Cost of Capital Estimation with Application to Workers Compensation Ratemaking

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Motivation. This paper discusses how NCCI estimates the cost of capital in its ratemaking framework. The implementation of this actuarial concept in ratemaking is challenging because financial economics offers more than one model for estimating the cost of capital. Even where there is agreement on the model, there may be questions about how to arrive at its input components.
Method. NCCI computes the cost of equity capital using the Discounted Cash Flow (DCF) and the Capital Asset Pricing Model (CAPM) approaches. The DCF method employs forecasts for the rate of dividend growth from Value Line Publishing, Inc. The CAPM model utilizes *betas* from Value Line Publishing, Inc., and historical returns on T-bills and the stock market from Morningstar, Inc.
Results. The two approaches to estimating the cost of capital are conceptually different and their estimates are similar, yet not identical.
Conclusions. In ratemaking, NCCI relies on two concepts of estimating the cost of equity capital in workers compensation. Important inputs to these approaches rest on long-term averages, thus making these methods robust to short-term economic fluctuations.
Availability. Historical returns on T-bills and the stock market are available from Morningstar, Inc. Dividend growth rates and CAPM *betas* are available from Value Line Publishing, Inc.
Keywords. Dividend Growth Model, Equity Valuation, Workers Compensation

1. INTRODUCTION

Central to developing the underwriting profit provision in actuarial ratemaking is the *total financial needs model*, which states that "the sum of underwriting profit, miscellaneous (non-investment) income, investment income from insurance operations, and investment income on capital, after income taxes, will equal the cost of capital" (see Actuarial Standards Board [1], p. 8). From this perspective, the cost of capital is an integral part of ratemaking at NCCI. What follows is a discussion of how NCCI estimates the cost of capital in its ratemaking framework.

Estimating the cost of capital is challenging, and the academic discussion surrounding this concept shows little signs of abating (see, for instance, Dimson, Marsh, and Phillips [6], Goetzmann and Ibbotson [8], and McGrattan and Prescott [17]). In actuarial practice, it is critical to follow a parsimonious, transparent, and robust approach for arriving at cost of capital estimates. At the same time, the approach should periodically be scrutinized and possibly updated in the light of new academic research findings.

1.1 Research Context

NCCI employs two concepts for estimating the cost of capital in the context of ratemaking in workers compensation; these two approaches and their implementation are periodically reviewed. What follows is a discussion of the two methods for estimating the cost of equity capital, along with a detailed description of how NCCI implements these approaches.

1.2 Objective

NCCI estimates of the cost of equity capital rest on both the discounted cash flow (DCF) and the capital asset pricing model (CAPM) concepts. The DCF approach employs estimates of the current dividend yield and forecasts for the rate of dividend growth from Value Line Publishing, Inc. The CAPM model utilizes *betas* from Value Line Publishing, Inc., and historical returns on T-bills and the stock market from Morningstar, Inc. Important inputs to these models rest on long-term averages, thus affording these methods robustness to short-term economic fluctuations.

The computed cost of capital is used within NCCI's internal rate of return (IRR) model to calculate an underwriting contingency provision (UCP, which is a profit factor) in those states where NCCI files rates (as opposed to loss costs).

NCCI's IRR model calculates the internal rate of return (based on changes in shareholder equity) of a $1 million workers compensation insurance policy written at proposed rates. The model incorporates all cash flows related to the policy, including factors such as premium inflows, losses, underwriting expenses, policyholder dividends, federal income taxes, and investment income earned on reserves and surplus. The model incorporates quarterly cash flows for the first five years and annual flows thereafter (through year 24 or 35, depending on the version of the model).

Once the IRR model has been estimated, the model is then backsolved to the cost to capital to calculate the UCP. The calculated UCP is used by state actuaries as an advisory input in their ultimate rate filing. The actual value of the UCP included in the filing (if any) depends on state regulatory practices as well as actuarial judgment. (The UCP is included as part of the expense provision that underlies the rate filing.)

1.3 Outline

In what follows we describe the two most widely used approaches in the estimation of the cost of capital and demonstrate how NCCI implements these methods to compute the cost of capital in workers compensation for ratemaking purposes. Further, we provide cost of capital estimates based on data available as of May 25, 2007.

2. BACKGROUND AND METHODS

The implementation of the actuarial concept of the *total financial needs model* in ratemaking is challenging because financial economics offers more than one approach to estimating the cost of capital. And even where there is agreement on the choice of the model, there often is no consensus on how to estimate the values of the parameters to be fed to this model.

Myers and Borucki [19] describe the DCF model as the "most widely used approach to estimate the cost of equity capital to regulated firms in the United States." The other commonly applied approach is the CAPM, which may be implemented as a one-factor model (which is our preferred approach) or a three-factor model (which is an approach that we do not pursue). NCCI employs both concepts in estimating the cost of equity capital for the property and casualty (P&C) insurance industry with application to ratemaking in workers compensation.

The cost of equity capital in the insurance industry has been studied by Fama and French [8] and, more recently, by Cummins and Phillips [5]—both studies implement the CAPM as one-factor and three-factor models. We will compare our methodology and results to theirs in Section 2.2.3.

2.1 The Discounted Cash Flow Model

Generally, the price of a financial asset is the present value of its (future) cash flow. When it comes to a share of stock, the cash flow consists of dividend payments. On a more aggregate level, such as the entire stock of a corporation, an industry or a country, cash returned to shareholders also includes cash dispensed in share repurchase programs, so long as these shares are retired (instead of being handed out to executives and employees, in which case the shares change hands but no cash is paid out on net).

A widely used model for the valuation of corporate stock, which is described in many corporate finance textbooks, is the Gordon dividend growth model (see Gordon [10]).

The Gordon model is suitable only for mature industries (such as the P&C industry) because this model assumes that (1) the industry in question returns cash to shareholders and that (2) the amount of cash paid to shareholders grows at a steady rate. As mentioned, cash returned to shareholders includes cash dispensed by means of repurchasing shares for the purpose of retiring them.

