

Risk Premium Project – Phase 3 Update

Estimating Cost of Capital By Line of Insurance

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Risk Premium Project Overview

- Overall Research Objective
 - Identify appropriate risk adjustments for insurer liabilities to determine equilibrium prices for insurance and fair valuation of reserves
- Milestones
 - Phase 1 – Literature Review
 - » Actuarial literature
 - » Finance literature
 - Phase 2 – Analysis and Theoretical Conclusions
 - » Report *CAS Forum* Fall 2000
 - Phase 3 – Empirical Research
 - » By-line costs of capital estimates
 - » Parameterization of recent capital allocation models

Primary Theoretical Conclusions

Conclusion I

Both systematic and non-systematic risk are relevant factors determining equilibrium prices for insurance

Conclusion II

A linkage exists between systematic risk and duration

Conclusion III

Multifactor asset pricing models are superior to the CAPM

Conclusion IV

Theoretically appealing surplus allocation model now exists, and Insurer default should be recognized in pricing risk transfer

Conclusion I: Role of Systematic and Non-Systematic Risk in Pricing

- Both systematic and non-systematic risk are relevant factors determining equilibrium prices for insurance
 - Diversifiable risk eliminated through portfolio selection by shareholders, but
 - Total risk imposes costs on firms
 - » Financial distress
 - » Under-investment
 - » Tax convexities
 - » Managerial risk aversion
 - » Signaling

Conclusion II: Systematic Risk and Duration

- A linkage exists between systematic risk and duration
- Campbell and Mei (1993) decomposition

$$\beta_{i,m} = \beta_{cf_{i,m}} - \beta_{r,m} - \beta_{e_{i,m}}$$

- Cornell (1999)
 - Investigates betas of intermediate vs. long-term treasuries
 - » 1994 – 1997
 - » Average beta
 - Intermediate term portfolio → 0.14
 - Long-term portfolio → 0.42

Conclusion III: Multifactor Extensions of the CAPM

- Multifactor asset pricing models superior to the CAPM
 - CAPM Model

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + \epsilon_{i,t}$$

- Multifactor Model (Fama – French 1996)

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + \beta_1 F_{1,t} + \beta_2 F_{2,t} + \epsilon_{i,t}$$

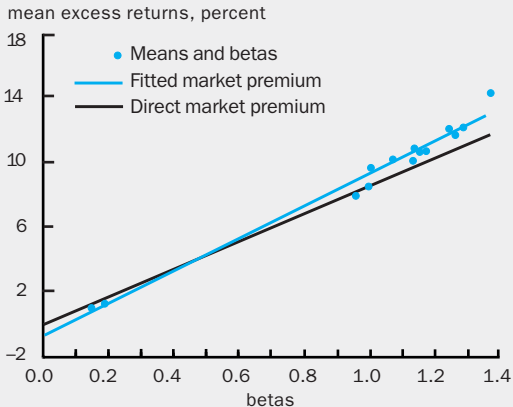
- » $F_{1,t}$ = Firm size Factor
- » $F_{2,t}$ = Book – to – Market Factor

Multifactor Figures

- The figures that follow were taken from Cochrane (1999).
- Cochrane, John H., 1999, “New Facts in Finance,” *Economic Perspectives* 23(3): 36-58. The paper can be found online at http://www.chicagofed.org/publications/economicperspectives/1999/ep3Q99_3.pdf.

