Book Versus Market Underwriting Betas

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Abstract

Previous researchers have estimated underwriting betas for application within the Capital Asset Pricing Model to determine the equilibrium rate of return to insurers. Both book and market returns have been used to estimate these risk measures, but previous studies have not been directly comparable and results have been inconsistent. This study provides the first direct, pairwise comparison of underwriting-specific betas derived from both book and market returns and considers the implications for researchers.

The underwriting-specific Capital Asset Pricing Model (CAPM) has been proposed to derive equilibrium rates of return to property-liability (P-L) insurers for purposes of both external regulation and internal capital budgeting (Fairley, 1979; Hill and Modigliani (HM), 1987; Venezian, 1983). The focal point of the empirical research is estimation of the single risk parameter, the underwriting beta. While these estimates often are extracted from market data, some researchers propose direct estimation using book returns (Biger and Kahane, 1978; Cummins and Harrington (CH), 1985). CH supply particularly counter-intuitive evidence that such book-derived underwriting betas are more sensitive to market factors than are market-derived estimators.

Researchers examining a book or market procedure have tended either to ignore the alternative estimation method or to compare their results with previous research using different samples and time periods. Consequently, two remaining research questions include whether the two methods produce different results over identical samples and whether either method is more sensitive to market factors over time. This study addresses these issues by supplying the first pairwise comparison of book and market underwriting betas over identical time periods. The previous literature and the rationale for this study are discussed in the next section.

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Previous Research

Consistent with contemporary financial theory, researchers exploring underwriting-specific pricing models generally assume that market prices best impound investors' views of future cash flows to insurers (Kahane, 1979). Estimation of underwriting-specific betas is particularly difficult, however, because insurer equities reflect returns on both underwriting operations and invested reserves. Fairley (1979) developed a procedure, later refined by HM, whereby a weighted proxy for an insurer's investment portfolio beta is deducted from the observable equity beta to produce a residual beta purported to be the underwriting beta. CH, however, noted inherent problems with sample size, accurate estimation of investment portfolio betas, and disaggregation by underwriting line.

An alternative, direct procedure was introduced by others, who initially regressed annual book returns to insurers on market index returns (Biger and Kahane (BK), 1978; Hill, 1979). Both BK and Hill found these betas do not differ significantly from zero, the latter suggesting that lag time between market adjustments and book profits creates a bias toward zero. A further confounding factor is provided by evidence that insurers smooth underwriting returns via manipulation of loss reserves (Weiss, 1985).

CH addressed the problem of bias by applying maximum likelihood (ML) regression models to quarterly book returns for 14 insurers during the periods 1970.1 through 1975.3 and 1975.4 through 1981.2. CH confirmed that simple regression betas closely approach zero, but five-period, lagged betas shifted significantly from positive to negative over the two periods. They noted that market underwriting betas generated by HM for the period 1976 through 1980 are not substantially negative and further asserted that the apparent differences "may be attributable to errors in the Hill-Modigliani parameter estimates" (p. 34). CH imply that lagged, book underwriting betas may be more sensitive to market factors than are market underwriting betas and they call for subsequent research to reconcile the two estimation methods.

Any comparison of CH and HM results must be questioned by researchers. The sample insurers and time periods clearly differ, e.g., the CH sample of 14 firms includes only eight firms tested by HM. The purpose of this study is to provide a direct comparison of the two estimation procedures for a larger sample. The research design is described next.

Research Design

Method

The market underwriting beta tested in this study is that developed by HM and restated by Cox and Griepentrog (1988b, pp. 208–9) as:

$$\beta_p = \frac{\beta_e - [(1-t_a)\,(ks+1)\beta_a] - (1-t_a)k_n s\beta_n}{(1-t)s} \tag{1}$$

where: β_p = residual underwriting beta,
β_e = equity beta for the insurer's stock,
β_a = beta for the insurer's actively traded portfolio,
β_n = beta for the insurer's non-actively traded portfolio,
s = premiums-to-surplus ratio,
k = reserves-to-premiums ratio,
k_n = ratio of non-traded assets to premiums,
t = mean income tax rate on underwriting income, and
t_a = mean income tax rate on investment income.[1]

Two specifications of book underwriting betas, corresponding to the previous work of CH, are tested and are expressed as:

$$R_{pt} = \alpha + b_1 R_{mt} + \epsilon_t \tag{2}$$

$$R_{pt} = \alpha + \beta_1 R_{mt} + b_2 R_{m,t-1} + b_3 R_{m,t-2} + b_4 R_{m,t-3} + b_5 R_{m,t-4} + \epsilon_t \tag{3}$$

where: α = intercept term,
β_i = regression coefficients (i = 1, 2, . . . ,n),
R_{pt} = underwriting book profit rate for period t,
R_{mt} = return on the market portfolio for period t, and
ϵ_t = random error term for period t.

