be accomplished when academics apply their knowledge to the problems that confront policy makers and policy makers listen carefully to what academics have to say.

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Discounted Cash Flow Estimates of the Cost of Equity Capital—A Case Study

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We investigated the usefulness of discounted cash flow (DCF) estimates of the cost of equity capital for regulated electric and gas utilities. Cost of equity estimates were calculated with several growth rate measures for nine New York utilities, a sample of large stable utilities operating in other states, and samples of utilities designed to match specific New York utilities. Variations of the DCF model which distinguish between short- and long-term growth rate forecasts were also evaluated. The estimates obtained were generally plausible, but an inexplicable scatter remained. The strong simplifying assumptions of the DCF method are probably not satisfied for the electric and gas utilities. The scatter of estimates does not imply the DCF method is useless, but underlines the importance of relying on benchmark averages rather than on single-company estimates. Moreover, the DCF method is not one but many methods, depending on which growth rate measure or variable-growth model is used. The results also underline the importance of not relying on DCF without confirmation from other methods.

The discounted cash flow or "DCF" formula is the most widely used approach to estimate the cost of equity capital to regulated firms in the United States. In the DCF method, the cost of equity capital is (properly) identified as the expected rate of return demanded by investors in the regulated firm's common stock. That rate of return is then estimated as the sum of the current dividend yield and a long-term growth rate of dividends per share.

This seems so simple and logical, and about as pointless to criticize as mother's apple pie. The rate of return to investors in common stock can be *defined* as the sum of dividend yield and the growth rate of share price; it seems a small step to assume that forecasted share prices grow along with dividends. Unfortunately, this assumption makes sense only if forecasted dividends grow at a constant rate forever, and if certain other factors are held constant.

Obviously, the assumption of constant, perpetual growth of forecasted dividends cannot be exactly true. Is it an acceptable approximation? If so, how should that growth rate be estimated? If not, how serious are the resulting errors likely to be? How useful is the DCF model in rate of return regulation? This study addresses these questions using data and estimates for a sample of electric and gas utilities.

After reviewing theory and underlying assumptions, we present and evaluate:

(1) DCF cost of equity estimates from 1986 to 1992 for nine New York utilities, and for a sample of large, stable utilities operating in other states (the Comparable Utilities Sample).

(2) DCF estimates for more general models in which future growth rates can vary, again for both New York and Comparable Utilities.

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(3) Estimates for samples of utilities matched to specific New York utilities.

All estimates are based on data available in September 1992.

SUMMARY AND CONCLUSIONS

Most of our estimates are summarized in Table 1. Medians, means, and ranges are given for the constant-growth and variable-growth DCF models using different approaches to estimate the growth rate. Similar estimates are reported for the Comparable Utilities Sample.

Most of our results are reported in figures rather than tables. The figures are located at the end of the article, before the Appendix, preceded by a key to abbreviations.

The company-by-company estimates are plotted in Figures 1a through 1d.[1] The shaded bar in each figure shows the cost of equity estimated using the Institutional Brokers Estimate System (I/B/E/S) average of security analysts' earnings growth rate forecasts. These bars do not change from figure to figure and can be used as constant reference points.

The figures show occasional obvious outliers which may unduly influence the means reported in Table 1. Median values are probably more reliable. The median cost of equity estimates for the New York utilities were 11%, more or less, using the three constant-growth estimates and a bit lower for the three variable-growth estimates. Corresponding figures for the Comparable Utilities are higher for some methods and lower for others.

Cost of equity capital estimates for the "matched" samples appear less robust than the estimates summarized in Table 1 and Figure 1. After reflection, we believe the matched samples' main value is as a check against unreasonably high or low cost of equity estimates for particular companies. The matched sample results are presented and discussed later in this article.

Our qualitative conclusions are as follows.

(1) The DCF formula is attractive because it looks simple. However, that simplicity comes at the cost of an exceedingly strong assumption, namely that dividends per share are expected to grow at a constant rate forever. Significant errors occur when that assumption is violated.

(2) Variable-growth DCF models, which distinguish between short- and long-term growth, are more plausible and seem to give cost of equity estimates that are less sensitive to changes in sample or specification. However, even these models rest on strong simplifying assumptions.

(3) It is very difficult to say which growth rate measure or variable-growth

[1] The companies are coded to encourage the reader to consider the overall performance of the DCF method rather than immediately asking whether a favorite company gets a high or low figure.

Table 1: DCF cost of equity estimates. New York utilities and Comparable Utility Sample.

	New York Utilities			***Comparable Utilities***		
	Median	*Mean*	*Range*	*Median*	*Mean*	*Range*
Constant-Growth Models (%)						
I/B/E/S	11.1	11.1	9.4–12.7	9.7	9.9	8.9–12.8
Value-Line	11.8	12.2	11.0–14.2	12.8	12.5	9.4–15.8
Sustainable Growth	10.1	10.2	9.6–11.2	10.5	10.9	9.7–12.6
Variable-Growth Models (%)						
Long-Run Growth Rate: Q9-Q20 I/B/E/S	10.4	11.1	8.6–15.0	10.6	10.7	8.8–14.3
Long-Run Growth Rate: Five-Year I/B/E/S	11.3	11.2	9.4–13.1	9.9	10.2	9.2–12.6
Long-Run Growth Rate: Sustainable Growth	10.4	10.6	9.7–11.3	10.6	11.0	9.8–12.5

method is "correct." One is therefore left with unexplained differences which could have considerable economic significance.

(4) It is important to look at a broad sample of DCF estimates. Single-company estimates for regulatory purposes are circular. Even if the circularity is overlooked, the intrinsic uncertainty in single-company cost of capital estimates makes them unreliable.

(5) A first look at Figure 1 suggests reasonable consistency between the DCF estimation methods if obvious outliers are ignored. In fact there is economically significant variation in the estimates. This is discouraging for two reasons. First, it proves that the strong simplifying assumptions of the DCF method are *not* satisfied in real life. Second, DCF in practice is not one but many methods, depending on how growth is forecasted. Each approach to forecasting growth seems plausible and no doubt "works" for some companies. But in the end there is no general rule for choosing among them. The DCF method at best requires a significant admixture of judgment. At worst, it can be cherry-picked to "prove" an advocate's point.

GOALS OF THE PAPER

In 1992 the New York Public Service Commission launched a wide-ranging review of its procedures for regulating the electric and gas distribution utilities under its jurisdiction. Our analysis was one of several which explored different approaches to estimating the cost of equity capital to these utilities. Therefore, we made no comparisons to the other approaches. We considered the DCF as we have seen it used in regulatory practice,[2] "ran the numbers" and evaluated the results for plausibility, robustness and consistency. Thus, the resulting paper should be read as a case study; we would not endorse extrapolation of our conclusions to other industries or circumstances.