The Gordon model requires only two inputs for determining the cost of capital of an industry, which are the *effective* dividend yield of the stock (i.e., cash paid out by means of dividends and share repurchases, divided by the stock market valuation) and the rate at which the amount of so dispensed cash grows. Prospective dividend growth rates are available on company-level and industry-level bases from disinterested third parties, which is a key factor in a regulatory proceeding.

The following sections provide a summary of the NCCI methodology for estimating the effective dividend yield, the prospective rate of growth of dividends, and how these estimates are combined to generate a measure for the cost of capital within a DCF context.

2.1.1 The Present Value of Future Dividend Payments

Conceptually, a share of stock has an infinite lifetime. This assumption is not invalidated by the fact that stock may be repurchased and retired, because the value of the share when repurchased is again the present value of all future dividends, which are paid out lump sum to those that sell shares back to the corporation.

In a generalized, two-stage Gordon dividend growth model, there are n periods during which the dividend payments grow at a forecast rate g^{fct}, followed by an infinite number of periods during which the dividend grows at its long-term sustainable rate g^{avg}.

In general, the present value of a stock, V_0, that pays a dividend for n periods, equals

$$V_0^n = D_0 \cdot \sum_{t=1}^{n} \frac{(1+g)^t}{(1+k)^t}, \tag{2.1}$$

where D_0 is the dividend paid at the present time (the end of period 0), g is the rate of growth of this dividend, and k is the cost of capital. This formula can be simplified to

$$V_0^n = D_0 \cdot \frac{1+g}{k-g} \cdot \left(1 - \frac{(1+g)^n}{(1+k)^n}\right). \tag{2.2}$$

For an infinite number of periods, the present value reads

$$V_0^\infty = D_0 \cdot \frac{1+g}{k-g}. \tag{2.3}$$

Hence, the present value of a stock the dividend payment of which grows at the rate g^{fct} for n periods, followed by an infinite number of periods at which the dividend grows at the rate g^{avg}, equals

$$V_0 = D_0 \cdot \left[\frac{1+g^{fct}}{k-g^{fct}} \cdot \left(1 - \frac{\left(1+g^{fct}\right)^n}{(1+k)^n} \right) + \frac{\left(1+g^{fct}\right)^n \cdot \left(1+g^{avg}\right)}{k-g^{avg}} \cdot \frac{1}{(1+k)^n} \right]. \qquad (2.4)$$

As a consequence, we obtain the marginal cost of capital by means of solving the following equation for k:

$$\frac{1}{\frac{D_0}{V_0}} = \left[\frac{1+g^{fct}}{k-g^{fct}} \cdot \left(1 - \frac{\left(1+g^{fct}\right)^n}{(1+k)^n} \right) + \frac{\left(1+g^{fct}\right)^n \cdot \left(1+g^{avg}\right)}{k-g^{avg}} \cdot \frac{1}{(1+k)^n} \right], \qquad (2.5)$$

where D_0/V_0 is the current (end of period 0) dividend yield. If it is assumed that the dividend payments occur in the middle of the fiscal year, then the equation above still offers the correct answer for the cost of capital, assuming that the dividend yield D_0/V_0 has been observed in the middle of fiscal year 0.

The solver module in Microsoft Excel provides a means of iteratively solving for k, given inputs for the dividend yield and the forecast and long-term average rates of dividend growth.

2.1.2 The Effective Dividend Yield

The NCCI estimate of the dividend yield of the P&C industry for NCCI ratemaking rests on dividend yield data of individual insurers as published by Value Line Publishing, Inc. [23]. Value Line Publishing, Inc. data are developed in a consistent manner and are generally viewed as reliable. Analyses based on Value Line Publishing, Inc. information are used in many regulatory settings, especially in the insurance industry and the utilities sector (see, for instance, Cummins and Phillips [5], and Morin [18]).

NCCI defines the domain of P&C companies pertinent to determining the cost of capital in workers compensation as consisting of 32 corporations, 29 of which are selected from the Value Line P&C Industry Grouping (PMI was omitted due to its specialization on residential mortgages) and another three (AIG, Hartford Financial Services, and Unitrin) are taken from the Diversified Financial Services Grouping. (AIG, Hartford Financial Services, and Unitrin have significant P&C business as a percent of total; moreover, AIG and Hartford are major writers of workers compensation insurance.) Of these 32 corporations, which are detailed in Table 1, 29 companies currently pay dividends.

The dividend yield is estimated by the (unweighted) average of the dividend yields of these 29 dividend-paying corporations; this average amounts to 1.84 percent. The use of an unweighted average (as opposed to an average weighted by the corporations' stock market valuations) rests on the premise that any company is as a good a representative of the industry as any other. Further, such an unweighted industry average is robust to possible discontinuities in the dividend payments over time of any single corporation; otherwise, the industry average may be affected by the idiosyncrasies of a few large companies. For the record, weighting individual company dividend yields by market capitalization reduces the average dividend yield (prior to adjustment for share repurchases) to 1.56 percent from 1.84 percent. The reduction largely reflects the 33 percent weight on the 0.98 percent dividend yield of AIG. (The market capitalization of AIG at the time this study was prepared was about one-third of the total market cap of all dividend-paying companies in the Value Line sample of companies used in this study.)

The list of companies in Table 1 includes insurers that pursue more than the P&C line of business (but may also have some life insurance business, for instance)—these companies may be labeled as diversified. Similar to calculating a so-called pure play *beta*, a pure play approach to calculating the dividend yield would necessitate exclusion of diversified companies. But whereas the CAPM *beta* is systematically affected by diversification (as diversification moves the *beta* closer to the unit value), there is no similar well-established theory regarding the relation between diversification and the dividend yield.