Equation (2) is the Market Model familiar to financial researchers. Equation (3) is the model introduced by CH to mitigate smoothing behavior by insurers.[2] To adjust for first-order autocorrelation inherent with lagged regressors, both the ML procedure applied by CH and a two-step full transformation (TSFT) method are tested. Monte Carlo simulations indicate the TSFT procedure is more efficient, especially for small samples (Harvey and McAvinchey, 1978).

Fields and Venezian (FV) (1989) note a problem with the all-lines underwriting betas estimated in this study if underwriting cycles exist for individual lines, resulting in aggregation bias. The value additivity principle, which underlies the CAPM, then may be violated. FV show that correlations of industry-wide profit margins across lines and between these margins and unexpected inflation can result in biased estimates of all-lines betas. Their results are predictable, however, because investment returns, a dominant factor compared to underwriting returns, are included in the book margins tested. In contrast to FV, Cummins and Outreville (1987) demonstrate that apparent underwriting cycles based upon book returns simply may be caused by institutional and regulatory rigidities in reporting financial information.

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[1] This underwriting beta is an all-lines estimator, following the rationale of Fairley (pp. 199–200). To derive betas for individual lines, Fairley and HM apply reserves-to-premiums ratios, which reflect the expected duration, hence riskiness, of future claims for a particular line.

[2] Variations of equation (3) were tested, e.g., with three, two, and one lagged regressors. The results did not differ substantially from those for equations (2) and (3) and, therefore, are not reported.

The research method compares market underwriting betas defined by equation (1) to book underwriting betas expressed in equations (2) and (3) via matched pair estimates for each sample insurer. Nonparametric statistical tests are necessary because the Shapiro-Wilk test indicates that neither market nor book returns are normally distributed at the.05 level.

Data

Quarterly book and market return data for the sample insurers were collected for 1972.1 through 1982.2.[3] The proxy for book returns is the combined ratio, available from Best's Executive Data Service and 10-Q reports, and the CRSP equally weighted stock index is the market portfolio proxy.[4] Annual financial data necessary for computing market underwriting betas were collected from Moody's Bank and Finance Manual. The proxy for the inactively traded insurer portfolio is the Market Model beta for the Standard and Poor's (S&P) High Grade Bond Index.[5] The actively traded portfolio beta is the weighted average of the S&P bond beta and the stock beta (1.0). Table 1 contains mean values for the data used to estimate market underwriting betas. Estimates are generated for 17 insurers from 1973.1 through 1977.3 and 21 insurers from 1977.4 through 1982.2.[6]

Several insurers in both this study and that of CH are more properly classified as multi-line (M-L), rather than P-L, insurers. Reduced samples of relatively pure insurers that derived over 50 percent of 1979 net premiums written from P-L lines include 14 insurers in the first period and 17 in the second. These samples are tested separately to analyze the impact of including some M-L insurers in a sample of P-L firms. Test results are reported and discussed in the next section.

Results and Discussion

The results shown in Table 2 allow comparison of market underwriting betas with Market Model (MM) and TSFT book estimates. Although all estimators exhibit a negative shift between the first and second period, the

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[3] Subsequent periods are excluded because of collection expenses, the merger or reorganization of five sample firms, and the impact of 1986 tax changes.

[4] Only aggregate, quarterly combined ratios are available for U.S. insurers. A stock market proxy is implemented in most previously cited CAPM applications. An exception is Biger and Kahane (1978), who observe higher correlation between combined stock and bond market proxies and annual profit ratios for some underwriting lines.

[5] Applying an inactively traded portfolio beta of zero produces market underwriting betas slightly closer to zero, but the essential results are the same.

[6] No adjustment is made for long-term debt or preferred stock in the insurers' capital structure, a possible limitation. Fuller and Kerr (1981), however, show that leverage adjustments do not improve beta predictions for divisions of firms in a particular industry and Cox and Griepentrog (1988a) confirm this result for insurers. In addition, data for 1975, 1979, and 1981 show that neither long-term debt nor preferred stock exceeded 30 percent of total capitalization for any sample insurer. Although debt levels rose slightly in 1979, 71 (95) percent of the sample firms maintained debt (preferred stock) ratios under 10 percent in that year.