We had hoped to find a way of implementing the constant- or variable-growth DCF model that generated little evident "noise" and tightly consistent estimates over time and across apparently similar regulated companies. We were disappointed. However, that does not disqualify DCF for other uses, for example, as a means of tracking expected returns for companies in the aggregate.[3]

We now turn to a review of the DCF model and its regulatory application. That is followed by a more complete presentation and evaluation of our estimates. An appendix covers the underlying numerical raw materials and machinery.

[2] In particular, we stuck with "obvious" proxies for expected growth and did not attempt to identify the "best" forecasting method for actual future dividends. We note, however, that analysts' forecasts are generally better predictions of future earnings than historical growth rates. See Brown and Rozeff (1978) and Vander Weide and Carleton (1988). We do not use historical growth rates in this study.

[3] See Harris and Marston (1992).

REVIEW OF THE DCF MODEL

The cost of equity capital to a regulated utility is the expected rate of return demanded by investors who buy the utility's common stock. This expected rate of return is also the discount rate which brings the present value of all future dividends back to the current stock price. The present value calculation takes a nice, simple form when future dividends are expected to grow at a constant rate forever:[4]

$$\textit{Stock price} = P = \frac{DIV_1}{r - g_{DIV}},$$

where r is the discount rate and the expected rate of return, g_{DIV} the dividend growth rate,[5] and DIV_1 next period's dividend per share. We just observe current stock price and solve for r as

$$\textit{Cost of equity} = r = \frac{DIV_1}{P} + g_{DIV}.$$

This is the usual derivation of the constant-growth DCF formula. However, the derivation is dangerous if it leaves the impression that a constant dividend growth rate is a natural assumption.

Here is another way of looking at it. The rate of return to equity investors comes as dividends and capital gains or losses. The expected rate of return—strictly speaking, a probability weighted average over all possible outcomes—is:

$$\textit{Expected return} = r = \frac{DIV_1}{P} + g_{PRICE},$$

where g_{PRICE} is the expected rate of stock price appreciation.

There is no harm in saying that "return equals dividend yield plus the rate of stock price appreciation." That is true by definition. However, although it may be a useful way for investors (or regulators) to *talk* about the company, it cannot give reliable *estimates* of the cost of equity. We need a way of tieing growth in stock price to the company's performance. The constant-growth DCF model "solves" this problem by assuming that the expected rate of return from capital gains equals the expected growth rate of dividends per share. However, this only works if the expected future growth rate of dividends is constant from here to eternity. If dividend growth is expected to vary, then the equation is wrong. It will overestimate the true cost of equity when immediate growth rates are temporarily high, and underestimate it when they are temporarily low.

Example. Table 2 summarizes simple examples which demonstrate this. The table shows the forecasted growth of dividends, earnings, book value, and stock

[4] The growth rate g *must* be less than the expected rate of return r, otherwise the model explodes.

[5] This formula was first suggested by J. B. Williams (1938) and M. J. Gordon and E. Shapiro (1956). Gordon (1962, 1974) was the leading advocate of the formula and various close relatives. The formula itself is now standard in corporate finance, and good textbooks give detailed expositions. See, for example, Brealey and Myers (1991), Ch. 4.

prices for three hypothetical companies. Each has the same true cost of equity, 12.5%.

(1) Company 1 is enjoying rapid temporary dividend growth, with an expected decline to normal growth at year five. Notice that as each year passes, the end of the fast-growth period gets one year closer. Thus, the company's stock price does not increase as fast as dividends during the initial phase. (The rapid short-run dividend growth is expected and already embodied in a higher stock price at year zero.) The DCF model, which assumes that dividends and stock price grow at the same rate, *overestimates* the true expected rate of return.[6]

(2) Company 2 offers no dividend increases at all until year five, when it resumes normal growth. The short-run growth rate is zero. Nevertheless, stock price gradually increases as year five approaches. The DCF model *underestimates* the true expected rate of return because dividends grow on average at only 1.7% per year to year six.

(3) Company 3's dividends are forecasted to grow at a stable rate forever. In this case, the stock price and dividends grow in parallel, and the DCF model gives the right answer.

The DCF model works for Company 3 because dividends and stock price grow at the same rate. Therefore, dividend yield (DIV/P) is constant for all future periods. This is an implicit assumption of the constant-growth model. That model does not work for Company 1, because its dividend yield increases in the early years, or for Company 2, because its dividend yield declines.

The constant-growth DCF method will *over*estimate the true expected return for companies offering rapid short-run dividend growth. (This does not necessarily mean high short-run profitability; often, it is simply a recovery from past financial difficulties.) The mistake occurs because the model incorrectly assumes that stock price will grow in parallel with short-run dividends. The method will *under*estimate the true expected return for companies where short-run growth of earnings and dividends is stalled or retarded. The method misses the expected stock price appreciation as the date of resumed normal growth approaches.

The DCF model is often implemented using forecasted short- or medium-term growth in earnings as a proxy for dividend growth. This works for Company 3, because its earnings grow at the same 7% rate as everything else. It does not work for Companies 1 and 2. Utilities like Company 2, whose profitability is gradually recovering from years one to five, show more rapid growth in earnings than in dividends or stock price, and simple DCF estimates based on earnings growth generate too high costs of equity. (The estimates will obviously be too low when short- or medium-term profitability is declining.) Utilities like Company 1, with

[6]Detailed calculations for Company 1 are given in Appendix Table A-4. Similar calculations for Companies 2 and 3 are omitted to save space.

Table 2: Company examples.