Table 1: Current Dividend Yield, Percent

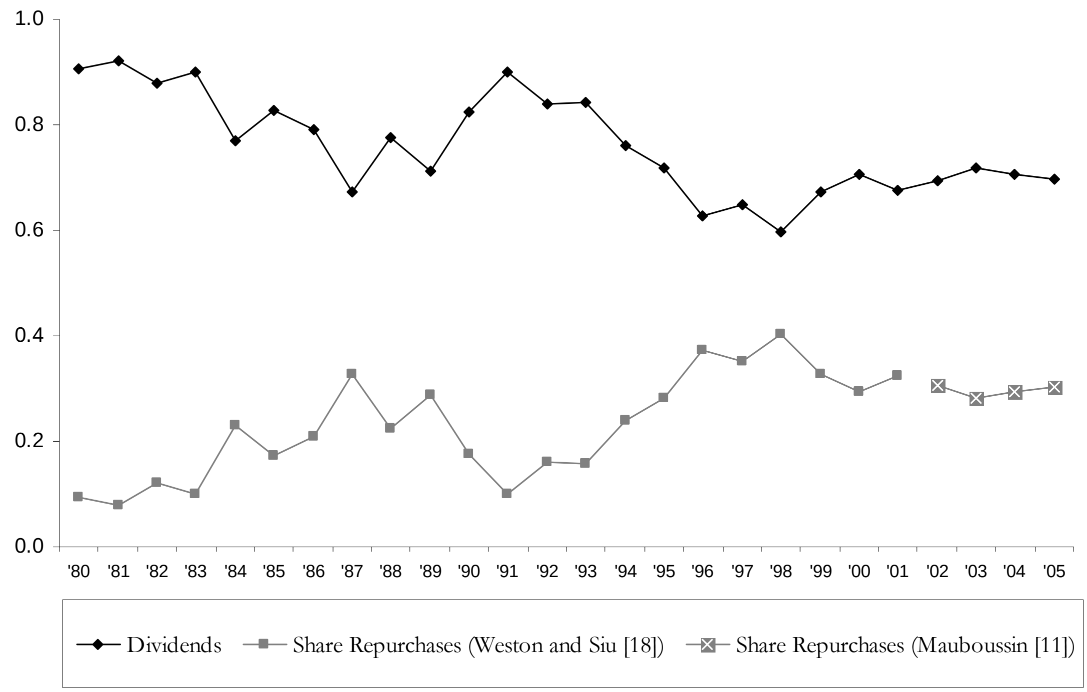
Company	Current Div. Yield
21st Century Insurance Group	2.90
ACE Limited	1.82
Alleghany Corporation	n/a
The Allstate Corporation	2.52
American Financial Group, Inc.	1.15
American International Group, Inc.	0.98
Assured Guaranty Ltd.	0.55
W.R. Berkley Corporation	0.58
Berkshire Hathaway Inc.	n/a
The Chubb Corporation	2.18
Cincinnati Financial Corporation	3.22
CNA Financial Corporation	0.83
Erie Indemnity Co.	3.08
Everest Re Group, Ltd.	1.89
The Hanover Insurance Group, Inc.	0.65
The Hartford Financial Services Group, Inc.	2.05
HCC Insurance Holdings, Inc.	1.28
Markel Corporation	n/a
Max Capital Group Ltd.	1.00
Mercury General Corporation	3.85
Ohio Casualty Corporation	1.68
Old Republic International Corporation	2.89
PartnerRe Ltd.	2.44
The Progressive Corporation	0.20
RenaissanceRe Holdings Ltd.	1.60
RLI Corp.	1.44
Safeco	1.91
Selective Insurance Group, Inc.	1.89
Transatlantic Holdings, Inc.	0.89
The Travelers Companies, Inc.	2.00
Unitrin, Inc.	3.88
XL Capital Ltd	2.10
Average	**1.84**

Source: Value Line Publishing, Inc. [23]. Note: "n/a" signifies non-dividend paying companies.

2.1.2.1 Adjustment for Share Repurchases

Dividends are not the only means by which companies return cash to shareholders. Chart 1 shows that share repurchases have become an important factor since the mid-1980s, and currently account for about 30 percent of all cash returned to shareholders. As argued above, to the extent that such share buybacks return cash to shareholders, the repurchases have to be added to the dividend payments when computing the *effective* dividend yield.

Chart 1: Fractions of Dividends and Share Repurchases in Total Cash Paid out to Shareholders



Source: Weston and Siu [26]; Mauboussin [16].

Quantifying the amount of cash that is returned to shareholders in stock repurchases is not straightforward. Compared to dividends, where management tends to maintain a steady payment pattern over time, share buybacks are "lumpy" and vary with overall stock market conditions. For instance, as shown in Chart 1, stock repurchases increased greatly during the stock market run-up of the mid-to-late 1990s. Another complicating factor is that such buybacks tend to be concentrated in a relatively small number of companies. Finally, not all shares that are repurchased are also retired; instead, repurchased shares may be handed out to employees or executives as part of their compensation. When repurchased shares are passed on to employees or executives, then there is no cash returned to shareholders in the aggregate; see Liang and Sharpe [14].

Table 2 provides data on share repurchases and cash dividends for the chosen set of 32 companies. The data, which were obtained from 10K reports filed with the U.S. Securities and

Exchange Commission (SEC; http://www.sec.gov), cover the period 2004-2006. As shown in the table, share buy-backs equaled $5.53 billion in the period 2004-2006, thus exceeding the cash dividends of $5.05 billion for the same period by 9.6 percent. Based on these numbers, one could argue that the *effective* dividend yield is about two percentage points above the reported 1.84 percent dividend yield. However, in light of the variable and skewed nature of share buy-backs in the P&C industry, and the possibility that some of the repurchased shares may fund share-based compensation and stock option grants, NCCI takes a conservative stance and estimates that the effective dividend yield exceeds the reported dividend yield by half a percentage point. (22 of 32 companies in the NCCI P&C company data set engaged in share repurchases in the period 2004-2006; of those 22 companies that repurchased shares, only one reported a reissuance of shares in its 10K statement; this reissuance amounted to about $250 million or, equivalently, 4 percent of the average annual share repurchases of all 22 companies taken together.)

2.1.3 The Prospective Rate of Growth in Dividends

Forecasting dividend growth is subject to the same principles as economic forecasting in general. Whereas in the short run, the path of future economic activity may be discernable in a fairly accurate way, in the long run, the growth of economic activity mean-reverts to a long-term average.

