time period for this study 1997–2000, 4.93 percent. The long-run historical market risk premium as of December 2000 was 8.44 percent (Ibottson, 2002).

Year	Market Cap Quartile	No. P&L Insurers	Average β	Cost of Capital	Average Sum β	Cost of Capital
1997	Small	21	0.646	0.104	0.893	0.125
	2	21	0.861	0.122	1.144	0.146
	3	21	0.709	0.109	0.809	0.118
	Big	22	0.820	0.119	0.932	0.128
	Total	85	0.760	0.113	0.944	0.129
1998	Small	18	0.632	0.103	0.926	0.127
	2	19	0.687	0.107	0.908	0.126
	3	19	0.652	0.104	0.811	0.118
	Big	19	0.917	0.127	0.999	0.134
	Total	75	0.723	0.110	0.911	0.126
1999	Small	19	0.570	0.097	0.812	0.118
	2	19	0.616	0.101	0.677	0.106
	3	19	0.642	0.103	0.736	0.111
	Big	19	0.690	0.107	0.746	0.112
	Total	76	0.629	0.102	0.743	0.112
2000	Small	18	0.316	0.076	0.631	0.103
	2	18	0.654	0.104	0.763	0.114
	3	18	0.642	0.104	0.696	0.108
	Big	19	0.712	0.109	0.817	0.118
	Total	73	0.583	0.098	0.728	0.111
Grand total		309	0.677	0.106	0.836	0.120

Overall Costs of Capital

In all of the cost of capital estimates presented in this article, we use as the risk-free rate the average of the 30-day Treasury-bill rate over the years used in this study, from 1997 through 2000. Likewise, as the expected risk-premia for systematic market risk, size, and financial distress, we use the long-run historical (from 1926 through 2000) market risk-premia on NYSE/AMEX/Nasdaq stocks from Kenneth French's Web site. We use the same risk-free rate and risk-premia for all cost of capital estimates to focus on the impact of the models and the beta coefficients on the cost of capital, holding constant the risk-free rate and market risk-premia.

The CAPM beta and sum-beta estimates for property-liability insurers are summarized in Table 2 along with the corresponding cost of capital estimates. The table gives the average beta and sum-beta by market capitalization size quartile for each year of the estimation period. As expected, the sum-beta estimates are consistently larger than the ordinary beta coefficients. For the sample as a whole, the average beta is 0.677 and the average sum-beta is 0.836. Thus, property-liability insurers on average tend to be characterized by infrequent trading, such that it is important to use sum betas to obtain accurate costs of capital. Interestingly, the quartile results do not show that large insurers consistently have smaller betas than small insurers, contrary to the usual finding for large and small stocks in general. In part, this is because the size difference between the average large and small property-liability insurers is not as high as for large and small stocks in general, e.g., in 2000, the average P&L insurer in the largest size quartile is approximately half as large as the average firm in that quartile. Even with the sum-beta adjustment, the betas for property-liability insurers tend to be somewhat less than the average CAPM beta coefficient of 1.0. The cost of capital estimate for the period as a whole is 10.6 percent without the sum-beta adjustment and 12.0 percent with the sum-beta adjustment.

Table 3 provides the overall beta and sum-beta estimates based on the FF3F method. The beta coefficients for systematic market risk, firm size, and the BE/ME factor are shown by quartile and year of the sample period. On average, the market systematic risk factor has a higher beta coefficient than the BE/ME factor, and the firm size factor has the lowest beta coefficient. For the sample as a whole, the market beta is 0.98, the size beta is 0.386, and the financial distress beta is 0.813.[16] The sum-beta estimates are larger than the estimates without the sum-beta adjustment, indicating that it is important to adjust for infrequent trading in the FF3F model as well as in the CAPM.

Comparing our results to the results in Fama and French (1997), we find that our market beta and size beta estimates for property-liability insurers are about the same as the all-industry averages for these two parameters in Fama and French (1997), suggesting that property-liability insurance stocks are about average in terms of their sensitivity to systematic market risk and firm size. However, our financial distress betas, which average 0.813, are *substantially* larger than the Fama–French all-industry average of 0.02 for this parameter.[17] This result suggests that property-liability stock returns are much more sensitive to financial distress than stocks in general and that

[16] By construction, in the Fama–French three-factor model, the market value weighted average of the size and financial distress betas *across all stocks in the market* will sum to zero. However, this does not imply that the betas will average to zero for a specific industry such as property-liability insurance.

[17] Our estimates of the size and financial distress beta for property-liability insurers are also much larger than the Fama–French estimates of these parameters for the insurance industry, 0.09 and 0.06, respectively. However, their definition of the insurance industry is much broader than ours, including life and health insurers as well as property-liability insurers.

TABLE 3
Fama–French Three Factor Beta and Cost of Capital Estimates for Property-Liability Insurers

Table shows average regression coefficients from Fama–French 3-Factor Model for firms which are identified as property-liability insurers by having overall NAICS codes of 524126 or 52413. Both beta and sum-beta regressions are estimated for each firm. The beta regression is as follows:

$$(r_{it} - r_{ft}) = \alpha_i + \beta_{mi}(r_{mt} - r_{ft}) + \beta_{si}\pi_{st} + \beta_{hi}\pi_{ht} + \varepsilon_{it}$$

where r_{it} is the return on firm i, r_{ft} is the 30 day Treasury bill rate observed at the beginning of the month, and r_{mt} is the value-weighted market return on all NYSE, AMEX, and Nasdaq stocks. The firm size and BE/ME factors, π_{st} and π_{ht}, respectively, are determined as follows. At the end of June of each year, all NYSE, AMEX, and Nasdaq stocks are allocated to two groups (small, S, or big, B) based upon whether their market capitalization is less than or greater than median market capitalization for NYSE stocks. Stocks are also sorted into three book-to-market groups (low, medium, high) based upon the breakpoints for the bottom 30 percent (L), middle 40 percent (M), and top 30 percent (H) values of book equity-to-market capitalizations for NYSE stocks. Six size-BE/ME portfolios (SL, SM, SH, BL, BM, BH) are then formed using the inter-sections of the breakpoints defined above. Value-weighted monthly returns on the six portfolios are calculated from July to the following June. The size factor, π_{st}, is the difference, each month, between the average returns on the three small-stock portfolios (SL, SM, SH) and the three big-stock portfolios (BL, BM, BH). The BE/ME factor, π_{ht}, is the difference each month between the average of the returns on the two high BE/ME portfolios (SH and BH) and the two low BE/ME portfolios (SL and BL). The "Sum β" model adjusts for nonsynchronous trading by including each factor and each factor lagged one time period. The reported sum betas equal the sum of the contemporaneous and lagged regression coefficients. Estimates are calculated using the previous 60-months of returns. More detail on the construction of the firm size and BE/ME factors can be found in Fama and French (1993). The factors are available on French's website at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/. The risk-free rate of interest used to estimate the cost of equity capital was the average 30 day T-bill rate over the time period for this study 1997–2000, 4.93 percent. The long-run historical excess market return, the size premium, and the BE/ME premium as of December 2000 were 8.44 percent, 2.35 percent, and 3.85 percent, respectively.

Year	Market Cap Quartile	No. P&L Insurers	β_m	β_s	β_h	Cost of Capital	Sum β_m	Sum β_s	Sum β_h	Cost of Capital
1997	Small	21	0.875	0.463	0.624	0.158	1.189	0.766	1.086	0.209
	2	21	1.080	0.610	0.743	0.183	1.205	0.785	0.834	0.201
	3	21	0.976	0.397	0.668	0.167	0.978	0.093	0.608	0.157
	Big	22	1.060	0.130	0.673	0.168	1.080	−0.220	0.355	0.149
	Total	85	0.998	0.397	0.677	0.169	1.112	0.349	0.716	0.179

1998	Small	18	0.765	0.652	0.538	0.150	1.091	1.346	1.328	0.224
	2	19	0.928	0.613	0.735	0.170	0.999	0.716	0.765	0.180
	3	19	0.989	0.412	0.850	0.175	0.992	0.349	0.982	0.179
	Big	19	1.253	0.175	0.983	0.197	1.238	−0.018	0.778	0.183
	Total	75	0.986	0.460	0.779	0.173	1.080	0.589	0.958	0.191
1999	Small	19	0.650	0.551	0.453	0.135	0.735	1.055	0.723	0.164
	2	19	0.805	0.517	0.633	0.154	0.651	0.751	0.578	0.144
	3	19	0.965	0.465	0.953	0.178	1.023	0.528	1.244	0.196
	Big	20	1.115	0.073	1.023	0.184	1.108	0.150	1.056	0.187
	Total	77	0.887	0.397	0.769	0.163	0.882	0.615	0.902	0.173
2000	Small	18	0.679	0.624	0.972	0.159	1.069	0.742	1.385	0.210
	2	19	1.060	0.536	0.990	0.190	1.038	0.635	1.059	0.193
	3	19	1.117	0.178	1.041	0.188	1.053	0.441	1.277	0.198
	Big	19	1.322	−0.174	1.183	0.202	1.167	0.105	1.180	0.196
	Total	75	1.050	0.286	1.048	0.185	1.082	0.477	1.223	0.199
Grand total		312	0.980	0.386	0.813	0.172	1.040	0.503	0.942	0.185

financial distress leads to significantly higher costs of capital for property-liability insurers.[18]