	Initial Value ($/Share)	Terminal Value ($/Share)	Growth Rates (%)					
			Period 1	Period 2	Period 3	Period 4	Period 5	5-Period Average
COMPANY 1								
Price	25.70	37.47	8.6	8.3	7.9	7.4	7.0	7.8
Book Value	20.00	29.44	9.0	8.6	8.1	7.6	7.0	8.0
EPS	2.80	4.12	9.0	8.6	8.1	7.6	7.0	8.0
Dividends	1.00	2.06	18.6	18.1	17.6	17.0	7.0	15.6
Sustainable Growth Rate	—	—	9.0	8.6	8.1	7.6	7.0	8.0
COMPANY 2								
Price	23.26	31.63	5.6	6.0	6.4	6.7	7.0	6.3
Book Value	20.00	24.85	2.0	3.2	4.4	5.7	7.0	4.5
EPS	2.00	3.48	12.2	12.5	13.1	13.8	7.0	11.7
Dividends	1.60	1.74	0.0	0.0	0.0	1.6	7.0	1.7
Sustainable Growth Rate	—	—	2.0	3.2	4.4	5.7	7.0	4.5
COMPANY 3								
Price	25.45	35.70	7.0	7.0	7.0	7.0	7.0	7.0
Book Value	20.00	28.05	7.0	7.0	7.0	7.0	7.0	7.0
EPS	2.80	3.93	7.0	7.0	7.0	7.0	7.0	7.0
Dividends	1.40	1.96	7.0	7.0	7.0	7.0	7.0	7.0
Sustainable Growth Rate	—	—	7.0	7.0	7.0	7.0	7.0	7.0

Notes: Table A-4 in the Appendix gives detailed calculations to support Company 1 figures. The ROE for Company 2 is 10% in period 1 and increases at a constant rate to 14% in period 5. The ROE for Company 3 is constant and equal to 14% for all periods. The cost of equity for each company is assumed equal to 12.5%. Terminal value is value in period 6.

constant return on equity but increasing dividend payout, will have temporarily low dividend yields, and DCF estimates will undershoot the true cost of equity.

Companies 1 and 2 would require a generalized DCF model to account for varying future growth rates. These models are described later.

ESTIMATING THE GROWTH RATE

Suppose it has been determined (or assumed) that the forecasted future dividend growth rate is constant. The next problem is to estimate that growth rate. Here we focus on two basic approaches.

Analysts' Forecasts. I/B/E/S publishes averages of security analysts' forecasts of most utilities' future earnings. (Forecasts published by Value Line are also often used.) The implied future earnings growth rates can be easily calculated. If these figures really represent a consensus of investors, they are obviously useful. But even if that is true, there are two potentially serious problems.

First, the I/B/E/S forecasts cover five years at most; the security analysts do not warrant their forecasts for the long-run. This is critical, because short-run earnings growth rates can fluctuate widely, even for supposedly "safe" companies like regulated utilities, and because stock prices embody a very long-run view of future dividends. Second, dividends do not always grow with earnings. They do so only when the company has settled into a steady-state growth path.

Sustainable Growth Rate. The long-run growth of earnings and dividends can also be derived from forecasted profitability and growth of assets. The sustainable growth rate is the product of the rate of return on equity (ROE) and the retention ratio, that is the fraction of earnings retained,

$$\textit{Sustainable growth rate} = ROE \times \textit{Retention ratio}.$$

Company 3, for example, starts with a book value per share of $20, an ROE of 14 percent, and earnings per share of $2.80. It pays out 50% of earnings as dividends and reinvests $1.40. Note that the retention ratio is 50%. The sustainable growth rate is therefore,

$$\textit{Sustainable growth rate} = .14 \times .50 = .07, \textit{ or } 7\%,$$

which in this case matches the long-term dividend growth rate.

The match works for Company 3 because it is on a steady-state growth path with *all ratios* constant, including payout rate, retention rate, and ROE. When these ratios vary, as they do for Companies 1 and 2, the sustainable growth rate varies too. Company 2's immediate sustainable growth rate is low because short-run ROE is depressed and the payout ratio is high. Using short-run sustainable growth (an oxymoron?) in the constant-growth DCF method understates that company's true cost of equity.

For Company 1, short-run sustainable growth is unsustainably high because the payout ratio is temporarily low. This would lead to an overestimate of the true cost

of equity. Nine percent sustainable growth plus a dividend yield of 3.9% gives an upward-biased cost of equity estimate of 12.9%.[7]

The apparent simplicity of the constant-growth DCF method unravels as we look at four possible growth rates or measures. The method requires that all four be the same. The figures below for Companies 1 and 2 show how difficult it is to achieve this alignment.

FIVE-YEAR AVERAGE EXPECTED GROWTH RATES (%)				
	Stock Price	***Dividends***	***Earnings***	***Sustainable Growth***
Company 1	7.8	15.6	8.0	8.0
Company 2	6.3	1.7	11.7	4.5
Company 3	7.0	7.0	7.0	7.0

Explicit forecasts for regulated companies rarely, if ever, extend beyond five years. Thus users of the DCF method have to work with short- or medium-term growth rates of the sort shown in this table. The figures in the table show how difficult it is to identify any single proxy that "works"—i.e., that gives a reasonable estimate of long-run growth and an unbiased estimate of the cost of capital.

The following table shows the DCF cost of capital estimates using these different forecasted growth rates. The estimates vary widely for Companies 1 and 2. Unfortunately, *there is no general rule* for choosing the most accurate growth forecasting method for companies like 1 and 2, which violate the DCF model's assumptions.

COST OF EQUITY ESTIMATES (%)				
	Stock Price	***Dividends***	***Earnings***	***Sustainable Growth***
Company 1	11.7	19.5	11.9	11.9
Company 2	13.2	8.6	18.6	11.4
Company 3	12.5	12.5	12.5	12.5

MEASUREMENT ERROR

In real life, errors in estimating investors' forecasts of future growth are inevitable. The errors will occur even if all the DCF method's assumptions are satisfied. This does not invalidate the method; all approaches to measuring the cost of equity are liable to random error. Responsible analysts attempt to average across similar companies whenever possible.

Analysts in regulated settings sometimes resist averaging because of the supposed difficulty in finding comparable companies. One side of a rate proceeding

[7] The five-year average sustainable growth is 8%, also unsustainable in the long run. However, the immediate dividend yield is only 3.9%. These two numbers combine to 11.9%, an underestimate of 0.6%.

for Utility X may argue that it is much safer than other utilities and therefore does not deserve as high a cost of equity. Utility X responds by pointing to the unusual risks it faces and arguing for a higher return than other utilities.

There is nothing wrong with giving the two sides air time to discuss relative risk. It is wrong to throw away DCF cost of equity estimates for other utilities which inevitably differ in some respects from Utility X. "Comparable" does not mean "identical." Even if the regulatory commission decides that Utility X is unusually risky, it still faces serious possible measurement errors when the DCF method is applied to Utility X alone. It should also estimate the DCF cost of equity for a reasonable sample of other utilities, and use that figure as a benchmark to be adjusted upwards as appropriate.