Table 2: Dividends and Common Stock Repurchases, 2004-2006

Company	Dividends			Common Stock Repurchases			Dividends	Repurchases
	2006	2005	2004	2006	2005	2004	2004-2006 Average	2004-2006 Average
21st Century Insurance Group	27.6	13.7	8.5	-	-	-	16.6	-
ACE Limited	312.0	253.0	226.0	-	-	-	263.7	-
Alleghany Corporation	-	-	-	39.2	-	-	-	13.1
The Allstate Corporation	873.0	830.0	756.0	1,770.0	2,484.0	1,373.0	819.7	1,875.7
American Financial Group, Inc.	38.2	33.1	35.1	-	-	-	35.5	-
American International Group, Inc.	1,638.0	1,421.0	730.0	20.0	176.0	1,083.0	1,263.0	426.3
Assured Guaranty Ltd.	10.5	9.0	4.6	171.1	19.0	6.0	8.0	65.4
W.R. Berkley Corporation	29.4	19.1	23.5	45.1	0.6	0.3	24.0	15.3
Berkshire Hathaway Inc.	-	-	-	-	-	-	-	-
The Chubb Corporation	403.0	330.0	291.0	1,228.0	135.0	-	341.3	454.3
Cincinnati Financial Corporation	228.0	204.0	177.0	120.0	61.0	59.0	203.0	80.0
CNA Financial Corporation	-	-	-	-	-	-	-	-
Erie Indemnity Co.	86.1	83.9	55.1	217.4	99.0	54.1	75.0	123.5
Everest Re Group, Ltd.	39.0	25.4	22.4	-	-	-	28.9	-
The Hanover Insurance Group, Inc.	15.4	13.4	-	200.2	-	-	9.6	66.7
The Hartford Financial Services Group, Inc.	460.0	345.0	325.0	-	-	-	376.7	-
HCC Insurance Holdings, Inc.	38.9	27.6	20.0	-	-	-	28.9	-
Markel Corporation	-	-	-	45.9	15.9	3.4	-	21.7
Max Capital Group Ltd.	14.3	9.0	5.5	0.0	7.4	4.9	9.6	4.1
Mercury General Corporation	105.0	93.9	80.6	-	-	-	93.2	-
Ohio Casualty Corporation	22.3	11.5	-	98.7	38.9	-	11.3	45.9
Old Republic International Corporation	135.8	300.7	91.6	-	-	-	176.0	-
PartnerRe Ltd.	125.4	118.9	92.3	(17.2.0)	(102.4)	152.5	112.2	10.9
The Progressive Corporation	25.0	23.7	23.3	1,214.5	482.8	1,628.5	24.0	1,108.6
RenaissanceRe Holdings Ltd.	60.4	57.0	53.8	-	0.7	38.8	57.1	13.2
RLI Corp.	19.0	15.9	12.6	37.6	-	0.0	15.9	12.5
Safeco	130.2	118.9	104.8	1,165.2	255.9	663.0	118.0	694.7
Selective Insurance Group, Inc.	22.8	19.9	17.3	116.4	22.9	8.7	20.0	49.3
Transatlantic Holdings, Inc.	33.6	29.0	24.7	-	6.3	1.2	29.1	2.5
The Travelers Companies, Inc .	702.0	628.0	642.0	1,120.0	33.0	23.0	657.3	392.0
Unitrin, Inc.	119.8	117.4	113.5	89.9	48.9	-	116.9	46.3
XL Capital Ltd	277.7	276.7	270.5	5.6	5.5	4.6	274.9	5.3
Total	**5,992.4**	**5,428.7**	**4,206.8**	**7,687.4**	**3,790.4**	**5,103.9**	**4,934.3**	**5,522.0**

Source: 10K reports, U.S. Securities and Exchange Commission, http://www.sec.gov. Note: Numbers are stated in millions of U.S. dollars. The Travelers Companies, Inc. were formerly known as The St. Paul Travelers Companies.

In a similar vein, the NCCI discounted cash flow approach draws on forecasts for the immediate future before reverting to a long-term average. Specifically, NCCI uses Value Line Publishing, Inc. forecasts for the dividend growth of the P&C industry for a five-year horizon before transitioning to a long-term average rate of growth of the industry; the long-term average rate of industry growth is gauged by the long-term average rate of growth of total financial assets of property-casualty insurance companies as stated in the Flow of Funds accounts of the Federal Reserve (http://www.federalreserve.gov/RELEASES/z1). This approach, which relies on professional forecasts for the near term and on a long-term average for the time thereafter, recognizes the benefit of near-term growth rates in accounting for short-term cyclical factors but, at the same time, restrains any potential optimism bias on the part of the analyst (see Easterwood and Nutt [7]).

To be specific, for the first five years of the forecasting period, we calculate the rate of dividend growth of the industry as an (unweighted) average across 28 (of the currently 29 dividend-paying) corporations based on company-level Value Line Publishing, Inc. [23] "five-year-ahead" forecasts, which are displayed in Table 3 below. (Value Line Publishing, Inc. did not offer a forecast for Ohio Casualty, which declared dividends in the years 2005 and 2006 but, prior to that, had not declared dividends four years running.) As of May 25, 2007, the estimated rate of dividend growth equals 11.19 percent.

The rate of growth that applies in perpetuity after the initial five-year period is calculated in two steps. First, we estimate for the period 1952-2005 the long-term real (that is, inflation-adjusted) rate of growth of the P&C industry based on its total financial assets; to this end, we deflate (that is, inflation-adjust) this measure of industry size, using the implicit price deflator of the Gross Domestic Product. (The Gross Domestic Product Deflator is published by the Department of Commerce, Bureau of Economic Analysis, as part of the National Income and Product Accounts; http://www.bea.gov.) Second, we multiply this long-term real rate of growth of the industry by the rate of expected inflation, which we gauge by the spread between the yields on 10-Year Treasury notes and 10-year Treasury Inflation-Indexed Securities. The resultant long-term rate of dividend growth equals 7.68 percent, based on data available as of May 25, 2007.