The FF3F costs of capital shown in Table 3 range from 16.3 percent in 1999 to 18.5 percent in 2000, without the sum-beta adjustment, and from 17.3 percent in 1999 to 19.9 percent in 2000, with the sum-beta adjustment. For the period as a whole, the average cost of capital is 17.2 percent without the sum-beta adjustment and 18.5 percent with the adjustment, considerably higher than the comparable CAPM costs of capital of 10.6 percent and 12.0 percent (Table 2). The higher FF3F estimates reflect the risk-premia for firm size and the BE/ME factor.[19] Hence, it is likely to be important for property-liability insurers to utilize a multiple-factor model when estimating the cost of capital.

Our FF3F cost of capital estimates for property-liability insurers are consistent with the FF3F estimates reported by Ibbotson Associates (2002, p. 153) for all industries in 2001, which average about 15.5 percent (after adjusting for the risk-free rate which was about 2 percentage points lower in Ibbotson's analysis than in ours). The FF3F cost of capital estimates for property-liability insurers should be somewhat higher than average because insurers tend to be smaller than average firms in other industries and because they tend to have more sensitivity to the BE/ME factor.

To provide further perspective on the FF3F cost of capital estimates, we also calculated the annualized return on an equally weighted index consisting of all NYSE, AMEX, and Nasdaq stocks in Standard Industrial Classification (SIC) classification 6331, fire, marine, and casualty insurance. We calculated the returns for our sample period, 1997–2000, and also for the longer sample period 1990–2003 and for several sub-periods. The returns on the SIC 6331 stocks are generally higher than for the Standard & Poor's (S&P) 500 Stock Index and also are generally consistent in magnitude with the FF3F cost of capital estimates shown in Table 3. For example, the annualized return on SIC 6331 stocks for 1997–2000 was 23.7% compared to 21.4% for the S&P 500, and the returns for 1990–2003 are 16.7% for SIC 6331 and 9.8% for the S& P 500. This provides further evidence that property-liability insurer stocks tend to have higher costs of capital than stocks in general, at least during recent periods.

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18 Additional evidence of a significant "flight to quality" effect for property-liability insurers is presented in Cummins and Lewis (2003). They analyze a sample of insurers that sustained losses due to the September 11, 2001, World Trade Center terrorist attack and show that stock prices for insurers with high financial ratings rebounded quickly following the attack, whereas stock prices for lower-rated insurers remained depressed. A model of capital budgeting under conditions where financial distress matters has been developed by Froot and Stein (1998).

19 The reader is reminded that the cost of capital estimation involves utilizing the estimated beta coefficients of the CAPM and FF3F models, multiplied by the long-term (from 1926 through 2000) average returns for the corresponding Fama–French risk factors (see Equations (1) and (3)). Thus, even though linear regression theory implies that the sum of the fitted values of the dependent variables from the CAPM and FF3F beta estimation regressions are equal to the sum of the actual rate of return dependent variable in the regressions, this does not mean that the cost of capital from the CAPM and FF3F models will be the same.

Full-Information Costs of Capital

The full-information CAPM beta coefficients for property-liability insurance, life insurance, health insurance, finance excluding insurance, and all other industries are shown in Table 4. The beta estimates shown in the table are the industry-participation intercept coefficients (β_{fmj}) from the CAPM FIB regression (Equation (5)) on all two-digit NAICS industries using all Compustat firms that met our sample selection criteria. The dependent variable in the regression is the vector of sum-beta estimates obtained from Equation (2). We conducted the FIB estimation separately by year and also conducted a panel data regression including the data from all 4 years of the sample period in a single regression. Both equally weighted and market value weighted averages are shown in the table. The equally weighted averages provide an indication of the beta for the average insurer, whereas the market value weighted averages provide an indication of the systematic risk sensitivity for the industry as a whole. We focus most of the discussion on the panel data results, but the annual averages are generally quite similar.[20]

Based on the panel regression results, the equally weighted CAPM beta coefficient for the property-liability insurance industry is 0.856 and the value-weighted beta is 0.843, i.e., the industry is slightly less risky than stocks in general, which have an average CAPM beta coefficient of 1.0. The equally weighted property-liability industry beta based on the panel estimation model is significantly less than the betas of the health insurance and all other nonfinancial industries categories but not significantly different from life insurance or finance excluding insurance. Based on the value-weighted estimates, the property-liability betas are significantly smaller than those of all other industry segments shown in the table. Hence, there is strong evidence that property-liability insurance has lower CAPM systematic risk on average than many other industries.

The CAPM costs of capital based on the beta estimates are shown in the last two panels of Table 4. Both the equally weighted and value-weighted estimates suggest that the FIB CAPM cost of equity capital for property-liability insurers is approximately 12 percent. Based on value-weighted estimates, the CAPM cost of capital for property-liability insurers is less than that for life insurers (13.5 percent), health insurers (15.1 percent), financial firms excluding insurers (16.0 percent), and all other industries (13.2 percent).

The FF3F full-information beta estimates and costs of capital for property-liability insurers are shown in Table 5. The estimates are based on regressions (5)–(7) with the sum-beta estimates as dependent variables. The models are estimated over all NAICS two-digit industries using all Compustat firms. Equally weighted estimates are shown in section A of the table and value-weighted estimates are shown in section B. Both sections of the table show the industry-participation betas for property-liability insurance from Equations (5)–(7), i.e., β_{fmj}, β_{f1sj}, and β_{f1hj}, as well as the average industry-participation betas for all other industries. Also shown in the table are the slope coefficients for the log of market capitalization and the log

[20] There is a tendency for betas to vary somewhat over time, as is the case with our individual year betas. The variability in our annual betas is not unusual and is generally consistent with patterns observed in Ibbotson Associates (2002, p. 108) and other sources.

TABLE 4
Full Information CAPM Beta and Cost of Capital Estimates With Sum Beta Adjustment

Table displays full information CAPM beta estimates for property-liability insurance, life insurance, health insurance, finance excluding insurance, and all other industries. The full-informaton beta is estimated from the following cross-sectional regression

$$\beta_{mi} = \sum \beta_{fmj}(\omega_{ij}) + \upsilon_{mi}$$

where β_{mi} is the equity beta estimated using Equation (3) for firm i, β_{fmj} is the estimated full-information beta for industry j, ω_{ij} is the proportion of firm i's net sales in industry j. The regression is estimated by OLS (equally weighted) and via weighted least squares (market weighted). The latter is used so we can obtain market-capitalization weighted industry full-information betas. The weight is equal to the market capitalization of firm i relative to the market capitalization of all NYSE, AMEX, and Nasdaq stocks. Any firm with an estimated beta greater than 5 or less than −5 is removed from the sample. The full-information regression was estimated separately for each calendar year and as a pooled regression across all four years. The risk-free rate of interest used to estimate the cost of equity capital was the average 30 day T-bill rate over the time period for this study 1997–2000, 4.93 percent. The long-run historical market risk premium as of December 2000 was 8.44 percent (Ibottson, 2002).