There is a good musical analogy here. Most of us, lacking perfect pitch, need a well-defined reference point, like middle C, before we can sing on key. But anyone who can carry a tune gets *relative* pitches right. Business people have good intuition about *relative* risks, at least in industries they are used to, but not about absolute risk or required rates of return. Therefore, they set a company- or industry-wide cost of capital as a benchmark. This is not the right hurdle rate for everything the company does, but judgmental adjustments can be made for more or less risky ventures.

Regulators need a benchmark, too. The benchmark should be calculated for a reasonably broad sample of comparable—of course, not identical—companies. This is the only responsible way to average out the noise that is inevitable with the DCF method. If Utility X's common stock is judged more or less risky than the average stock in the benchmark sample, then its cost of equity can be moved up or down from the benchmark figure. The benchmark is essential regardless of the final answer. Applying the DCF method only to Utility X, when many other comparable utilities are available for analysis, is not serious finance.

AVOIDING CIRCULARITY

Applying the DCF method solely to Utility X also falls into a trap of regulatory circularity. The DCF method rests on investors' expectations of future growth in assets, earnings, and dividends. Investors know that growth depends on regulatory decisions. So the DCF method applied to Utility X alone has regulators looking to investors to determine what they think regulators will do. The DCF method then instructs regulators to do something different.

Take Company 3 for example. Investors expect a future ROE of 14%. The DCF analyst must forecast future dividends at that level of profitability in order to estimate the cost of equity correctly at 12.5%. But if the company is only allowed to earn that cost of capital, the dividend forecasts used in the DCF method must have been wrong in the first place.

Calculating a benchmark cost of equity for comparable utilities in different regulatory jurisdictions escapes the circularity. It does not matter that investors' forecasts of earnings and dividends for the comparables depend on *other* regulators' actions. Those forecasts do not determine the cost of capital. Investors combine those forecasts with the cost of capital to determine stock prices. The DCF method observes the price, approximates the forecasts, and backs out the cost of capital.

The expected rate of return r is not the private property of any company; it is identical for all stocks of the same risk. For example, if investors take a more optimistic view of future dividends, r does not increase; today's stock price rises by just enough to hold the expected rate of return constant.[8] The DCF method then observes the higher stock price and the higher forecasted future dividends, and indicates the same cost of equity.

There is another problem here. How can investors bid up utility stock prices on the assumption of future ROEs above the cost of capital if regulators allow earnings only equal to the cost of capital? If return on (book) equity is pushed back to the cost of capital, then stock price will be pushed back to book value per share. Yet investors evidently did *not* expect that to happen in the next five to ten years; if they did, stock prices would have been much lower. We return to this point at the end of this article.

THE DCF ESTIMATES

Tables 1 and 3 and Figures 1a to 1d summarize the empirical part of this report. We constructed cost of equity estimates for several constant-growth and variable-growth DCF models for a large number of utilities both inside and outside of New York. As Figures 1a through 1d show, there is reasonable consistency across models and companies if obvious outliers are set aside. The remaining differences are not surprising given the strong simplifying assumptions demanded by the DCF approaches and the intrinsic difficulties of estimating the cost of capital.

These differences, though probably not significant in a strict statistical sense, could have considerable impacts on the utilities and their equity investors. In the end, regulatory commissions have to settle on a specific number for the cost of, and allowed rate of return on, equity. In that context, the choice of a particular method or growth measure can be critically important.

This section describes how the sample companies were chosen, and how the various DCF cost of equity estimates were calculated. The advantages and disadvantages of the different approaches are noted. The Appendix contains a more detailed description of samples, methods, and sources of data.

Samples. The nine New York utilities formed the first group. However, a broader sample of non-New York utilities was also investigated, both to avoid circularity and to average out the inevitable measurement errors.

[8] The higher expected dividend may also be offset by a drop in expected future stock price, leaving both r and the current stock price unchanged.

This Comparable Utilities Sample serves as a general benchmark. It comprises 17 large, stable utilities operating outside New York State. There are nine further samples, each consisting of four to seven companies matched to a particular New York utility.

The Comparable Utilities Sample was not chosen randomly. Instead we chose large, stable utilities *for which the DCF method would be expected to work well.* For example, we demanded stable past growth in earnings and dividends and the absence of disruptive events, such as large recent cost disallowances or nuclear difficulties, which would invalidate the DCF methods' simplifying assumptions. Thus, this sample is not identical to the New York utilities, some of which have suffered this sort of disruption.

The nine matched samples were constructed by a statistical screen designed to pick out utilities with approximately the same size, risk, and market-to-book ratio as each New York utility. Companies which survived the screens were checked for differences on several qualitative dimensions, and each matched sample reduced to about six utilities. Of course, there are no utilities *identical* to the New York utilities, either singly or as a group. You can pick any company, no matter how carefully matched, and find differences. To repeat, "comparable" should not mean "identical." The samples provide benchmark cost of equity estimates which could be adjusted if necessary for any differences that could materially affect investors' expectations and the cost of equity.

One such difference is financial leverage. The Comparable and Matched Utilities have different debt ratios than their New York counterparts. Therefore, cost of equity estimates reported for the Comparable Utilities have been adjusted to correspond to the average debt-to-value ratio of the New York utilities. The Matched Utilities' cost of equity estimates have been adjusted to the debt-to-value ratios of the respective New York utilities. Thus Tables 1 and 3 and Figures 1a to 1d can be read without concern for differences in financial leverage.

Constant-Growth DCF Models. The constant-growth method assumes that forecasted earnings, dividends, and assets *all* grow at the same constant rate forever. If that is true, the growth rate of forecasted earnings will serve as well as the growth in dividends. Earnings growth rates can be obtained from security analysts' forecasts compiled by I/B/E/S or published by Value Line.

The I/B/E/S and Value Line constant growth DCF cost of equity estimates are given on the first two lines of Table 1. The I/B/E/S figures are more plausible a priori, since they are an average of many analysts' views. Therefore, it is puzzling to find median cost of equity estimates substantially less for the Comparable Utilities Sample than for the New York utilities, when the other constant-growth methods give similar estimates for the two samples.

The constant-growth DCF model was also estimated using a forecasted sustainable growth rate. The implied rate of return on book equity and retention ratio were calculated from Value Line 1995 to 1997 forecasts of dividends, earnings, and book value per share. The resulting cost of equity estimates are generally lower than those based on growth rates of earnings.