Table 3: Dividend Growth

Company	Forecast 2011
21st Century Insurance Group	30.0
ACE Limited	7.5
Alleghany Corporation	n/a
The Allstate Corporation	9.0
American Financial Group, Inc.	2.5
American International Group, Inc.	21.0
Assured Guaranty Ltd.	15.0
W.R. Berkley Corporation	13.0
Berkshire Hathaway Inc.	n/a
The Chubb Corporation	7.0
Cincinnati Financial Corporation	7.0
CNA Financial Corporation	n/a
Erie Indemnity Co.	10.0
Everest Re Group, Ltd.	28.0
The Hanover Insurance Group, Inc.	23.0
The Hartford Financial Services Group, Inc.	14.5
HCC Insurance Holdings, Inc.	15.5
Markel Corporation	n/a
Max Capital Group Ltd.	12.0
Mercury General Corporation	5.5
Ohio Casualty Corporation	-- *
Old Republic International Corporation	12.0
PartnerRe Ltd.	6.0
The Progressive Corporation	20.5
RenaissanceRe Holdings Ltd.	3.0
RLI Corp.	12.0
Safeco	8.0
Selective Insurance Group, Inc.	6.0
Transatlantic Holdings, Inc.	12.0
The Travelers Companies, Inc.	3.0
Unitrin, Inc.	1.0
XL Capital Ltd	-2.0
Average	**11.19**

Source: Value Line Publishing, Inc. [23]. Note: * indicates value labeled "not meaningful" by Value Line Publishing, Inc.

2.1.3.1 The TIIS Spread

The spread between the yields of conventional and Treasury Inflation-Indexed Securities (TIIS) offers an objective, market-based estimate of future inflation. The advantage of such an inflation gauge over opinion surveys is that it reflects actions taken by investors in the market place (see Kwan [13]).

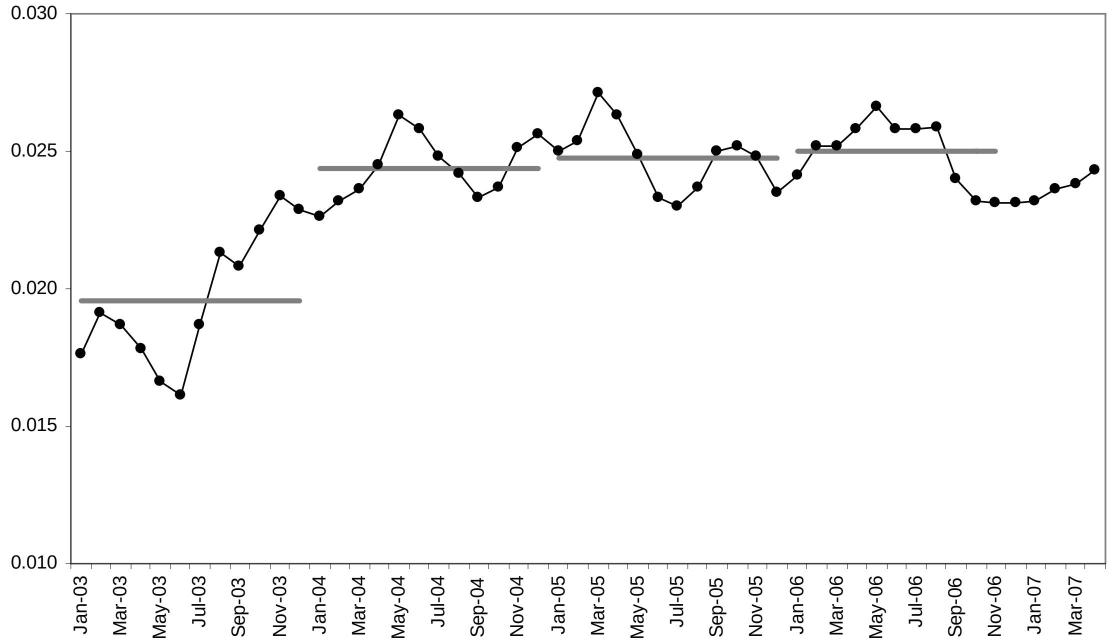
TIIS, which are also known as TIPS (Treasury Inflation-Protected Securities), were introduced by the Treasury Department in 1997 as a new class of government debt. Although the coupon yield (ratio of interest payment to principal) of TIIS is fixed for the time to maturity, the actual coupon payments rise according to the rate of inflation as the principal adjusts to the CPI (Consumer Price Index). The average future rate of inflation for which an investor is indifferent between holding a conventional Treasury note and holding a TIIS, is known as the break-even rate of inflation. This break-even rate of inflation may serve as a gauge of the rate of inflation that investors expect on average for the time to maturity (see Kwan [13]). To smooth out noise, we measure such inflation expectations by the average of the past 12 monthly observed TIIS spreads.

For the time period ending in April 2007, the trailing average of 12 monthly TIIS spreads equals 2.44 percent, with relatively small variations on a month-to-month basis. As Chart 2 shows, inflation expectations as gauged by a rolling trailing 12-month TIIS spread have changed only little since 2004.

2.1.4 The DCF Estimate

The DCF approach delivers an estimate for the cost of capital of 10.62 percent, based on data available as of May 25, 2007. When using a dividend yield average weighted by market capitalization (of 1.56 percent, instead of an equally weighted dividend yield average of 1.84 percent), the cost of capital amounts to 10.26 percent.

Chart 2: Spread between Rate on Conventional and TIIS 10-Year Government Securities



Source: U.S. Department of the Treasury, Office of Debt Management; daily observations, not seasonally adjusted. Note: Observations are charted on a monthly basis; horizontal bars indicate calendar year averages.

2.2 The CAPM

The Sharpe-Lintner (one-factor) CAPM rests on the fundamental insight that the total risk of an equity investment can be broken down into a component that can be eliminated by means of diversification, and a residual component known as systematic risk; see Sharpe [22] and Lintner [15]. Because diversification is brought about by holding (a representative slice of) the entire market, the risk that cannot be eliminated is the one that correlates with the market. The degree of such correlation with the market of an individual stock is known as *beta* (β). Further, only systematic risk generates a risk premium in the marketplace, because this is the risk component that has to be born by the investor. From this it follows that the return an investor demands for holding a given stock equals

$$k = r_f + \beta \cdot (r_m - r_f), \tag{2.6}$$

where r_f is the return on the risk-free asset (commonly referred to as the risk-free rate of return) and r_m is the expected return on the market portfolio. The difference between the expected return on the equity market and the return on the risk-free asset, $r_m - r_f$, is known as the equity risk premium. The return k defines the marginal cost of equity capital.