Table 1

Mean Values of Input Variables for Market Underwriting Betas

Input Variable[1]	1973.1-1977.3	1977.4-1982.2
k	.894	1.036
k_N	.900	1.122
s	2.206	1.958
t	.240	.240
t_a	.210	.210
β_E	.574	.876
β_A	.275	.637
β_N	.053	.549

[1] Definitions of input variables follow equation (1) in the text. Mean values are for 17 insurers in the first period and 21 in the second.

signed ranks test shows that the mean MM book beta is significantly positive at the .05 level in the first period and significantly negative in the second period, while the market beta is significantly negative in both periods. Squaring the Spearman coefficient for the MM book and market betas produces the coefficient of determination, which indicates less than 5 percent of the variation in market betas across the full sample is explained by MM book estimates for both periods. The Wilcoxon matched-pairs test confirms significant differences between market and MM book estimates at the .01 level in both periods. Similar tests for the reduced sample show less than 10 percent of the variation in market betas is explained by MM book estimates and significant differences exist at the .01 level, so the inclusion of several M-L firms in the full sample has little effect on these results.

The TSFT book betas shown in Table 2 are even less sensitive to market factors than are MM book betas. The signed ranks test indicates that TSFT estimates are not significantly different from zero in either period, contrary to the results of CH. Correlation coefficients are lower than those reported previously and the market and TSFT book betas are significantly different at the .02 level for the first period and the .01 level for the second period.[7]

The negative shift in market betas for the second period may be attributable to inflationary effects. Double digit inflation occurred during 1973 through

[7] One reviewer suggests that all book betas may be subject to seasonal bias because quarterly book returns are audited only in the fourth quarter, with all adjustments impounded at that time. Analysis reveals some seasonal variation for most of the insurers tested. Consequently, the book returns available for 17 insurers during the entire study period were adjusted using the U.S. Census Bureau X-11 seasonal adjustment program and betas were reestimated, but little change occurred. The mean adjusted MM betas are.063 in the first period and −.074 in the second versus.068 and −.089 for unadjusted estimates, with Spearman correlation coefficients above.80 in both periods.

1974, declined to more normal rates, then resumed in 1978, reaching 17.2 percent by the first quarter of 1980. Inflation subsequently fell well below 10 percent by the terminal date for this study. These relatively extreme swings in U.S. inflation caused bond and stock price movements to correlate closely. The bond beta, which serves as both the proxy for the inactively traded portfolio beta and a component of the actively traded portfolio beta, reached abnormally high levels and effectively drove estimates of market underwriting betas lower during the second period.[8]

The results in Table 3 provide insight into whether the findings in this study vary from those of CH because of different econometric procedures. Maximum likelihood (ML) book betas for both periods converge more closely toward zero than do previous book estimates and correlations with market betas decline. The ML method generates no additional sensitivity to market factors for the sample insurers tested in this study.[9] The evidence suggests that the greater sensitivity observed by CH may be a time- and sample-specific result.

Conclusions and Implications

This study provides the first direct, pairwise comparison of market-derived and book-derived underwriting betas. The evidence shows that substantially different results are produced by book and market estimation methods. Virtually no relationship is observed between the two types of estimates. Both simple and autoregressive book betas converge toward zero and are less sensitive to market factors than are market betas. These findings conflict with those of Cummins and Harrington (CH).

Rather than reconciling book and market estimation methods, this study demonstrates the incongruity of the two techniques, given the limitations of currently available data and procedures. Most researchers indicate theoretical preference for using market-based methods to estimate underwriting risk. If observable sensitivity to market factors also is a criterion, as inferred by CH, then the results of this study suggest that market underwriting betas may be preferable for empirical reasons, too. While further refinement of both book and market techniques may yield useful information, the study results support emphasis on further development of market-based models for the estimation of underwriting risk.

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[8]The observed impact of relatively high inflation on market underwriting betas may reflect reality. Biger and Kahane (BK) (1977, p. 17) supply an analysis of why underwriting returns and stock market returns may not be similarly affected by inflation rates.

[9]ML book betas also were estimated for 20 insurers for 1975.4 through 1981.2, the period during which CH observed significantly negative betas. The mean ML book beta for this broader sample is 0.00 and the signed ranks test indicates no significant difference from zero.