	1997	1998	1999	2000	Average	Panel Estimate
Panel A: Equally Weighted Estimates						
Property-liability insurance	0.939	0.931	0.769	0.759	0.849	0.856
	(0.109)	(0.108)	(0.099)	(0.103)		(0.053)
Life insurance	0.974	0.952	0.821	0.785	0.883	0.897
	(0.182)	(0.198)	(0.193)	(0.190)		(0.095)
Health insurance	0.722	1.023	1.584	1.160	1.122	1.096
	(0.203)	(0.229)	(0.190)	(0.214)		(0.105)
Finance (excluding insurance)	0.915	0.822	0.868	0.782	0.847	0.847
	(0.060)	(0.057)	(0.050)	(0.190)		(0.027)
Average all nonfinancial industries	1.108	1.082	1.099	1.057	1.087	1.091
F-test: $\beta_{fm\text{P\&L}} = \beta_{fm\text{Life}}$	0.050	0.070	0.030	0.010		0.200
F-test: $\beta_{fm\text{P\&L}} = \beta_{fm\text{Health}}$	0.750	0.230	13.80***	2.700		4.40**
F-test: $\beta_{fm\text{P\&L}} = \beta_{fm\text{Finance (Excluding Insurance)}}$	0.010	0.310	0.580	0.010		0.000
F-test: $\beta_{fm\text{P\&L}} = \beta_{fm\text{Average all Nonfinancial Industries}}$	2.450	2.530	9.24***	7.06***		18.65***

Panel B: Market Value Weighted Estimates						
Property-liability insurance	0.847	0.858	0.764	0.964	0.858	0.843
	(0.054)	(0.050)	(0.067)	(0.085)		(0.031)
Life insurance	1.114	0.971	0.880	1.057	1.006	1.012
	(0.097)	(0.088)	(0.104)	(0.136)		(0.059)
Health insurance	1.007	1.434	1.324	1.150	1.229	1.208
	(0.103)	(0.112)	(0.113)	(0.141)		(0.053)
Finance (excluding insurance)	1.327	1.199	1.365	1.330	1.305	1.309
	(0.036)	(0.031)	(0.029)	(0.032)		(0.016)
Average all nonfinancial industries	1.026	0.983	0.968	0.987	0.991	0.986
F-test: $\beta_{fm\text{P\&L}} = \beta_{fm\text{Life}}$	5.97**	2.78*	0.940	0.260		9.23***
F-test: $\beta_{fm\text{P\&L}} = \beta_{fm\text{Health}}$	2.490	24.79***	18.30***	1.150		32.88***
F-test: $\beta_{fm\text{P\&L}} = \beta_{fm\text{Finance (Excluding Insurance)}}$	55.95***	40.42***	67.70***	15.76***		184.75***
F-test: $\beta_{fm\text{P\&L}} = \beta_{fm\text{Average All Nonfinancial Industries}}$	10.09***	8.86***	8.16***	0.020		22.22***
Panel C: Industry Cost of Equity Capital Equally Weighted						
Property-liability insurance	12.9%	12.8%	11.4%	11.3%	12.1%	12.2%
Life insurance	13.2%	13.0%	11.9%	11.6%	12.4%	12.5%
Health insurance	11.0%	13.6%	18.3%	14.7%	14.4%	14.2%
Finance (excluding insurance)	12.7%	11.9%	12.3%	11.5%	12.1%	12.1%
Average all nonfinancial industries	14.3%	14.1%	14.2%	13.9%	14.1%	14.1%
Panel D: Industry Cost of Equity Capital Market Value Weighted						
Property-liability insurance	12.1%	12.2%	11.4%	13.1%	12.2%	12.0%
Life insurance	14.3%	13.1%	12.4%	13.8%	13.4%	13.5%
Health insurance	13.4%	17.0%	16.1%	14.6%	15.3%	15.1%
Finance (excluding insurance)	16.1%	15.0%	16.4%	16.1%	15.9%	16.0%
Average all nonfinancial industries	13.6%	13.2%	13.1%	13.3%	13.3%	13.2%

***,**,* significant at the 1, 5, or 10 percent level, respectively. Standard errors in parentheses.

TABLE 5
Full Information Fama–French 3-Factor Beta and Cost of Capital Estimates With Sum Beta Adjustment

Table displays full information beta estimates for the Fama–French 3-Factor Model. The full-information beta for each factor is the estimated from the following cross-sectional system of regressions

$$\beta_{mi} = \sum \beta_{fmj}(\omega_{ij}) + \upsilon_{mi}$$

$$\beta_{si} = \sum \beta_{f1sj}(\omega_{ij}) + \beta_{f2s} \ln(\mathrm{ME}_i) + \upsilon_{si}$$

$$\beta_{hi} = \sum \beta_{f1hj}(\omega_{ij}) + \beta_{f2h} \ln(\mathrm{BE}_i/\mathrm{ME}_i) + \upsilon_{hi}$$

where β_{mi}, β_{si}, and β_{hi} are the excess market, firm size, and BE/ME factor loadings, respectively, estimated using Equation (6) for firm i. β_{fmj}, β_{f1sj}, and β_{f1hj} are the estimated full-information excess market, firm size, and BE/ME betas for industry j, respectively. β_{f2s} and β_{f2h} are the size and BE/ME slope adjustments, respectively. ω_{ij} is the percent of firm i's net sales in industry j. The regression is estimated by SUR (equally weighted) and by SUR (market weighted). The latter is used so we can obtain market-capitalization weighted industry full-information betas. The weight equals the market capitalization of firm i relative to the market capitalization of all NYSE, AMEX, and Nasdaq stocks. Stocks with betas of greater than 5 or less than -5 are removed from the sample. The full-information regression was estimated for each calendar year and as a pooled regression across all years. The risk-free rate of interest used in the analysis is the average 30 day T-bill rate over the time period for this study 1997–2000, 4.93 percent. The long-run historical premia for the excess market return, the size factor, and the BE/ME factor as of December 2000 were 8.44 percent, 2.35 percent, and 3.85 percent, respectively.

	1997	1998	1999	2000	Average	Panel Estimate
Panel A: Equally Weighted Estimates						
Property-liabilty insurance intercept betas						
Market risk factor	1.096	1.083	0.932	1.141	1.063	1.064
	(0.109)	(0.108)	(0.103)	(0.110)		(0.054)
Small - big capitalization factor	1.330	1.645	1.456	1.130	1.390	1.392
	(0.145)	(0.140)	(0.129)	(0.129)		(0.068)
High - low book/market factor	0.871	1.041	0.993	1.199	1.026	1.030
	(0.142)	(0.174)	(0.156)	(0.153)		(0.079)

Average of all other industries intercept betas[1]						
Market risk factor	0.909	0.909	0.894	1.109	0.955	0.962
Small - big capitalization factor	1.739	1.798	1.590	1.211	1.585	1.586
High - low book/market factor	0.346	0.282	0.308	0.685	0.406	0.417
Estimated coefficients for adjustments for firm size and book-to-market						
Log(Market Capitalization) β_{f2s}	−0.160	−0.164	−0.131	−0.113	−0.142	−0.144
	(0.009)	(0.008)	(0.007)	(0.006)		(0.004)
Log(Book-to-Market) β_{f2h}	0.224	0.119	0.172	0.274	0.197	0.213
	(0.020)	(0.017)	(0.015)	(0.013)		(0.008)
Panel B: Market Value Weighted Estimates						
Property-liabilty insurance intercept betas						
Market risk factor	1.003	1.096	1.140	1.356	1.149	1.099
	(0.057)	(0.055)	(0.071)	(0.082)		(0.032)
Small - big capitalization factor	1.711	2.058	1.755	1.514	1.759	1.669
	(0.098)	(0.088)	(0.080)	(0.103)		(0.047)
High - low book/market factor	0.447	1.004	1.124	1.256	0.958	0.882
	(0.083)	(0.101)	(0.101)	(0.125)		(0.052)
Average of all other industries intercept betas[1]						
Market risk factor β_{fm}	0.981	0.979	1.026	1.203	1.047	1.019
Small - big capitalization factor β_{f1s}	2.115	2.212	1.809	1.446	1.895	1.887
High - low book/market factor β_{f1h}	0.481	0.593	0.504	1.032	0.652	0.655
Estimated coefficients for adjustments for firm size and book-to-market						
Log(Market Capitalization) β_{f2s}	−0.215	−0.224	−0.180	−0.165	−0.196	−0.192
	(0.006)	(0.005)	(0.004)	(0.005)		(0.003)
Log(Book-to-Market) β_{f2h}	0.331	0.367	0.247	0.501	0.361	0.381
	(0.015)	(0.014)	(0.011)	(0.012)		(0.007)
Panel C: Industry Cost of Equity Capital Equally Weighted[2]						
Property-liability insurance	17.7%	19.4%	18.4%	20.7%	19.1%	19.1%
Life insurance	17.9%	17.9%	18.6%	19.5%	18.5%	18.6%

(continued)

TABLE 5
(Continued)