The sustainable growth rates include an "SV adjustment" to capture the additional value accruing to shareholders from investment not financed by retained earnings. The adjustment adds to the estimated cost of equity when the market-to-book ratio is greater than one, and subtracts when it is less than one.[9] For the New York utilities, the SV adjustment adds about 0.1 percentage point on average to the sustainable growth cost of equity estimates shown on the third line of Table 1.[10]

Variable-Growth DCF Models. Forecasted growth rates are obviously not constant forever. Variable-growth DCF models, which distinguish short- and long-term growth rates, should give more accurate estimates of the cost of equity. Use of such models guards against naive projection of short-run earnings changes into the indefinite future.

I/B/E/S reports averages of analysts' earnings forecasts for one, two, and five-year horizons. This allows calculation of forecasted earnings growth rates for years one, two and three to five. Forecasted dividends per share were assumed to grow at a constant long-term growth rate after year five. The cost of equity is the expected rate of return to an investor purchasing stock at the current market price, receiving the dividend stream to year five, and then selling for the year-five stock price. That stock price is the present value of forecasted dividends from year six on.

Three long-term growth rates were assumed: the I/B/E/S earnings growth rate for years three to five (quarters nine through 20), the five-year I/B/E/S growth rate used in the first constant-growth DCF model, and a long-run sustainable growth rate (including the SV adjustment). The results are summarized in the bottom panels of Table 1, and in Figures 1b and 1d.

The variable-growth cost of equity estimates appear more reasonable than their constant-growth counterparts, although the estimates for the Comparable Utilities Sample are still low when the five-year I/B/E/S earnings growth rate is used. Use of the I/B/E/S five-year forecasts, which are strongly weighted towards year one and two, apparently understates the expected long-run rate of return to investors in these companies. For the Comparable Utilities, relatively more weight should be given to the Value Line and sustainable growth estimates in the top panel of Table 1, and to the variable-growth estimates based on long-run sustainable growth.

DCF Estimates for the Matched Utilities. Table 3a summarizes DCF cost of equity estimates as of September 1992 for samples matched to three New York utilities. For these three, sufficient data were collected to calculate all of the constant- and variable-growth models described above. The results are interesting.

[9] Such positive SV adjustments are sometimes attributed to the ability to issue new common stock for more than book value. If the stock market is in equilibrium, the gain should instead be attributed to the utilities' assumed ability to invest the proceeds of new share issues at an expected rate of return on equity exceeding the cost of equity. Shareholders neither gain nor lose if shares are issued for more than book value, but invested at only the cost of equity capital. Examples are given in the Appendix.

[10] Analysts' earnings-per-share forecasts should already include any extra growth from the SV adjustment. Therefore, no such adjustment is made to DCF estimates based on growth in forecasted earnings.

For New York Utility D, which had some of the lowest cost of equity estimates of the New York sample, the matched portfolio gave consistently higher estimates. The matched portfolios for New York Utilities A and I gave cost of equity estimates about equal to, or in some cases slightly lower than, direct estimates for Utilities A and I.

Compared to the constant-growth models, the variable-growth models generally provided more plausible and consistent estimates. For New York Utilities D and I and their matched companies, the variable-growth cost of equity estimates were nearly identical across models. However, the variable-growth DCF estimates for Utility A and its matched companies were widely dispersed, with some of the lowest cost of equity estimates in the study.

Costs of equity were also estimated for the remaining six New York utilities using one constant-growth and two variable-growth methods. The results are shown in Table 3b.

The main value of the matched-sample results is to reveal unrealistically high or low DCF estimates for particular New York utilities. However, we believe the Comparable Utilities Sample is a more useful general benchmark. It averages over a larger sample (17 companies versus, at most, seven in the matched samples[11]). Moreover, DCF has a much better chance of working for the Comparable Utilities. It is very difficult to "match" a particular utility's size, risk, and market-to-book ratio without selecting companies for which the DCF assumptions are violated. These assumptions clearly are violated for many of the "matching" companies—note the extreme ranges shown in several cells of Tables 3a and 3b.

Backcasting. Backcasting every DCF measure reported in Tables 1 and 3 proved impossible. We did obtain I/B/E/S earnings forecasts semiannually from January 1986. This allowed retrospective calculation of one constant-growth DCF estimate (CG-IBES) and two variable-growth DCF estimates for the New York utilities and the Comparable Utilities Sample.

The results are summarized in Figures 2a to 2f. Each graph shows the median DCF estimates and contemporaneous ten-year Treasury yields.[12] Estimates for individual utilities are arranged vertically as black dots. Thus each graph shows changes over time, relative to Treasury yields, and the cross-sectional variation of individual estimates.

The cross-sectional differences in Figures 2a to 2f confirm the existence of "noise" and other measurement problems in any DCF cost of equity estimate. The dispersion of the estimates for September 1992 (reported in Tables 1 and 2 and depicted in Figures 1a to 1d) is not unusual. The dispersion in early years of the estimates based on I/B/E/S quarter nine to 20 growth rates is striking—and also somewhat disappointing, since that method's median results for the Comparable Utilities Sample in 1992 appears more reasonable than estimates based on the

[11] For one New York utility only four companies qualified for the matched sample.
[12] Utility stocks have roughly the same exposure to interest rate risks as ten-year Treasuries.

Table 3a: DCF cost of equity estimates for three matched samples.

	Utility	*Utility A Matched Sample*			Utility	*Utility D Matched Sample*			Utility	*Utility I Matched Sample*		
	A	*Median*	*Mean*	*Range*	*D*	*Median*	*Mean*	*Range*	*I*	*Median*	*Mean*	*Range*
Constant-Growth Models (%)												
I/B/E/S	12.3	11.0	11.2	10.9 – 12.0	9.4	10.1	10.0	8.9 – 11.0	10.3	9.6	10.2	9.4 – 12.2
Value-Line	14.2	12.7	12.7	11.6 – 14.7	11.0	12.3	12.2	8.8 – 15.1	12.3	12.2	12.0	8.2 – 15.1
Sustainable Growth	11.2	11.2	11.5	9.7 – 14.9	9.8	10.6	10.6	8.6 – 12.2	10.1	10.0	9.9	8.8 – 10.7
Variable-Growth Models (%)												
Long-Run Growth Rate: Q9-Q20 I/B/E/S	10.4	10.5	8.6	0.6 – 13.9	8.6	11.2	11.1	8.7 – 13.4	10.3	9.9	10.2	9.7 – 11.1
Long-Run Growth Rate: Five-Year I/B/E/S	12.2	11.4	11.3	10.1 – 11.8	9.4	10.5	10.3	9.0 – 11.3	10.4	9.7	10.4	9.6 – 12.1
Long-Run Growth Rate: Sustainable Growth	11.3	11.0	11.6	10.5 – 14.6	9.7	11.1	10.7	8.8 – 12.0	10.3	10.1	10.1	9.0 – 11.1

Table 3b: DCF cost of equity estimates for six remaining matched samples.