Conclusion IV: Surplus Allocation

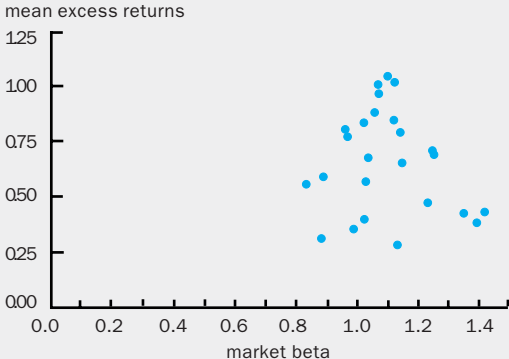
- Theoretically appealing surplus allocation model now exists
 - Long history of prior research
 - » Little theoretical basis
 - Myers/Read (2001)
 - » Allocate surplus holding marginal default rates across lines of insurance fixed
- Further reading
 - Cummins (2000), *Risk Management and Insurance Review*

FIGURE 1**CAPM—Mean excess returns vs. beta, version 1**

Notes: Average returns versus betas on the NYSE value-weighted portfolio for ten size-sorted stock portfolios, government bonds, and corporate bonds. Sample period 1947–96. The black line draws the CAPM prediction by fitting the market proxy and Treasury bill rates exactly (a time-series test) and the colored line draws the CAPM prediction by fitting an OLS cross-sectional regression to the displayed data points (a second-pass or cross-sectional test). The small-firm portfolios are at the top right. Moving down and to the left, one sees increasingly large-firm portfolios and the market index. The points far down and to the left are the government bond and Treasury bill returns.

FIGURE 3

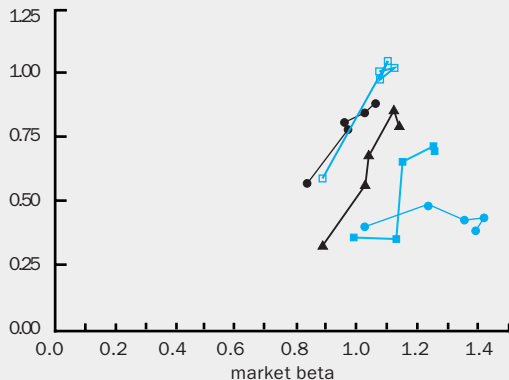
**Mean excess returns vs. market beta,
Fama–French portfolios**



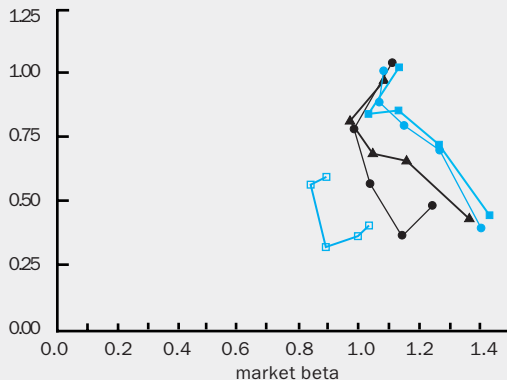
Notes: Average monthly returns versus market beta for 25 stock portfolios sorted on the basis of size and book/market ratio.

FIGURE 4**Mean excess returns vs. market beta, varying size and book/market ratio****A. Changing size within book/market category**

mean excess return

**B. Changing book/market within size category**

mean excess return



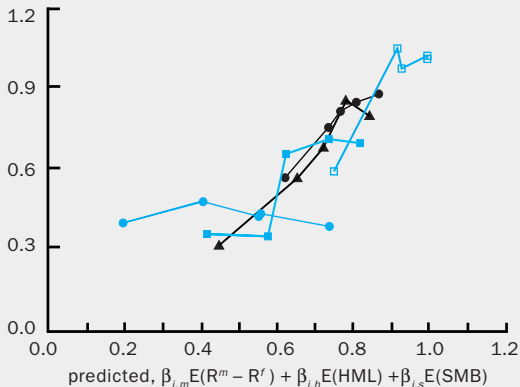
Notes: Average returns versus market beta for 25 stock portfolios sorted on the basis of size and book/market ratio. The points are the same as figure 3. In panel A, lines connect portfolios as size varies within book/market categories; in panel B, lines connect portfolios as book/market ratio varies within size categories.