	1997	1998	1999	2000	Average	Panel Estimate
Health insurance	5.7%	12.6%	17.1%	21.9%	14.3%	13.7%
Finance excluding insurance	17.3%	16.7%	15.1%	15.9%	16.3%	16.4%
Average all nonfinancial industries	15.2%	15.4%	15.6%	18.6%	16.2%	16.4%
F-test: $r_{P\&L} = r_{Life}$	0.010	0.605	0.000	0.190		0.170
F-test: $r_{P\&L} = r_{Health}$	17.90***	4.38**	0.240	0.160		13.41***
F-test: $r_{P\&L} = r_{Finance\ (Excluding\ Insurance)}$	0.050	2.75*	5.66**	11.55***		13.58***
F-test: $r_{P\&L} = r_{Average\ All\ Nonfinancial\ Industries}$	3.19**	7.35***	4.93**	2.650		16.04***
Panel D: Industry Cost of Equity Capital Market Value Weighted[2]						
Property-liability insurance	15.1%	20.3%	20.8%	23.5%	19.9%	19.1%
Life insurance	23.5%	22.6%	16.1%	18.4%	20.2%	21.2%
Health insurance	10.8%	19.6%	21.6%	25.3%	19.3%	18.4%
Finance excluding insurance	23.1%	25.8%	22.5%	23.9%	23.8%	23.9%
Average all nonfinancial industries	15.5%	17.4%	17.1%	20.9%	17.7%	17.5%
F-test: $r_{P\&L} = r_{Life}$	28.03***	1.610	7.52***	5.95**		5.40**
F-test: $r_{P\&L} = r_{Health}$	8.33***	0.120	0.260	1.100		0.630
F-test: $r_{P\&L} = r_{Finance\ (Excluding\ Insurance)}$	85.80***	32.17***	3.66*	0.200		103.40***
F-test: $r_{P\&L} = r_{Average\ All\ Nonfinancial\ Industries}$	0.020	10.89***	16.52***	5.26**		12.04***

***,**,* significant at the 1, 5, or 10 percent level, respectively. Standard errors in parentheses.

[1]This section reports the average factor loadings for all industries other than property-liability insurance.

[2]Cost of capital estimates are determined using the average market capitalization and average book-to-market ratio for property-liability insurers for each data year.

The average property-liability insurer had a market capitalization of $1.9 billion and an average book-to-market ratio of 2.24 over the years 1997–2000.

of the BE/ME ratio from Equations (6) and (7), respectively, i.e., β_{f2s} and β_{f2h}. Standard errors are shown for the property-liability industry-participation betas and the slope coefficients. All coefficients are highly statistically significant. Although standard errors for other industries are not shown, nearly all of the industry-participation coefficients are also statistically significant.

Focusing on the panel estimates in Table 5, property-liability insurance has a higher market systematic risk beta, lower firm size beta, and a higher BE/ME beta than all other industries, based on both the equally weighted and value-weighted results. This provides further evidence that property-liability stock returns are much more sensitive to financial distress than stocks in general and that financial distress significantly increases the cost of capital for property-liability firms. As expected, the log of market capitalization has a negative coefficient in the equation for the size beta (Equation (6)), indicating an inverse relationship between firm size and the cost of capital. Likewise, the coefficient of the log of the BE/ME ratio has the expected positive sign in the equation for the BE/ME beta (Equation (7)), indicating a positive relationship between the cost of capital and the book-to-market equity ratio. These results apply to both the equally weighted and value-weighted regressions.

The full-information costs of capital based on the equally weighted and value-weighted regressions are shown in sections C and D of Table 5, respectively. In estimating the full-information costs of capital, it is necessary to specify values for market capitalization and the BE/ME ratio in Equations (6) and (7) to obtain the full-information betas for size and financial distress. In order to focus attention on the difference between beta coefficients rather than differences in market capitalization and book-to-market ratios, we used the average values of market capitalization (ME) and the book-to-market ratio (BE/ME) for property-liability insurers for all cost of capital estimates shown in Table 5. Thus, the results for other industries should be interpreted as the costs of capital for firms in those industries that have the same market capitalization and book-to-market ratios as the average property-liability insurer rather than the average cost of capital for firms in those industries.

Based on both the equally weighted and value-weighted estimates, the cost of equity capital for property-liability insurance is 19.1 percent. Because the FIB estimates focus only on the property-liability insurance industry component of insurer betas, the numbers differ from those in Table 3, which presents betas for the entire firm rather than specific business lines. However, the full-information costs of capital for property-liability insurance in Table 5 are consistent with the results shown in Table 3.

Based on the equally weighted results shown in Table 5, the average property-liability insurer has a significantly higher cost of capital than would a firm with the same market capitalization and BE/ME ratio specializing in health insurance, finance excluding insurance, and all other nonfinancial industries but is not significantly different from life insurance. Based on the value-weighted results, the average property-liability insurer has a significantly lower cost of capital than would a firm with the same market capitalization and BE/ME ratio specializing in life insurance and finance excluding insurance but significantly higher than for all other nonfinancial industries.

The most important implication of Tables 4 and 5 is that the FF3F costs of capital appear to be substantially larger than the CAPM costs of capital for property-liability insurers. The FIB FF3F cost of capital for property-liability firms is approximately 19.1 percent, whereas the CAPM cost of capital is about 12 percent. The FF3F model leads to higher cost of capital estimates for property-liability insurers than the CAPM for two primary reasons: (1) the FF3F systematic market risk betas in Table 5 are larger than the comparable CAPM betas in Table 4, and (2) the FF3F model imposes positive cost of capital premia for small size and financial distress which are not present under the CAPM. The risk-premium component of the CAPM cost of capital for property-liability insurers for the equally weighted case in Table 4 is 7.27 percent. For the equally weighted case in Table 5, the risk-premium from the CAPM beta factor is 9.23 percent, the risk-premium for the size factor is 0.51 percent, and the risk-premium for the BE/ME factor is 4.37 percent, for a total risk-premium of 14.16 percent, approximately twice as large as for the CAPM.[21] Clearly, controlling for factors other than systematic market risk makes a significant difference, with the financial distress premium playing a pivotal role. This suggests that property-liability insurers relying on the CAPM may be significantly underestimating the cost of capital and making suboptimal decisions.

Costs of Capital by Line

In this section, we illustrate the use of the FIB method to estimate the cost of capital by line of property-liability insurance. The results are based on regressions where we replace the Compustat industry-participation variable for property-liability insurers with two or more variables representing line of business distribution within the property-liability insurance industry. For example, if an insurer has its business equally distributed among three lines of insurance and has 75 percent of its total revenues from property-liability insurance, we would replace the 75 percent industry-participation ratio with three line of business participation ratios, each equal to 25 percent. As mentioned above, the line of business data are from the NAIC regulatory annual statement files.[22]

[21] Because the risk-premium for systematic market risk is the same in Tables 4 and 5, the difference for the CAPM risk factor is driven entirely by the difference in the CAPM beta estimates in the two tables. The risk-premia for size and the BE/ME ratio are based on the average market capitalization and BE/ME ratios for the property-liability insurance firms in the sample.

[22] We calculate the property-liability insurance line-of-business participation weights by multiplying the percentage of the firm's statutory premiums in a particular line of insurance by the firm's overall proportion of net sales in the property-liability insurance industry calculated using the consolidated GAAP revenue data reported in Compustat. An alternative way to calculate the property-liability line-of-business participation weights would have been to divide the firm's total statutory premiums in the particular line of insurance by the total net sales for the firm as reported on Compustat. We do not use this latter method owing to the differences that exist between GAAP and Statutory accounting rules and because the NAIC data files only contain information on the insurer's domestic U.S. business while the GAAP consolidated data contain net sales of the insurer's domestic and foreign subsidiaries. Our preferred method makes the assumption that the insurer's foreign property-liability insurance business is divided among the various property-liability lines of insurance in proportions similar to its domestic business.

The first by-line cost of capital results, for the personal and commercial lines of property-liability insurance,[23] are presented in Table 6, which shows full-information CAPM sum-beta costs of capital. The panel regression equally weighted results show a cost of capital of 12.8 percent for the personal lines and 11.8 percent for the commercial lines, whereas the ordering is reversed in the value-weighted estimates (10.7 percent for personal lines and 12.6 percent for commercial lines). The difference is statistically significant for the value-weighted but not for the equally weighted results. Thus, for the average insurer, the cost of capital is slightly higher for personal lines, but for the market as a whole the cost of capital is higher for commercial lines. This may indicate that the types of commercial business written by larger insurers (e.g., national and multinational accounts) are more risky than those written by smaller insurers, which tend to focus on local or regional risks. In addition, it may reflect the superior ability of larger insurers to cover catastrophic personal line property risks because of their better capitalization.

The full-information betas and costs of capital for personal versus commercial lines based on the Fama–French methodology are shown in Table 7. The table shows the industry-participation beta coefficients for the three risk factors as well as the slope coefficients for the log of market capitalization and the log of the BE/ME ratio in the size and financial distress factor regressions. To conserve space, only the value-weighted coefficient estimates are shown in the table.