	Utility B	Utility B Matched Sample			Utility C	Utility C Matched Sample			Utility E	Utility E Matched Sample		
		Median	*Mean*	*Range*		*Median*	*Mean*	*Range*		*Median*	*Mean*	*Range*
DCF Model (%)												
Constant-Growth: I/B/E/S	12.7	10.4	11.2	9.7 – 13.3	12.5	10.7	11.2	9.5 – 13.8	9.7	9.8	9.9	7.9 – 13.2
Variable-Growth: Q9-Q20	15.0	12.1	11.0	8.9 – 12.4	11.6	10.4	12.4	9.3 – 19.7	10.4	9.1	9.6	6.6 – 13.4
Variable-Growth: I/B/E/S	13.1	10.4	11.5	9.8 – 13.4	12.5	10.9	11.6	9.6 – 15.2	9.8	9.9	10.1	8.0 – 12.6

	Utility F	Utility F Matched Sample			Utility G	Utility G Matched Sample			Utility H	Utility H Matched Sample		
		Median	*Mean*	*Range*		*Median*	*Mean*	*Range*		*Median*	*Mean*	*Range*
DCF Model (%)												
Constant Growth: I/B/E/S	10.4	9.8	10.2	8.6 – 13.8	11.1	9.9	10.5	9.0 – 14.1	11.1	11.0	10.9	9.1 – 12.2
Variable-Growth: Q9-Q20	9.4	10.4	10.1	6.4 – 14.0	10.2	9.6	10.4	5.5 – 19.6	14.1	10.4	9.8	0.2 – 13.6
Variable-Growth: I/B/E/S	10.4	10.0	10.5	8.8 – 13.0	11.3	9.8	10.9	9.0 – 14.1	12.0	11.4	11.2	9.4 – 12.6

I/B/E/S five-year forecast. Nevertheless, backcasting suggests that the quarter nine to 20 forecast gives estimates which are not always robust.

Figure 3 takes out the individual company scatter and shows the average backcasted cost of equity estimates for the New York utilities. The averages are close in 1992 but differ substantially during the late 1980s. Estimates based on the variable-growth DCF model using the quarter nine to 20 growth rates appear to be unreasonably high during that period.

Figures 4a and 4b track backcasted estimates for two individual New York utilities. The DCF estimates for Utility G in Figure 4a show implausible year-to-year changes, and illustrate again the dangers of relying on single-company DCF measures. DCF estimates for other New York utilities show similar fluctuations. The relative stability of the estimates for New York Utility E, in Figure 4b, are the exception.

A REGULATORY REALITY CHECK

The median or average DCF estimates are generally substantially lower than the rates of return earned by these companies on book equity. This result is not "noise." All the DCF variants project current or near-future profitability out to the indefinite future. When current stock price increases, holding near-term profitability constant, the DCF rate of return estimate has to fall. Thus stock prices above book value per share generate costs of equity below the rates of return on equity projected from now to, say, 1996.

Of course, current stock prices above book value, and costs of equity less than current ROE, are easily explained *if* investors expect utilities to earn more than the cost of equity capital for the *very* long-run. But this is implausible, given the tendency of regulation to force returns toward the cost of equity and market-to-book ratios toward one. Moreover, DCF estimates that assume future reversion of earned ROEs to the cost of equity give ridiculous estimates.

Table 4 illustrates this for the New York and Comparable Utilities. We calculated each company's cost of equity using the same variable-growth DCF model described above, except for using a forecasted book value per share as the terminal stock price. This assumes that regulators will step in suddenly at, say, year five, cut the allowed return on equity to exactly the cost of capital, and hold it there subsequently. At that step-in point price would have to go to book value per share.

Of course the expected rates of return must fall below standard DCF cost of equity estimates, which implicitly project near-term profitability—and stock prices above book value—into the far future. Median costs of equity in Table 4 fall to 2.8% for the New York and −0.9% for the Comparable Utilities. Of course these results are not credible—most estimates are below Treasury bond yields and 11 out of 17 estimates for the Comparable Utilities are negative, for example.

There is no way to square these numbers with the standard view of the objectives of rate of return regulation. Regulators are supposed to set allowed returns

Table 4: DCF cost of equity estimates assuming expected share price falls to book value. New York utilities and Comparable Utility Sample*.

	New York Utilities			Comparable Utilities		
	Median	*Mean*	*Range*	*Median*	*Mean*	*Range*
Variable-Growth Models (%)						
Expected Share Price = Book Value in Year 5	2.8	2.7	−1.1 – 5.9	−0.9	−0.8	−5.9 – 3.2
Expected Share Price = Book Value in Year 10	7.0	7.2	5.5 – 9.4	5.7	5.6	2.8 – 7.1
Expected Share Price = Book Value in Year 20	9.5	9.6	8.3 – 11.6	8.3	8.5	6.9 – 10.0

*Cost of equity estimates for the Comparable Utilities have not been relevered.

equal to the cost of capital, perhaps with a regulatory lag to give incentives for cost reduction, better management, etc.[13] But this does not allow an expectation of long-run profitability exceeding the cost of equity or market-to-book ratios substantially above one for virtually all utilities.

Perhaps regulators pay only lip service to the accepted theory of rate of return regulation, and are content to allow "excess" returns as long as inflation is low and consumers' monthly utility bills are stable. Perhaps the regulatory lag is very long (although the figures in Table 4 for a reversion of price to book in 20 years are still implausibly low). In these cases investors may rationally extrapolate current profitability. It seems just as likely that they are myopic and riding for a fall.

If investors are just unrealistically optimistic, and bid utility stocks above their intrinsic value, then DCF estimates may understate the true, long-run cost of equity. On the other hand, there may be some hidden but systematic flaw in all DCF methods. Even variable-growth DCF models are oversimplified, and may miss some important "upside" that is reflected in real-life stock prices.