According to the cost of capital equation stated above, differences in the cost of capital across companies are due to differences in the degree to which their returns co-vary with the return on the stock market as a whole. A *beta* equal to one indicates that the company in question offers the same expected return as the market as a whole ($k = r_m$). For companies with *betas* greater than one, the cost of capital exceeds the expected return on the market portfolio.

2.2.1 Inputs to the CAPM

Employing the CAPM for the purpose of estimating the cost of capital of the P&C industry necessitates estimating the risk-free rate of return, r_f, the *beta* of the industry, β, and the expected market return, r_m. Below follows a description of the NCCI estimates of these three variables.

2.2.1.1 Risk-Free Yield

Only short-term rates are free from both default *and* inflation risks. Thus, we gauge the risk-free rate of return, r_f, by a short-term Treasury yield; see Bodie and Merton[4]. Because short-term interest rates mean-revert as they follow the monetary tightening and easing cycle of the Federal Reserve, NCCI uses a long-term average as measured by the arithmetic return on U.S. Treasury bills with about 30 days to maturity for the period 1926-2006; this value equals 3.8 percent (see Morningstar, Inc. [20]).

Note that the choice of the risk-free rate has only a minor impact on the NCCI CAPM cost of capital estimate because the *beta* of the P&C industry is close to unity, as shown below; for a *beta* of unity, the risk-free rate of return drops out of the cost-of-capital equation.

2.2.1.2 The *Beta*

NCCI obtains company-level estimates for the *betas* of the mentioned set of 32 P&C companies from the Value Line Publishing, Inc. [23]. These *betas*, which are displayed in Table 4, have been adjusted (by Value Line) for their tendency to mean-revert to unity, as suggested by Blume [3]. Specifically, a Blume-adjusted *beta* is the sum of a constant (0.35) and the weighted original estimated CAPM *beta* (weight: 0.67).

We use two alternative ways of aggregating the company-level *betas* to an industry *beta*. The first approach is to calculate the industry *beta* as an unweighted average of the Blume-adjusted (one-factor) CAPM *betas* displayed in Table 4; this is our favored approach. The reason for using an unweighted average in computing the pertinent industry statistic was stated above in connection with the industry dividend yield. Again, using an unweighted average views any corporation operating in the P&C industry as good a representative of the industry as any other. Further, an unweighted average is robust to mean reversion, although the Blume-adjustment already diminishes this problem. Using the unweighted average of Blume-adjusted company-level *betas*, we arrive at a P&C industry *beta* of 0.95, based on data available as of May 25, 2007.

The second approach that we pursue in aggregating company-level *betas* into an industry *beta* is the (stock market capitalization-weighted) full-information *beta* concept detailed in Kaplan and Peterson [12]. For this purpose, we collect the stock market capitalization of the P&C companies listed in Table 4, the (one-factor) CAPM *betas* and the stock market capitalizations of the Value Line Life Insurance companies (see Table 5), as well as the business volume of the these Value Line P&C and Life companies, broken by line of insurance. We distinguish only between P&C and life business, thus ignoring any residual (of which there was only one, which originated in the two-percent banking business of Aegon); the weights were scaled such that P&C and life add up to 100 percent. Business volume is measured (in lexicographic order) either by earned premium, net earned premium, revenue or gross written premium, whichever allowed us to break down the business by line of insurance. (When calculating the full-information industry *beta*, we exclude Berkshire Hathaway from the list of P&C companies for the purpose of estimating the industry *beta*, as this company is a conglomerate with many lines of business outside the insurance industry. Further, the *betas* of the life companies and the values for the stock market capitalization of the P&C companies are of more recent vintage than the *betas* of the P&C companies.) Using the full-information industry *beta* approach, we arrive at a P&C industry *beta* of 1.097, based on data available as of May 25, 2007.

2.2.1.3 The Prospective Return on the Market Portfolio

The expected rate of return on the equity market is a heavily debated issue in financial economics; mostly, this debate is stated in terms of the equity risk premium. Remember that the equity risk premium is the *expected* return on the market in excess of the risk-free rate.

A measure of the equity risk premium that suggests itself is the *realized* return on the stock market in excess of the return on short-term Treasury bills. Based on such realized returns, the equity risk premium for the period 1926-2006 equals 8.6 percent; this calculation rests on the difference between the arithmetic mean returns on the S&P 500 and on T-bills, as published by Morningstar, Inc. [21]. However, it has been argued that gauging the equity risk premium by past returns overstates its value; this is because the 20th century stock market return came in part at the expense of a secular decline in the dividend yield, which may not repeat itself in the future (see Arnott and Bernstein [2]).

In a comprehensive study of market expectations and realized equity returns over more than 200 years, Goetzmann and Ibbotson [9] find that the realized equity risk premium of the 20th century, although much higher than what finance scholars had expected at the time, was not out of line with historical experience. At the same time, these authors confirm that, indeed, there has been a secular decline in the dividend yield in the history of the U.S. stock market.