As with the CAPM results, the equally weighted cost of capital estimates in Table 7 imply that the cost of capital for the average insurer is slightly larger for personal lines than for commercial lines, 21.7 percent versus 18.2 percent based on the panel regression. However, the value-weighted results show the opposite relationship, costs of capital of 17.6 percent versus 20.5 percent based on the panel regression. These results thus provide additional evidence to suggest that the commercial lines have a higher cost of capital than the personal lines for the market as a whole but not for insurers on average.

The second set of cost of capital decompositions subdivides property-liability insurance into automobile insurance, workers' compensation, and all other property-liability lines combined.[24] This decomposition was chosen to focus on the two most heavily price-regulated lines—automobile and workers' compensation insurance.[25] The CAPM sum-beta results are reported in Table 8. Based on the equally weighted panel estimate results, the cost of capital for automobile insurance is slightly higher than for workers' compensation (12.6 percent versus 12.3 percent), although this

[23] Personal lines of insurance include homeowners, farmowners, earthquake, personal automobile liability, and automobile physical damage. All other lines of insurance are considered commercial lines.

[24] We also estimated costs of capital for short-tail and long-tail lines of insurance as part of our research on this article. The results are available from the authors.

[25] Automobile insurance includes personal and commercial automobile liability insurance and automobile physical damage. Further decomposition of the automobile insurance line of business showed that personal automobile liability (the most heavily regulated automobile insurance line) had higher costs of capital than automobile insurance in the aggregate (results available from the authors). Data to decompose automobile physical damage into personal and commercial components are not available in our data source.

TABLE 6
Full Information CAPM Beta Estimates With Sum Beta Adjustment: Personal Lines vs. Commercial Lines

Table displays full information CAPM beta estimates for personal lines and commercial lines property-liability insurance controlling for nonsynchronous trading. Personal lines include all net premiums written in homeowners, farmowners, earthquake, personal automobile liability, and automobile physical damage. All others lines were considered commercial lines. The full-information beta comes from the following cross-sectional regression:

$$\beta_{mi} = \sum \beta_{fmj}(\omega_{ij}) + \upsilon_{mi}$$

where β_{mi} is the equity beta estimated using Equation (3) for firm i, β_{fmj} is the estimated full-information beta for industry j, ω_{ij} is the percent of firm i's net sales in industry j. The regression is estimated by OLS (equally weighted) and via weighted least squares (market weighted). The latter is used so we can obtain market-capitalization weighted industry full-information betas. The weight is equal to the market capitalization of firm i relative to the market capitalization of all NYSE, AMEX, and Nasdaq stocks. Any firm with an estimated beta greater than 5 or less than −5 is removed from the sample. The full-information regression was estimated separately for each calendar year and as a pooled regression across all four years. The risk-free rate of interest used to estimate the cost of equity capital was the average 30 day T-bill rate over the time period for this study 1997–2000, 4.93 percent. The long-run historical market risk premium as of December 2000 was 8.44 percent (Ibottson, 2002).

	1997	1998	1999	2000	Average	Panel Estimate
Beta (equally weighted)						
Personal lines	1.114	1.007	0.779	0.734	0.908	0.929
	(0.263)	(0.276)	(0.256)	(0.258)		(0.132)
Commercial lines	0.839	0.853	0.778	0.778	0.812	0.813
	(0.156)	(0.154)	(0.140)	(0.149)		(0.075)
F-test: $\beta_{fm\text{Personal}} = \beta_{fm\text{Commercial}}$	0.630	0.180	0.000	0.020		0.450
Beta (market value weighted)						
Personal lines	0.749	0.736	0.446	0.725	0.664	0.686
	(0.103)	(0.091)	(0.137)	(0.187)		(0.061)
Commercial lines	0.876	0.875	0.955	1.132	0.959	0.914
	(0.085)	(0.079)	(0.106)	(0.139)		(0.049)
F-test: $\beta_{fm\text{Personal}} = \beta_{fm\text{Commercial}}$	0.690	1.040	6.50***	2.200		6.58**
Cost of equity capital (equally weighted)						
Personal lines	14.3%	13.4%	11.5%	11.1%	12.6%	12.8%
Commercial lines	12.0%	12.1%	11.5%	11.5%	11.8%	11.8%
Cost of equity capital (market value weighted)						
Personal lines	11.3%	11.1%	8.7%	11.0%	10.5%	10.7%
Commercial lines	12.3%	12.3%	13.0%	14.5%	13.0%	12.6%

***, **, *significant at the 1, 5, or 10 percent level, respectively. Standard errors in parentheses.

difference is not statistically significant. Based on the value-weighted results, the cost of capital for automobile insurance is less than for workers' compensation insurance—10.3 percent versus 12.4 percent, although again the difference is not statistically significant. The cost of capital for all other property-liability (P&L) lines of business is not

TABLE 7

Full Information Fama–French 3-Factor Estimates With Sum Beta Adjustment: Personal Lines vs. Commercial Lines

Table displays full information coefficient estimates for the Fama–French 3-Factor model for personal lines and commercial lines property-liability insurance. Personal lines include all net premiums written in homeowners, farmowners, earthquake, personal auto liability, and automobile physical damage. All other lines of business were considered commercial lines. The full-information betas come from the following cross-sectional system of regressions:

$$\beta_{mi} = \sum \beta_{fmj}(\omega_{ij}) + \upsilon_{mi}$$

$$\beta_{si} = \sum \beta_{f1sj}(\omega_{ij}) + \beta_{f2s}\ln(\mathrm{ME}_i) + \upsilon_{si}$$

$$\beta_{hi} = \sum \beta_{f1hj}(\omega_{ij}) + \beta_{f2h}\ln(\mathrm{BE}_i/\mathrm{ME}_i) + \upsilon_{hi}$$

where β_{mi}, β_{si}, and β_{hi} are the excess market, firm size, and BE/ME betas, respectively, estimated using Equation (6) for firm *i*. β_{mj}, β_{f1sj}, and β_{f1hj} are the estimated full-information excess market, firm size and BE/ME coefficients for industry *j*, respectively. β_{f2s} and β_{f2h} are the size and BE/ME slope adjustments, respectively. ω_{ij} is the proportion of firm *i*'s net sales in industry *j*. The regression is estimated by SUR (equally weighted) and weighted SUR (market weighted). The latter is used so we can obtain market-capitalization weighted industry full-information betas. The weight equals the market capitalization of firm *i* relative to the market-capitalization of all NYSE, AMEX, and Nasdaq stocks. Stocks with estimated factor coefficients greater than 5 or less than −5 is removed from the sample. The full-information regression was estimated each calendar year and as a pooled regression across all four years. The risk-free rate of interest used to estimate the cost of equity capital was the average 30 day T-bill rate of the time period for this study 1997–2000, 4.93 percent. The long-run historical premia for the excess market return, the size factor, and the BE/ME factor as of December 2000 were 8.44 percent, 2.35 percent, and 3.85 percent, respectively.

	1997	1998	1999	2000	Average	Panel Estimate
Market value weighted estimates						
Market systematic risk factor						
Personal lines	0.890	1.035	0.979	1.260	1.041	0.995
	(0.106)	(0.098)	(0.143)	(0.178)		(0.061)
Commercial lines	1.086	1.145	1.249	1.419	1.225	1.175
	(0.087)	(0.084)	(0.110)	(0.133)		(0.050)
SMB factor						
Personal lines	1.532	1.918	1.750	1.531	1.683	1.535
	(0.154)	(0.138)	(0.143)	(0.204)		(0.078)
Commercial lines	1.845	2.166	1.757	1.501	1.817	1.765
	(0.132)	(0.120)	(0.113)	(0.155)		(0.065)
Log(Market	−0.215	−0.224	−0.180	−0.165	−0.196	−0.192
Capitalization) β_{f2s}	(0.006)	(0.005)	(0.004)	(0.005)		(0.003)
HML factor						
personal lines	0.226	0.871	1.334	1.237	0.917	0.754
	(0.154)	(0.180)	(0.202)	(0.272)		(0.099)

(continued)

TABLE 7
(Continued)