CONCLUDING COMMENTS

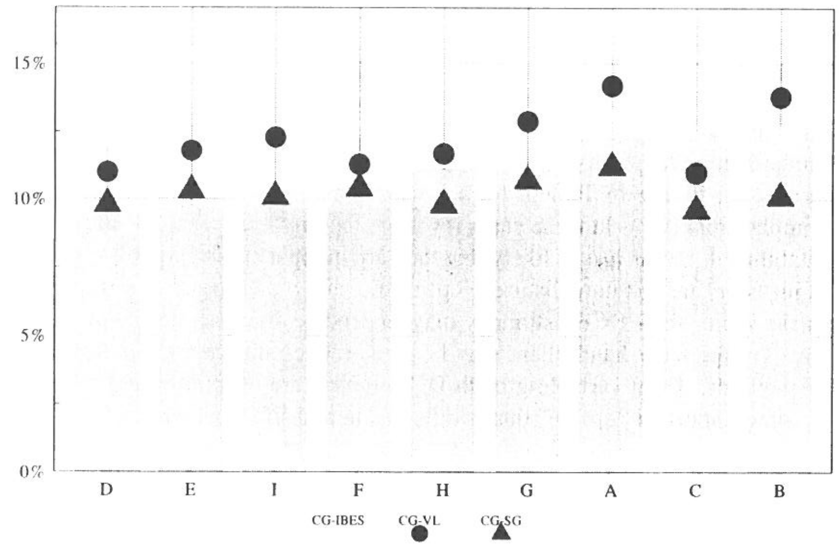
Anyone who has reviewed and tried to absorb Figures 1 through 4 will be frustrated at the inexplicable scatter of the DCF cost of equity estimates plotted there. It is tempting to look for some simple rule or message in these results. Unfortunately, the scatter is the rule, and is the message. DCF is not one method but many; it is difficult (probably impossible) to say which growth rate measure or variable-growth method is correct.

KEY TO DCF MODELS IN FIGURES 1–4

Abbreviation	*Long-Term Growth Rate*
Constant-Growth Models	
CG-IBES	I/B/E/S Mean Five-Year Earnings Growth Rate Forecast
CG-VL	Implied Value Line Long-Run Average Earnings Growth Rate
CG-SG	Sustainable Growth Rate
Variable-Growth Models	
VG-Q920	Implied I/B/E/S Quarter Nine to 20 Earnings Growth Rate
VG-IBES	I/B/E/S Mean Five-Year Earnings Growth Rate Forecast
VG-SG	Sustainable Growth Rate

[13] *See* Myers (1972).

Constant-Growth DCF Cost of Equity Estimates for New York Utilities



Variable-Growth DCF Cost of Equity Estimates for New York Utilities

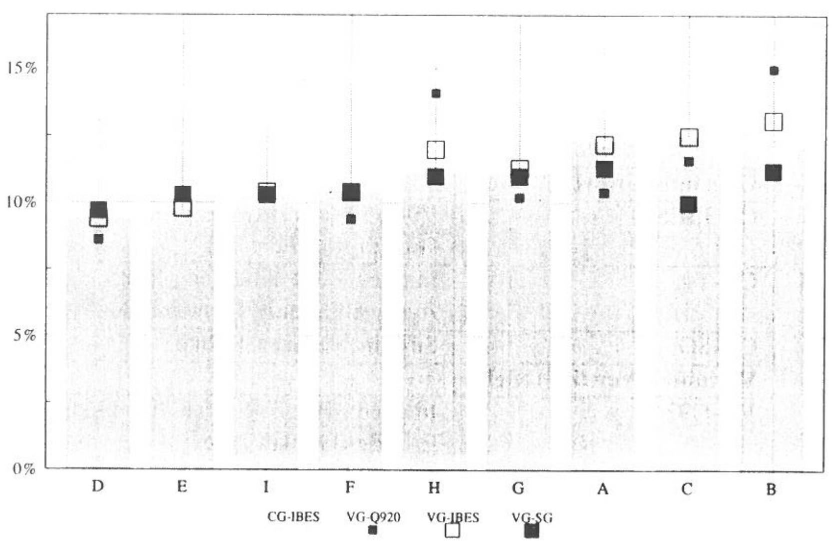
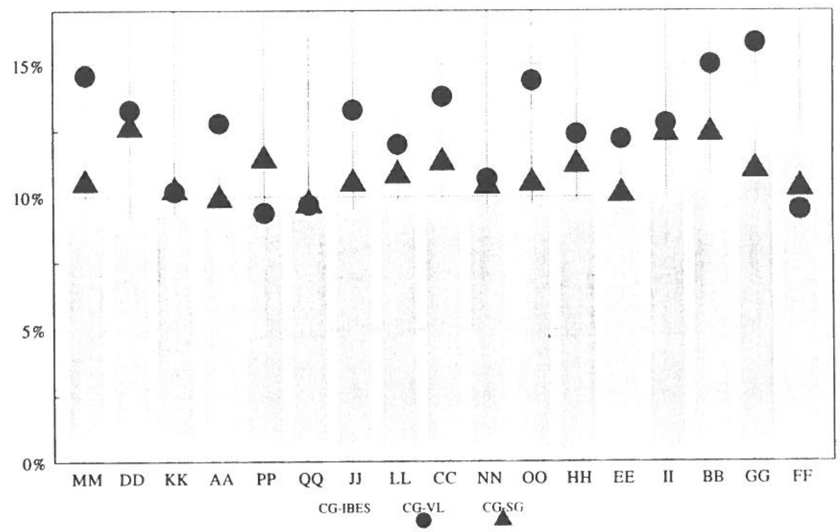


Figure 1: (a,b)