FIGURE 5

Mean excess return vs. three-factor model predictions

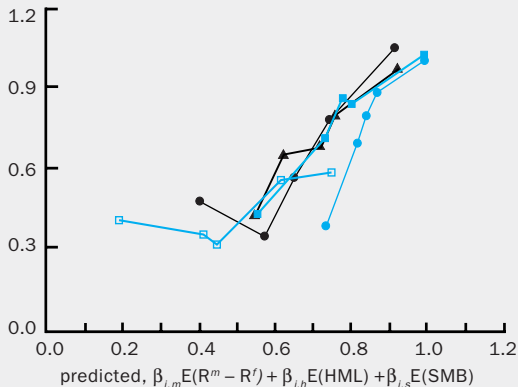
A. Changing size within book/market category

actual mean excess return, $E(R^i - R^f)$



B. Changing book/market within size category

actual mean excess return, $E(R^i - R^f)$



Notes: Average returns versus market beta for 25 stock portfolios sorted on the basis of size and book/market ratio versus predictions of Fama–French three-factor model. The predictions are derived by regressing each of the 25 portfolio returns, R_t^i , on the market portfolio, R_t^m , and the two Fama–French factor portfolios, SMB_t (small minus big) and HML_t (high minus low book/market). (See equation 4 in box 1.)

Surplus Allocation II

- Insurer default should be recognized in pricing risk transfer

Assets		Liabilities	
Investments	P + S	Claims	L
		Income Taxes	T
		Equity	S

- Empirical evidence that insurer default risk is priced
 - » Sommer (1996)
 - » Cummins and Danzon (1997)
 - » Phillips, Cummins and Allen (1998)

Surplus Allocation III

- Insurer default should be recognized in pricing risk transfer

Assets		Liabilities	
Investments	P - D + S	Claims	L - D
		Income Taxes	T
		Equity	S

- D = Equilibrium value of default option

$$D = \int e^{-rt} [P + S - (L + T)]_+ f^*(L) dL$$

Surplus Allocation IV

- Myers/Read (2001) Surplus Allocation Formula

$$s_i = s - \frac{1}{\sigma} \left(\frac{\partial p}{\partial s} \right)^{-1} \left(\frac{\partial p}{\partial \sigma} \right) [(\sigma_{iL} - \sigma_L^2) - (\sigma_{iV} - \sigma_{LV})]$$

where s = surplus-to-liability ratio of insurer

♦ = overall volatility parameter of insurer

p = insolvency put per dollar of liabilities

♦_{iL} = covariance between losses for line i and overall loss portfolio

♦_L² = volatility parameter for total losses

♦_{iV} = covariance between losses for line i and firm assets

♦_{LV} = covariance between assets and liabilities

Estimating Equity Cost of Capital by Line

- Extend Full-Information Industry Betas
 - Kaplan and Peterson (1997, 1998)
 - Firm specific betas are weighted average of betas from individual business units
- Two steps in estimation
 - 1. Estimate firm specific equity betas - β_i
 - 2. Impute full – information industry betas

$$\beta_i = \sum_{j=1}^n \text{Ind} \beta_j w_{i,j}$$

» Estimate via instrumental variables to control for market capitalizations

Methodology and Data Sources

- Equity betas

- Data source: CRSP tapes
- Estimated using 36 to 60 monthly returns

- » Beta

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + e_{i,t}$$

- » and “Sum” Beta (Dimson 1979)

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + \beta_{i,t-1}(r_{m,t-1} - r_{f,t-1}) + e_{i,t}$$

- » Years: 1997 – 2000 ending in June for each year

Methodology and Data Sources II

- Industry participation weights

- Data source: Segment Information File, Compustat
- Industry groups defined as 2 digit NAICS code
 - » Further disaggregating 52 - Finance and Insurance group
- Weights equal % of firm’s sales in industry j
- Date period: Year-end fiscal year t-1