	1997	1998	1999	2000	Average	Panel Estimate
Commercial lines	0.611	1.108	0.981	1.268	0.992	0.975
	(0.127)	(0.155)	(0.156)	(0.203)		(0.081)
Log(Book-to-Market) β_{f2h}	0.331	0.367	0.247	0.501	0.361	0.381
	(0.015)	(0.014)	(0.011)	(0.012)		(0.007)
F-test: $\beta_{fm\text{Personal}} = \beta_{fm\text{Commercial}}$	1.58	0.58	1.70	0.37		3.99**
F-test: $\beta_{f1s\text{Personal}} = \beta_{f1s\text{Commercial}}$	2.29	1.77	0.00	0.01		4.60**
F-test: $\beta_{f1h\text{Personal}} = \beta_{f1h\text{Commercial}}$	2.89*	0.80	1.44	0.01		2.30
Cost of equity capital (equally weighted)[1]						
Personal lines	20.8%	21.0%	21.0%	23.3%	21.7%	21.7%
Commercial lines	16.3%	18.8%	17.4%	19.5%	18.1%	18.2%
F-test: $r_{\text{Personal}} = r_{\text{Commercial}}$	1.31	0.21	0.78	0.89		2.86*
Cost of equity capital (market value weighted)[1]						
Personal lines	12.9%	19.0%	20.2%	22.6%	18.8%	17.6%
Commercial lines	16.8%	21.4%	21.2%	24.0%	21.0%	20.5%
F-test: $r_{\text{Personal}} = r_{\text{Commercial}}$	4.06**	1.27	0.16	0.22		6.41***

***, **, *significant at the 1, 5, or 10 percent level, respectively. Standard errors in parentheses.
[1]Cost of capital estimates are determined using the average market capitalization and average book-to-market ratio for property-liability insurers for each data year. The average property-liability insurer had a market capitalization of $1.9 billion and an average book-to-market ratio of 2.24 over the years 1997–2000.

statistically different from the costs of capital of automobile and workers' compensation insurance based on the equally weighted results, but automobile insurance has a significantly lower cost of capital than all other lines based on the value-weighted results. Thus, the CAPM costs of capital are about the same for automobile and workers' compensation insurance but the value-weighted (market-wide) cost of capital for automobile insurance is significantly lower than for all other lines combined.

Another important inference from Table 8 is that the market-wide (value-weighted) cost of capital for automobile insurance is significantly lower than the cost of capital for the average insurer for this line. This result illustrates one of the hazards of insurance price regulation, which tends to be based on industry-wide costs of capital rather than costs of capital by firm. As Table 8 indicates, basing prices on industry-wide results could lead to significant pricing errors for many firms in the industry.

The FF3F full-information beta and cost of capital estimates for automobile insurance, workers' compensation, and all other lines are presented in Table 9. As in Table 7, only the value-weighted beta estimates are shown in order to conserve space. However, both equally weighted and value-weighted costs of capital are shown in the table. The results in Table 9 show that the FF3F method again leads to cost of capital estimates that are significantly higher than the CAPM cost of capital estimates (Table 8). For example, the equally-weighted panel estimate costs of capital are 20.7 percent for automobile

TABLE 8
Full Information CAPM Beta Estimates: Auto vs. Workers' Compenstion vs. All Other Property-Liability Lines of Insurance

Table displays full information CAPM beta estimates by-line of property-liability insurance. Automobile insurance includes personal automobile liability, commercial automobile liability, and automobile physical damage insurance.The full-information beta comes from the following cross-sectional regression

$$\beta_{mi} = \sum \beta_{fmj}(\omega_{ij}) + \upsilon_{mi}$$

where β_{mi} is the equity beta estimated using Equation (3) for firm i, β_{fmj} is the estimated full-information beta for industry j, ω_{ij} is the proportion of firm i's net sales in industry j. The regression is estimated by OLS (equally weighted) and weighted least squares (market weighted). The latter is used so we can obtain market-capitalization weighted industry full-information betas. The weight is equal to the market capitalization of firm i relative to the market capitalization of all NYSE, AMEX, and Nasdaq stocks. Any firm with an estimated beta greater than 5 or less than −5 is removed from the sample. The full-information regression was estimated separately for each calendar year and as a pooled regression across all 4 years. The risk-free rate of interest used to estimate the cost of equity capital was the average 30 day T-bill rate over the time period for this study 1997–2000, 4.93 percent. The long-run historical market risk premium as of December 2000 was 8.44 percent (Ibottson, 2002).

	1997	1998	1999	2000	Average	Panel Estimate
Beta (equally weighted)						
Automobile insurance	1.119	1.180	0.568	0.817	0.921	0.906
	(0.250)	(0.263)	(0.249)	(0.250)		(0.127)
Workers' compensation	0.543	0.826	1.095	0.986	0.862	0.872
	(0.596)	(0.585)	(0.444)	(0.499)		(0.265)
All other P&L lines of insurance	0.863	0.840	0.815	0.713	0.808	0.808
	(0.180)	(0.175)	(0.162)	(0.171)		(0.086)
F-test: $\beta_{fm\text{Auto}} = \beta_{fm\text{Workers' comp}} = \beta_{fm\text{All Other P\&L lines}}$	0.470	0.130	0.530	0.140		0.17
Beta (market value weighted)						
Automobile insurance	0.655	0.691	0.441	0.731	0.630	0.636
	(0.114)	(0.098)	(0.153)	(0.204)		(0.066)

(continued)

TABLE 8
(Continued)

	1997	1998	1999	2000	Average	Panel Estimate
Workers' compensation	0.716	0.865	0.860	0.953	0.849	0.882
	(0.497)	(0.454)	(0.546)	(0.883)		(0.282)
All other P&L lines of insurance	0.962	0.909	0.954	1.139	0.991	0.9486
	(0.104)	(0.091)	(0.127)	(0.174)		(0.059)
F-test: $\beta_{fm\text{Auto}} = \beta_{fm\text{Worker's comp}} = \beta_{fm\text{All Other P\&L lines}}$	1.520	1.090	2.54*	0.850		4.97***
Cost of equity capital (equally weighted)						
Automobile insurance	14.4%	14.9%	9.7%	11.8%	12.7%	12.6%
Workers' compensation	9.5%	11.9%	14.2%	13.2%	12.2%	12.3%
All other P&L lines of insurance	12.2%	12.0%	11.8%	10.9%	11.7%	11.7%
F-test: $r_{\text{Auto}} = r_{\text{Worker's Comp}}$	0.710	0.080	0.960	0.080		0.010
F-test: $r_{\text{Auto}} = r_{\text{All Other P\&L lines}}$	0.550	0.250	0.540	0.090		0.320
F-test: $r_{\text{Workers' Comp}} = r_{\text{All other P\&L lines}}$	0.240	0.000	0.330	0.250		0.050
Cost of equity capital (market value weighted)						
Automobile insurance	10.5%	10.8%	8.7%	11.1%	10.2%	10.3%
Workers' compensation	11.0%	12.2%	12.2%	13.0%	12.1%	12.4%
All other P&L lines of insurance	13.0%	12.6%	13.0%	14.5%	13.3%	12.9%
F-test: $r_{\text{Auto}} = r_{\text{Workers' Comp}}$	0.010	0.140	0.530	0.060		0.700
F-test: $r_{\text{Auto}} = r_{\text{All Other P\&L lines}}$	3.03*	2.080	4.87**	1.620		9.45***
F-test: $r_{\text{Workers' Comp}} = r_{\text{All Other P\&L lines}}$	0.200	0.010	0.020	0.040		0.050

***,**,* significant at the 1, 5, or 10 percent level, respectively. Standard errors in parentheses.

TABLE 9
Full Information Fama–French 3-Factor Estimates With Sum Beta Adjustment: Auto vs. Workers' Compensation

Table displays full information beta estimates for the Fama–French 3-Factor Model by-line of property-liability insurance. Automobile insurance includes personal automobile liability, commercial automobile liability, and automobile physical damage. The full-information betas come from the following cross-sectional system of regressions:

$$\beta_{mi} = \sum \beta_{fmj}(\omega_{ij}) + \upsilon_{mi}$$

$$\beta_{si} = \sum \beta_{f1sj}(\omega_{ij}) + \beta_{f2s}\ln(\mathrm{ME}_i) + \upsilon_{si}$$

$$\beta_{hi} = \sum \beta_{f1hj}(\omega_{ij}) + \beta_{f2h}\ln(\mathrm{BE}_i/\mathrm{ME}_i) + \upsilon_{hi}$$

where β_{mi}, β_{si}, and β_{hi} are the excess market, firm size, and BE/ME betas, respectively, for firm i. β_{mj}, β_{f1sj}, and β_{f1h} are the estimated full-information excess market, firm size and BE/ME coefficients for industry j, respectively. β_{f2s} and β_{f2h} are the size and BE/ME slope adjustments, respectively. ω_{ij} is the percent of firm i's net sales in industry j. The regression is estimated by SUR (equally weighted) and weighted SUR (market weighted). The latter is used so we can obtain market-capitalization weighted industry full-information betas. The weight equals the market capitalization of firm i relative to the market-capitalization of all NYSE, AMEX, and Nasdaq stocks. Stocks with estimated betas greater than 5 or less than −5 were removed from the sample. The full-information regression was estimated each calendar year and as a pooled regression across all four years. The risk-free rate of interest used to estimate the cost of equity capital was the average 30 day T-bill rate over the time period for this study 1997–2000, 4.93 percent. The long-run historical premia for the excess market return, the size factor, and the BE/ME factor as of December 2000 were 8.44 percent, 2.35 percent, and 3.85 percent, respectively.