Table 4: CAPM *Betas* P&C

Company	***Beta*** **(Blume-adjusted)**	**Market Capitalization (Billons of U.S. dollars)**
21st Century Insurance Group	0.90	1.9
ACE Limited	1.35	19.7
Alleghany Corporation	0.60	3.4
The Allstate Corporation	0.90	30.0
American Financial Group, Inc.	1.00	3.4
American International Group, Inc.	1.25	118.0
Assured Guaranty Ltd.	0.60	1.2
W.R. Berkley Corporation	0.90	5.7
Berkshire Hathaway Inc.	0.65	168.0
The Chubb Corporation	1.05	20.6
Cincinnati Financial Corporation	0.90	6.5
CNA Financial Corporation	1.00	9.5
Erie Indemnity Co.	0.70	2.7
Everest Re Group, Ltd.	1.05	6.0
The Hanover Insurance Group, Inc.	1.65	2.4
The Hartford Financial Services Group, Inc.	1.30	22.7
HCC Insurance Holdings, Inc.	0.90	3.4
Markel Corporation	0.80	4.6
Max Capital Group Ltd.	0.90	1.7
Mercury General Corporation	0.85	2.8
Ohio Casualty Corporation	0.95	2.6
Old Republic International Corporation	1.05	3.6
PartnerRe Ltd.	0.95	4.3
The Progressive Corporation	0.90	13
RenaissanceRe Holdings Ltd.	0.70	3.9
RLI Corp.	0.80	1.4
Safeco	0.85	5.3
Selective Insurance Group, Inc.	0.85	1.2
Transatlantic Holdings, Inc.	0.80	4.2
The Travelers Companies, Inc.	1.25	34.0
Unitrin, Inc.	1.05	2.4
XL Capital Ltd	1.05	10.3
Unweighted Average	**0.95**	**---**

Source: Value Line Publishing, Inc. [23] (*betas*) and [24] (market capitalization).

Table 5: CAPM *Betas* Life

Company	***Beta*** (Blume-adjusted)	Market Capitalization (Billons of U.S. dollars)
Aflac, Inc.	0.80	31.5
Aegon	1.55	26.6
Delphi Financial Group	0.95	1.4
Genworth Financial	1.15	10.3
Lincoln National	1.30	14.3
Manulife Financial	0.95	58.0
Metlife, Inc.	1.05	44.0
Nationwide Financial	1.10	6.6
The Phoenix Companies	1.35	1.4
Protective Life Corp	0.95	2.9
Prudential Financial	1.15	36.0
Reinsurance Group	0.95	3.4
Torchmark Corp	0.90	5.7
Unum Group	1.50	8.0
Unweighted Average	**1.12**	**---**

Source: Value Line Publishing, Inc. [25].

Specifically, Goetzmann and Ibbotson [9] show that over the period 1792-1925, the difference between the arithmetic mean return on stocks and the arithmetic mean rate of inflation was 7.08 percentage points (7.93 percent minus 0.85 percent); this compares to a 8.63 percentage point difference between the arithmetic mean returns on the U.S. stock market (12.39 percent) and on Treasury bills (3.76 percent) for the period 1926-2004 (see Goetzmann and Ibbotson). Assuming a stable difference between the risk-free rate of return and the rate of inflation, the findings by Goetzmann and Ibbotson suggest that the realized equity risk premium over the period 1792-1925 was 2.19 percentage points ([12.39 minus 3.12] minus [7.93 minus 0.85] percent) lower than over the period 1926-2004 (see Goetzmann and Ibbotson).

We now detail how to calculate the arithmetic mean return on the S&P 500 stock market index for the period 1926 through 2006, adjusted for the secular decline in the dividend yield. First, the pertinent 2006 total return index value, TRI^{2006}, is adjusted such that the implied dividend yield equals the dividend yield observed in the year 1926 (as advocated in section 2.2.1.3):

$$\frac{TRI^{2006} \times \text{dividend}\ yield^{2006}}{adjusted\ TRI^{2006}} = dividend\ yield^{1926}. \tag{2.7}$$

Second, we calculate the geometric mean annual return as the arithmetic mean annual return in logarithmic space:

$$return^{geometric} = \frac{\log(adj.\ TRI^{2006}) - \log(TRI^{1926})}{80}. \qquad (2.8)$$

Third, we obtain the desired arithmetic mean return by exponentiating and bias-adjusting:

$$return^{arithmetic} = \exp(return^{geometric} + \hat{\sigma}^2/2), \qquad (2.9)$$

where $\hat{\sigma}^2$ is an estimate of the variance of the actual annual logarithmic returns (which equal the first differences in the annual logarithmic *TRI* values).

The numerical values associated with these calculations are displayed in Table 5. As this table shows, the historical arithmetic average annual return on the S&P 500 index equals 11.39 percent when adjusted for the secular decline in the dividend yield, down from the actually observed 12.3 percent (per calculation of Morningstar, Inc. [21]). The implied equity risk premium equals 7.59 percent (11.39 percent minus 3.8 percent), which compares to an unadjusted risk premium of 8.6 percent (using data before rounding; see Morningstar, Inc. [21]).

2.2.2 Bottom-Line CAPM Estimate

Taken together, we arrive at a CAPM-based cost of capital estimate of 11.02 percent, based on data available as of May 25, 2007; the implied estimate of the equity risk premium equals 7.59 percent.

Table 6: Total Return Calculation

Total Return Index in 1926 (TRI^{1926}) (1)	1,334.79
Dividend Yield in 1926 (2)	5.41%
Total Return Index in 2006 (TRI^{2006}) (3)	3,679,817.89
Dividend Yield in 2006 (4)	2.01%
Adjustment for Share Repurchases	0.50%
Estimated Effective Dividend Yield	2.51%
Adjusted Total Return Index ($Adj.\ TRI^{2006}$)	1,707,272.26
Arithmetic Mean Using Adjusted Total Return Index	11.39%
Arithmetic Mean Using Actual Total Return Index	12.3%

Source: Own calculations; Morningstar, Inc. [20]: (1) p. 204, (2) p. 228, (3) p. 205, and (4) p. 229.

According to Equation (2.7), $Adj.\ TRI^{2006}$ equals the product of (1) TRI^{1926} (3,679,817.89) and (2) the ratio of the 2006 and 1926 dividend yields (inclusive of share repurchases) (2.51/5.41), thus resulting in *Adj. TRI* ^{2006} of 1,707,272.26. The computation of the arithmetic and geometric mean returns is based on Equations (2.8) and (2.9).

2.2.3 Discussion

As mentioned, our *betas* were obtained from the (one-factor) CAPM; we aggregate these *betas* in two alternative ways to a *beta* for the P&C industry. In one aggregation approach, we Blume-adjust the company-level *betas* and then calculate an unweighted average. In the other approach, we estimate a full-information industry *beta* as suggested by Kaplan and Peterson [12] and implemented for the insurance industry by Cummins and Phillips [5]; here, the (one-factor) CAPM company-level *betas* are not Blume-adjusted.