- By-line of insurance participation weights

- Data source: NAIC data tapes
- Line groupings - TBD

Revenue Sources for Firms Underwriting P&C Risk - 1998

	NAICS	P & C Insurers		All Others		Total	
		Sales (\$M)	Num	Sales (\$M)	Num	Sales (\$M)	Num
Property & Casualty Ins. and Reinsurance	524126	167,711	108	32,475	21	200,186	129
Life Insurance	524113	27,500	14	77,988	9	105,489	23
Health Insurance	524114	10,116	3	16,343	7	26,459	10
Finance Excluding Insurance	52	8,910	47	22,396	9	31,307	56
Real Estate and Rental and Leasing	53	3,882	5	1,215	4	5,097	9
Mfg - Consumer Items	31	3,228	3	-	0	3,228	3
Mining	21	1,446	2	-	0	1,446	2
Retail Trade	44	1,233	1	-	0	1,233	1
Mfg - Heavy Ind., Machinery, Electronic & Comp.	33	1,002	1	61,616	3	62,618	4
Education Services	61	858	1	-	0	858	1
Admin. Support, Waste Mgm't and Remediation	56	659	1	1,010	2	1,669	3
Professional, Scientific, and Technical Services	54	441	4	1,865	2	2,305	6
Wholesale Trade	42	285	3	-	0	285	3
Accommodation and Food Services	72	242	1	21	1	263	2
Information	51	183	3	172	1	355	4
Construction	23	136	3	25	1	161	4
Mfg - Light Commercial Products	32	57	1	1,532	1	1,589	2
Transportation and Warehousing	48	33	1	1,366	2	1,399	3
Management of Companies and Enterprises	55	1	1	-	0	1	1
Arts, Entertainment, and Recreation	71	< 1	1	-	0	< 1	1
Agriculture, Forestry, Fishing and Hunting	11	-	0	-	0	-	0
Utilities	22	-	0	-	0	-	0
Health Care and Social Assistance	62	-	0	9	2	9	2
Other Services (except Public Administration)	81	-	0	-	0	-	0
Public Administration	92	-	0	-	0	-	0

Full Information Industry Betas

	Beta	Sum Beta	Obs. w/ Sales > 0
Agriculture, Forestry, Fishing and Hunting	0.783	0.917	111
Mining	0.831	0.650	1014
Utilities	0.442	0.419	570
Construction	1.086	1.348	470
Manufacturing - Consumer Items	0.795	0.783	1071
Manufacturing - Light Commercial Products	0.806	0.726	2711
Manufacturing - Heavy Ind., Machinery, Electronic & Computer	1.337	1.342	5724
Wholesale Trade	0.700	0.618	1262
Retail Trade 1	0.842	0.883	730
Retail Trade 2	1.035	1.124	496
Transportation and Warehousing	0.986	0.927	625
Information	1.201	1.118	1668
Finance and Insurance	1.207	1.271	1749
Real Estate and Rental and Leasing	1.242	1.420	656
Professional, Scientific, and Technical Services	1.148	1.256	1079
Administrative Support, Waste Management and Remediation	1.123	1.230	575
Education Services	0.748	0.744	71
Health Care and Social Assistance	1.100	1.265	447
Arts, Entertainment, and Recreation	0.859	1.169	195
Accommodation and Food Services	0.912	0.784	507
Other Services (except Public Administration)	1.046	0.838	145
Life Insurance	1.010	1.012	233
Health Insurance	1.225	1.206	128
Property & Casualty Ins. and Reinsurance	0.875	0.861	467
			22704

Insurance Industry “Sum” Betas – Yearly Estimates

	1997	1998	1999	2000*
Finance Ex. Ins.	1.280	1.184	1.371	1.207
Life Ins.	1.103	0.971	0.891	1.089
Health Ins	1.010	1.441	1.262	1.128
P&C Ins. and Reinsurance	0.864	0.879	0.767	0.996

* Year 2000 estimates are preliminary

Remaining Work

- **Complete by-line estimates**
 - Disaggregate Ins. DPW by line of insurance
 - Incorporate Fama-French additional factors
- **Capital Allocation Project**
 - Develop market value balance sheets for individual insurers
 - Estimate correlations across
 - » Lines of insurance, and
 - » Assets
 - Quarterly data, 1991 - 2000

Stay Tuned!!