	1997	1998	1999	2000	Average	Panel Estimate
Market value weighted results						
Beta factor						
Automobile insurance	0.799	1.021	1.021	1.282	1.031	0.965
	(0.117)	(0.105)	(0.159)	(0.195)		(0.067)
Workers' compensation	0.900	0.906	0.803	0.568	0.794	0.871
	(0.511)	(0.486)	(0.567)	(0.842)		(0.286)

(continued)

TABLE 9
(Continued)

	1997	1998	1999	2000	Average	Panel Estimate
All other P&L lines of insurance	1.171	1.176	1.262	1.487	1.274	1.226
	(0.106)	(0.097)	(0.132)	(0.166)		(0.059)
Small - big capitalization factor						
Automobile insurance	1.608	1.926	1.688	1.522	1.686	1.549
	(0.166)	(0.146)	(0.158)	(0.222)		(0.084)
Workers' compensation	0.754	2.133	2.076	2.058	1.755	1.543
	(0.680)	(0.627)	(0.541)	(0.933)		(0.341)
All other P&L lines of insurance	1.909	2.155	1.763	1.452	1.820	1.772
	(0.156)	(0.136)	(0.132)	(0.190)		(0.076)
Log(Market Capitalization) β_{f2s}	−0.215	−0.224	−0.180	−0.165		−0.192
	(0.006)	(0.005)	(0.004)	(0.005)		(0.003)
High - low book/market factor						
Automobile insurance	0.299	0.965	1.344	1.198	0.952	0.800
	(0.169)	(0.193)	(0.225)	(0.298)		(0.108)
Workers' compensation	0.074	0.887	0.420	0.461	0.461	0.361
	(0.742)	(0.892)	(0.804)	(1.288)		(0.463)
All other P&L lines of insurance	0.603	1.045	1.047	1.378	1.019	1.000
	(0.155)	(0.179)	(0.187)	(0.254)		(0.096)
Log(Market Capitalization) β_{f2s}	0.331	0.367	0.247	0.501		0.381
	(0.015)	(0.014)	(0.011)	(0.012)		(0.007)

F-test: $\beta_{fm\text{Auto}} = \beta_{fm\text{Workers' Comp}} = \beta_{fm\text{All Other P\&L lines}}$	2.15	0.50	0.61	0.56		3.30**
F-test: $\beta_{f1s\text{Auto}} = \beta_{f1s\text{Workers' Comp}} = \beta_{f1s\text{All Other P\&L lines}}$	1.55	0.64	0.26	0.18		1.67
F-test: $\beta_{f1h\text{Auto}} = \beta_{f1h\text{Workers' Comp}} = \beta_{f1h\text{All Other P\&L lines}}$	0.72	0.04	0.87	0.23		1.19
Cost of equity capital (equally weighted)[1]						
Automobile insurance	20.8%	20.7%	17.5%	22.5%	20.4%	20.7%
Workers' compensation	18.2%	18.4%	17.2%	17.9%	17.9%	18.0%
All other P&L lines of insurance	15.7%	18.9%	19.1%	20.2%	18.5%	18.6%
F-test: $r_{\text{Auto}} = r_{\text{Workers' Comp}}$	0.74	0.79	0.00	0.42		0.50
F-test: $r_{\text{Auto}} = r_{\text{All Other P-L Lines}}$	1.65	0.14	0.16	0.28		0.96
F-test: $r_{\text{Workers' Comp}} = r_{\text{All Other P-L Lines}}$	0.12	0.00	0.11	0.13		0.03
Cost of equity capital (market value weighted)[1]						
Automobile insurance	12.6%	19.2%	20.5%	22.6%	18.7%	17.5%
Workers' compensation	10.5%	18.5%	16.0%	15.0%	15.0%	15.0%
All other P&L lines of insurance	17.6%	21.4%	21.6%	24.9%	21.4%	21.0%
F-test: $r_{\text{Auto}} = r_{\text{Workers' Comp}}$	0.09	0.01	0.43	0.59		0.43
F-test: $r_{\text{Auto}} = r_{\text{All Other P-L Lines}}$	5.12**	0.81	0.15	0.42		7.11***
F-test: $r_{\text{Workers' Comp}} = r_{\text{All Other P-L Lines}}$	1.04	0.14	0.61	0.88		2.28

***, **, *significant at the 1, 5, or 10 percent level, respectively. Standard errors in parentheses.

[1]Cost of capital estimates are determined using the average market capitalization and average book-to-market ratio for property-liability insurers for each data year. The average property-liability insurer had a market capitalization of $1.9 billion and an average book-to-market ratio of 2.24 over the years 1997–2000.

insurance, 18.0 percent for workers' compensation, and 18.6 percent for all other lines, compared to 12.6 percent for auto, 12.3 percent for workers' compensation, and 11.7 percent for all other lines based on the CAPM. The value-weighted FF3F estimates are also higher than those for the CAPM.

The results in Table 9 also suggest that failure to recognize sources of risk other than the CAPM market systematic risk factor could lead to significant underpricing in regulated lines. The results reinforce the conclusion based on Table 8 that the industry-wide cost of capital is significantly lower than the average-firm cost of capital for automobile insurance; and in Table 9 this relationship also holds for workers' compensation. Thus, basing regulated prices on industry-wide costs of capital is likely to be value-destroying for the average firm in the industry.

CONCLUSIONS

This article investigates the estimation of the cost of equity capital for property-liability insurers using a relatively new methodology, the FIB approach. The method is designed to obtain the cost of capital for a division or line of business of a firm, where the divisions of the firm are not publicly traded. Estimating the cost of capital by line is important because costs of capital are known to vary significantly for different types of economic activities. Using an incorrect cost of capital can lead to the destruction of firm value through incorrect project decision making and pricing decisions.

The FIB procedure estimates the divisional cost of capital by obtaining the beta coefficients for a sample of firms and then regressing the betas cross-sectionally against variables measuring each firm's business composition across industries. The business composition variables used in this study are the ratios of the revenues coming from each industry divided by total revenues from all industries. The estimated regression coefficients are interpreted as full-information betas.

Beta coefficients are estimated using two principal cost of capital models in order to implement the full-information beta approach—CAPM and the FF3F model. The CAPM includes a single risk factor representing the firm's exposure to systematic market risk. The FF3F model adds risk factors for firm size (total market capitalization) and the financial distress of the firm, proxied by the ratio of the book value (BE) of equity to the market value (ME) of equity. Based on prior empirical research, firm size is expected to be inversely related to the cost of capital, and the BE/ME ratio is expected to be positively related to the cost of capital. In estimating the beta coefficients for the CAPM and the FF3F method, we utilize the sum-beta procedure to adjust for infrequent trading—this is especially important in property-liability insurance, where many stocks are characterized by infrequent trading.

To estimate the full-information betas for the property-liability insurance industry, we utilize a sample consisting of all Compustat firms for the estimation period from 1997 through 2000. The sample includes 172 publicly traded firms writing property-liability insurance. Industry-participation variables are included for all two-digit industries defined by the NAICS. The coefficient of the industry-participation ratio for a particular industry is then interpreted as the full-information beta coefficient for that industry. For the CAPM, only one FIB regression is conducted, with the market systemic risk factor (beta) as the dependent variable. For the FF3F method, three FIB regressions are estimated, one for each of the three factors in the Fama–French model. The beta regressions for the Fama–French size and BE/ME risk factors also include the log of each firm's market capitalization and the log of the BE/ME ratio, respectively, as regressors to control for the negative (positive) relationship between the size (BE/ME) beta and market capitalization (BE/ME ratio), respectively, and the betas for size and financial distress.

In the first set of full-information beta regressions considered in the article, we estimate the full-information betas for the entire property-liability insurance industry using only Compustat data to obtain the industry-participation ratios. In the second set of regressions, we utilize data from the NAIC to break down the revenues of property-liability insurers by line of insurance. We estimate full-information betas for two insurance-line groupings—(1) personal versus commercial lines, and (2) automobile insurance versus workers' compensation versus all other lines.