Alternative to using (one-factor) CAPM *betas*, three-factor *betas* may be used—the Fama French three-factor model may be viewed as a generalization of the (one-factor) CAPM. In their 1997 study of the (one-factor) CAPM and three-factor *betas* of major U.S. industries, Fama and French [8] find little difference between these two *betas* (as mentioned above) and little difference between the implied risk premiums—the risk premium obtained with the three-factor model exceeds the 5.14 percent risk premium of the (one-factor) CAPM by only 0.58 percentage points. On the other hand, Cummins and Phillips [5] in their 2005 paper, find that the three-factor *betas* greatly exceed the (one-factor) CAPM *betas*, thus resulting in large differences in the estimated costs of equity capital between these two approaches. Based on market-value weighted estimates for the P&C industry, these authors come up with a (one-factor) CAPM *beta* of 0.843 (their Table 4, Panel B) and the Three-Factor *beta* of 1.099 (their Table 5, Panel B); the corresponding implied cost of equity capital equal 12.0 percent (one-factor CAPM; Table 4, Panel D) and 19.1 percent (three-factor model; Table 5, Panel D).

We are skeptical of the three-factor model because of its lacking theoretical foundation and, with regard to the Cummins and Phillips [5] study, we are unconvinced of (1) the seven percentage-point difference in the implied cost of equity capital between the two approaches (remember that Fama and French [8] found only a small difference in risk premiums between the two models) and (2) of the high cost of equity capital of 19.1 percent. Note that the arithmetic mean stock market return of large (small) capitalization stocks from 1926 to 2000 ran at only 12.3 (17.4) percent, which casts doubt on the proposed 19.1 percent cost of equity capital for the P&C industry, whose *beta* was estimated in the neighborhood of unity by Fama and French [8]. In fact, the Cummins and Phillips estimate of the cost of equity capital of 12.0 percent (as obtained with the one-factor CAPM, market-value weighted; their Table 4, Panel D) agrees more with the U.S. long-term average large cap stock return and with our estimate of the cost of capital.

It is worthy of note that our implementation of the CAPM generates a risk premium that is fairly stable over time; this is because our model rests on long-term averages. An alternative approach to estimating the cost of capital is to choose a level for the equity risk premium and then deduce the cost of capital by adding this risk premium to the short-term or long-term Treasury yield (depending on whether the risk premium is measured over short-term or long-term Treasuries). A major drawback of such an approach is the high degree of cross-sectional variation in opinions regarding the appropriate level of risk premium, as well as high degree of time-variation of such opinions, as documented by Graham and Harvey [11]. For a discussion of this subject matter in relation to NCCI ratemaking, see Wolf [27].

3 THE OVERALL COST OF CAPITAL

The DCF and CAPM are market-based approaches to estimating the cost of capital. That is, they both use financial market data to develop estimates for the expected return demanded by the marginal investor. The DCF method uses current stock prices and dividend yields as key inputs, but is sensitive to the projected growth in dividends. In contrast, the CAPM is sensitive to the choice of the industry *beta* and, perhaps more critically, to the projected return on the market portfolio and the implied equity risk premium.

Given the uncertainty surrounding the projected dividend growth and the ongoing debate among financial economists regarding the equity risk premium, it seems appropriate not to rely on one method alone. For this reason, the NCCI estimate of the cost of capital of the P&C industry is computed as an average of the estimates delivered by the DCF and CAPM approaches. Such averaging is likely to lead to less variation in the cost of capital estimate over time, which is a desirable feature in a regulatory setting.

Table 6 summarizes the DCF and CAPM results based on the NCCI cost of capital methodology; this table displays an overall cost of capital of 10.82 percent.

Note that NCCI updates its cost of capital estimates throughout the year as (1) Value Line Publishing, Inc., releases quarterly updates for the DCF inputs and the CAPM *beta* coefficients and (2) Morningstar, Inc. publishes annual updates of the historical returns on T-bills and the S&P 500 stock price index, which enter the CAPM.

Table 7: Cost of Equity (CE) Estimates Using Data as of May 25, 2007

CE Discounted Cash Flow (DCF) Model	10.62 %
Current Dividend Yield	2.34%
Forecast Avg. Ann. Growth in Dividends	11.19%
Long-term Avg. Ann. Growth in Dividends	7.68%
CE Capital Asset Pricing Model (CAPM)	11.02 (12.12)%
Risk-Free Rate	3.8%
beta	0.95 (1.097)%
Market Return	11.39%
Equity Risk Premium	7.59%
Overall Cost of Capital	10.82 (11.37)%

Note: CE indicates the cost of equity capital; in parentheses are the results using full-information *betas*. Some of the data used in the full-information *beta* approach is of more recent vintage (December 2007 and February 2008), as documented in the footnotes to Tables 4 and 5.

4. CONCLUSIONS

The cost of capital is an integral part of ratemaking at NCCI, as its value is a key element used in the specification of the profit factor. NCCI uses both the DCF and CAPM approaches in estimating of the cost of capital of the P&C industry. The data that feed into these estimates are from publicly available sources that are frequently cited in similar analyses prepared for regulatory proceedings; these sources include governmental institutions (U.S. Treasury Department and the Board of Governors of the Federal Reserve System) and private organizations (Value Line Publishing, Inc. and Morningstar, Inc.). In addition, NCCI uses long-term averages where appropriate, for instance when estimating the prospective dividend growth in the DCF analysis, and the risk-free rate and market return in the CAPM. The use of such long-term averages makes the cost of capital estimates robust to short-term economic fluctuations. The practice of averaging the DCF and CAPM estimates in determining the ultimate cost of capital acknowledges model uncertainty and uncertainty in the employed data inputs. Further, such averaging reduces the time variation of the cost of capital estimates, which is a desirable attribute from a regulatory perspective.

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Abbreviations and notations
CAPM, Capital Asset Pricing Model
CE, Cost of Equity Capital
DCF, Discounted Cash Flow
P&C, Property and Casualty
NCCI, National Council on Compensation Insurance

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