Table 2

Comparison of Book and Market Underwriting Betas

	Period 1 (1973.1-1977.3)			Period 2 (1977.4-1982.2)		
Insurers	**MM[1] Book Beta**	**TSFT[2] Book Beta**	**Market Beta**	**MM[1] Book Beta**	**TSFT[2] Book Beta**	**Market Beta**
Chubb	-.011	-.010	-.083	-.090	.006	-1.181
CNA Financial	—	—	—	-.175	-.050	-1.590
Continental	.047	.013	-.798	.141	-.072	-1.810
Crum & Forster	.020	-.029	-.079	-.116	-.084	-.671
Employers Casualty	-.099	-.140	-.095	-.075	-.025	-.440
GEICO	.250	.080	-.219	.001	.008	-.158
General Re	.054	.032	-.221	.012	.028	-.491
Hanover	.052	-.006	.015	-.070	-.045	-.618
INA	.092	.058	-.349	-.093	.010	-1.774
Kemper	.128	.094	.036	-.082	-.035	-1.444
Mission Group	—	—	—	-.016	.028	-.434
Ohio Casualty	.077	.066	.164	-.143	-.025	-.467
Republic Financial	—	—	—	-.213	-.174	-.397
SAFECO	-.030	-.065	-.257	-.164	-.156	-1.123
St. Paul	.139	.171	.088	-.024	.051	-1.444
USF&G	.030	.017	-.098	-.188	.016	-.804
Western Casualty	.115	0.000	.059	-.065	-.058	-.657
Aetna Life & Casualty[3]	.053	.029	-.114	-.210	-.025	-1.892
American General[3]	.132	.070	-.345	.007	.082	-2.076
American International[3]	—	—	—	-.067	-.039	-.384
Travelers[3]	.082	.021	.109	-.064	-.012	-1.579

Mean	.068	.024	-.129	-.093	-.027	-1.021
Standard Deviation	(.077)	(.069)	(.231)	(.072)	(.061)	(.607)
Spearman r^4	.162	.091		.219	-.140	
Reduced Sample Mean	.063	.020	-.131	-.095	-.034	-.912
Standard Deviation	(.083)	(.075)	(.240)	(.070)	(.062)	(.535)
Spearman r^4	.319	.248		.303	.066	

[1] Indicates market model betas represented by equation (2)
[2] Indicates two-step full transformation betas represented by equation (3)
[3] Insurer is excluded from reduced sample.
[4] Denotes correlation of book beta with estimated market beta.

Table 3
Comparison of Market and Maximum Likelihood Book Underwriting Betas

Insurers	Period 1 (1973.1-1977.3) Book Beta	Period 1 (1973.1-1977.3) Market Beta	Period 2 (1977.4-1982.2) Book Beta	Period 2 (1977.4-1982.2) Market Beta
Chubb	-.012	-.083	.077	-1.181
CNA Financial	—	—	.024	-1.590
Continental	.001	-.798	-.082	-1.810
Crum & Forster	-.082	-.079	-.061	-.671
Employers Casualty	-.189	-.095	.010	-.440
GEICO	.055	-.219	.021	-.158
General Re	.031	-.221	.085	-.491
Hanover	-.073	.015	-.022	-.618
INA	.051	-.349	.021	-1.774
Kemper	.049	.036	-.027	-1.444
Mission Group	—	—	.024	-.434
Ohio Casualty	.065	.164	-.006	-.467
Republic Financial	—	—	-.177	-.397
SAFECO	-.056	-.257	-.139	-1.123
St. Paul	.165	.088	.074	-1.444
USF&G	.022	-.098	.073	-.804
Western Casualty	-.016	.059	-.064	-.657
Aetna Life & Casualty*	.023	-.114	-.006	-1.892
American General*	.039	-.345	.096	-2.076
American International*	—	—	-.033	-.384
Travelers*	.012	.109	.001	-1.579
Mean	.005	-.129	-.005	-1.021
Standard Deviation	(.077)	(.231)	(.072)	(.607)
Spearman r**	.044		-.196	
Reduced Sample Mean	.001	-.131	-.010	-.912
Standard Deviation	(.084)	(.240)	(.075)	(.535)
Spearman r**	.152		-.044	

* Insurer is excluded from reduced sample.
** Denotes correlation of book beta with estimated market beta.

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