The primary conclusions of the article are the following:

1. It is important to use the sum-beta technique to control for infrequent trading when estimating betas for the property-liability insurance industry under both the CAPM and FF3F methods. Failure to adjust for this problem is likely to lead to underestimation of the cost of capital.
2. The cost of capital estimates from the FF3F method are significantly higher than the estimates based on the CAPM. Hence, failure to adjust for firm size and financial distress could lead to significant underestimation of the cost of capital.
3. The cost of capital varies significantly by line of insurance and also varies between large and small insurers. Thus, it is important to consider firm and line-specific costs of capital in applications such as project selection and pricing.
4. Value-weighted estimates of the cost of capital often differ significantly from equally weighted estimates. Thus, basing price regulation on industry-wide results rather than costs of capital by firm may lead to significant pricing errors for many firms in the industry.

In general, the full-information beta approach provides a reliable method for estimating costs of capital by line for property-liability insurers. The method is likely to obtain the most reliable results if it is used with the sum-beta adjustment and the FF3F method.

Full-information betas can be used by insurers in a variety of contexts, including the estimation of RAROC, insurance pricing, and decision making about entering or exiting lines of business. Full-information costs of capital also could be used to evaluate potential merger, acquisition, and divestiture transactions. Another important advantage is that the full-information model can be used to estimate the cost of capital for insurers that do not have traded equity, including mutuals, reciprocals, and untraded stock insurers. The findings also will be useful to researchers seeking to identify the determinants of cross-sectional pricing differences across insurers.

Finally, it is also important to note that cost of capital estimates vary over time for a variety of reasons. For example, changes in interest rates as well as changes in economic conditions may affect estimated beta coefficients. Variability also arises because property-liability insurers are impacted by a variety of economic and regulatory factors affecting both underwriting and investment results that can change the relationship between their stock returns and the market return factors in the CAPM and FF3F models. Estimates that are unusually high or low by historical standards also can occur due to random variation inherent in the estimation of any regression model. Accordingly, judgment will be needed in practical applications of the methodology proposed in this article. For example, it is recommended that the cost of capital be estimated for several years prior to the period in which the estimates will be used and that averages of the cost of capital over some reasonable period be employed in order to smooth somewhat the fluctuations in beta estimates over time. Thus, capital budgeting decisions based upon a sound theoretical framework coupled with the expert discretion should lead to better pricing and project selection decisions.

REFERENCES

Barber, B. M., and J. D. Lyon, 1997, Firm Size, Book-to-Market Ratio and Security Returns: A Holdout Sample of Financial Firms, *Journal of Finance*, 52(2): 875-883.

Brealey, R. A., and S. C. Myers, 2002, *Principles of Corporate Finance*, 7th edition (Boston: McGraw-Hill/Irwin).

Campbell, J. Y., A. W. Lo, and A. C. MacKinlay, 1997, *The Econometrics of Financial Markets* (Princeton, NJ: Princeton University Press).

Cochrane, J. H., 1999, New Facts in Finance, *Economic Perspectives*, 23(3): 36-58.

Cox, L. A., and G. L. Griepentrog, 1988, The Pure-Play Cost of Equity for Insurance Divisions, *Journal of Risk and Insurance*, 55: 442-452.

Cummins, J. D., 1990, Multi-Period Discounted Cash Flow Ratemaking Models in Property-Liability Insurance, *Journal of Risk and Insurance*, 57: 79-109.

Cummins, J. D., and S. E. Harrington, 1985, Property-Liability Insurance Rate Regulation: Estimation of Underwriting Betas Using Quarterly Profit Data, *Journal of Risk and Insurance*, 52: 16-43.

Cummins, J. D., and S. E. Harrington, eds., 1987, *Fair Rate of Return in Property-Liability Insurance* (Hingham, MA: Kluwer Academic Publishers).

Cummins, J. D., and J. Lamm-Tennant, 1994, Capital Structure and the Cost of Equity Capital in Property-Liability Insurance, *Insurance: Mathematics and Economics*, 15: 187-201.

Cummins, J. D., and C. M. Lewis, 2003, Catastrophic Events, Parameter Uncertainty, and the Breakdown of Implicit Long-Term Contracting: The Case of Terrorism Insurance, *Journal of Risk and Uncertainty*, 26: 153-178.

Cummins, J. D., and R. D. Phillips, 2000, Financial Pricing of Property-Liability Insurance, in: G. Dionne, ed., *Handbook of Insurance Economics* (Boston, MA: Kluwer Academic Publishers).

Derrig, R. A., and E. Orr, 2004, Equity Risk Premium: Expectations Great and Small, *North American Actuarial Journal* 8: 45-69.

Dickinson, G., 2003, The Search for an International Accounting Standard for Insurance: Report to the Accountancy Task Force of the Geneva Association, *Geneva Papers on Risk & Insurance: Issues & Practices*, 28(2): 151-175.

Dimson, E., 1979, Risk Measurement When Shares Are Subject to Infrequent Trading, *Journal of Financial Economics*, 7: 197-226.

Ehrhardt, M. C., and Y. N. Bhagwat, 1991, A Full-Information Approach for Estimating Divisional Betas, *Financial Management*, 20: 60-69.

Fama, E. F., and K. R. French, 1992, The Cross-Section of Expected Stock Returns, *Journal of Finance*, 47: 427-465.

Fama, E. F., and K. R. French, 1993, Common Risk Factors in the Returns on Stocks and Bonds, *Journal of Financial Economics*, 39: 3-56.

Fama, E. F., and K. R. French, 1995, Size and Book-to-Market Factors in Earnings and Returns, *Journal of Finance*, 50: 131-155.

Fama, E. F., and K. R. French, 1996, Multifactor Explanations of Asset Pricing Anomalies, *Journal of Finance*, 51: 55-84.

Fama, E. F., and K. R. French, 1997, Industry Costs of Equity, *Journal of Financial Economics*, 43: 153-193.

Froot, K. A., 2003, Risk Management, Capital Budgeting and Capital Structure Policy for Insurers and Reinsurers, Harvard Working Paper (Boston, MA).

Froot, K. A., and J. C. Stein, 1998, Risk Management, Capital Budgeting, and Capital Structure Policy for Financial Institutions: An Integrated Approach, *Journal of Financial Economics*, 47: 55-82.

Fuller, R. J., and H. S. Kerr, 1981, Estimating the Divisional Cost of Capital: An Analysis of the Pure-Play Technique, *Journal of Finance*, 36: 997-1009.

Girard, L. N., 2002, An Approach to Fair Valuation of Insurance Liabilities Using the Firm's Cost of Capital, *North American Actuarial Journal*, 6: 18-41.

Graham, J. R., and C. R. Harvey, 2001, The Theory and Practice of Corporate Finance: Evidence From the Field, *Journal of Financial Economics*, 60: 187-243.

Ibbotson Associates, 2002, *Stocks, Bonds, Bills, and Inflation: Valuation Edition (2002 Yearbook)*, Chicago.

Kaplan, P. D., and J. D. Peterson, 1998, Full-Information Industry Betas, *Financial Management*, 27: 85-93.

Lee, A. C., and J. D. Cummins, 1998, Alternative Models for Estimating the Cost of Equity Capital for Property/Casualty Insurers, *Review of Quantitative Finance and Accounting*, 10: 235-267.

Myers, S. C., and J. A. Read, Jr., 2001, Capital Allocation for Insurance Companies, *Journal of Risk & Insurance*, 68: 545-580.

Panjer, H. H., 1998, *Financial Economics With Applications to Investments, Insurance, and Pensions* (Schaumburg, IL: The Actuarial Foundation).

Phillips, R. D., J. D. Cummins, and F. Allen, 1998, Financial Pricing of Insurance in the Multiple Line Insurance Company, *Journal of Risk and Insurance*, 65: 597-636.

Ross, S. A., 1976, The Arbitrage Theory of Capital Asset Pricing, *Journal of Economic Theory*, 13(2): 383-402.

Scholes, M., and J. Williams, 1977, Estimating Beta From Nonsynchronous Data, *Journal of Financial Economics*, 5(3): 309-327.

Sommer, D., 1996, The Impact of Firm Risk on Property-Liability Insurance Prices, *Journal of Risk and Insurance*, 63: 501-514.

Taylor, G., 1994, Fair Premium Rating Methods and the Relations Between Them, *Journal of Risk & Insurance*, 61: 592-615.

Wang, K. Q., 2003, Asset Pricing With Conditioning Information: A New Test, *Journal of Finance*, 58: 161-196.

Wei, K. C. J., 1988, An Asset-Pricing Theory Unifying the CAPM and APT, *Journal of Finance*, 43: 881-892.