Constant-Growth DCF Cost of Equity Estimates for Comparable Utilities



Variable-Growth DCF Cost of Equity Estimates for Comparable Utilities

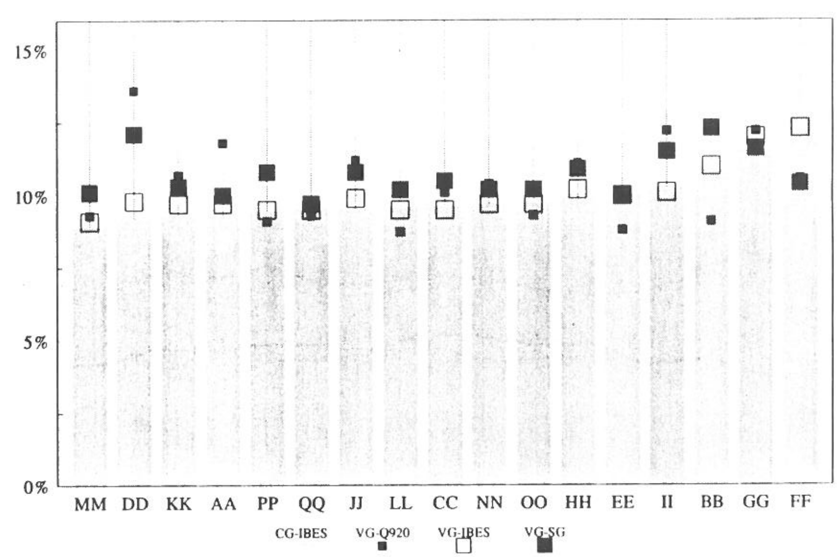
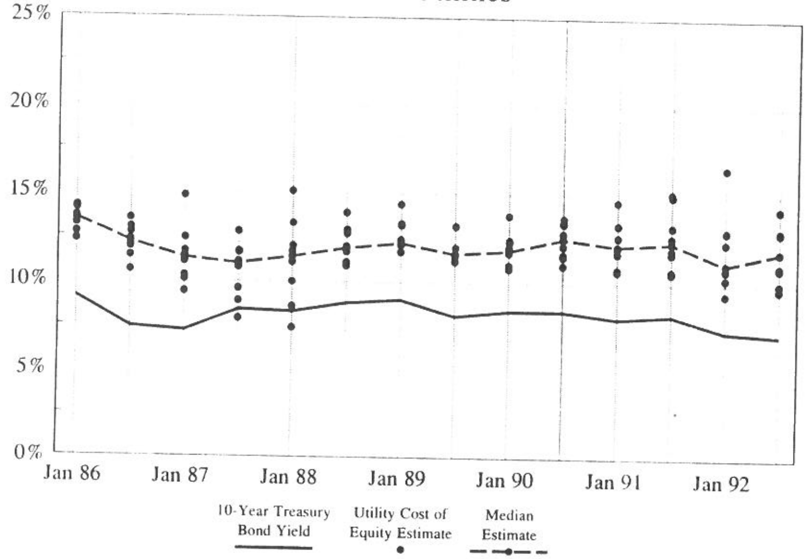


Figure 1: (c,d)

CG-IBES Cost of Equity Estimates
New York Utilities



VG-IBES Cost of Equity Estimates
New York Utilities

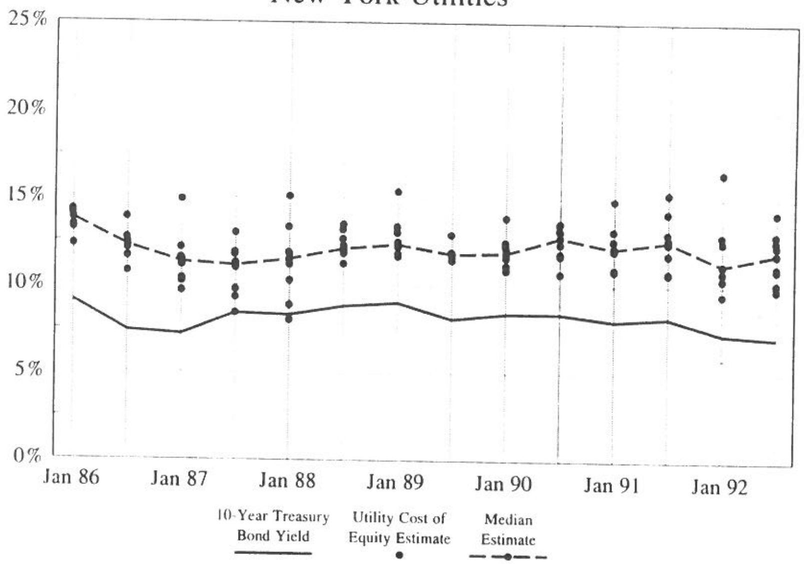
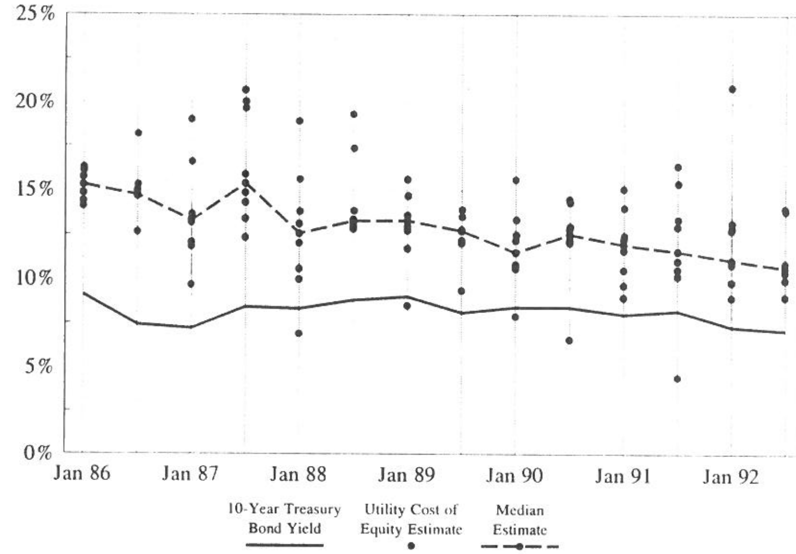


Figure 2: (a,b)

VG-Q920 Cost of Equity Estimates
New York Utilities



CG-IBES Cost of Equity Estimates
Comparable Utilities

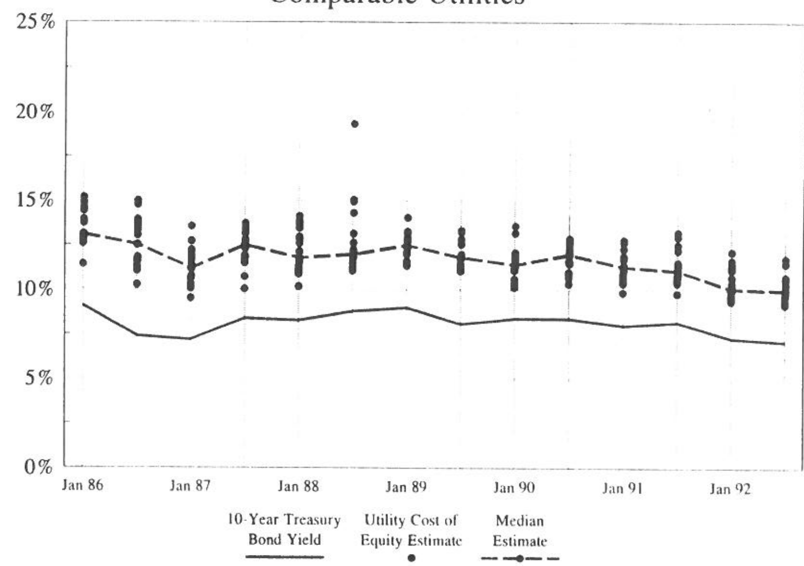
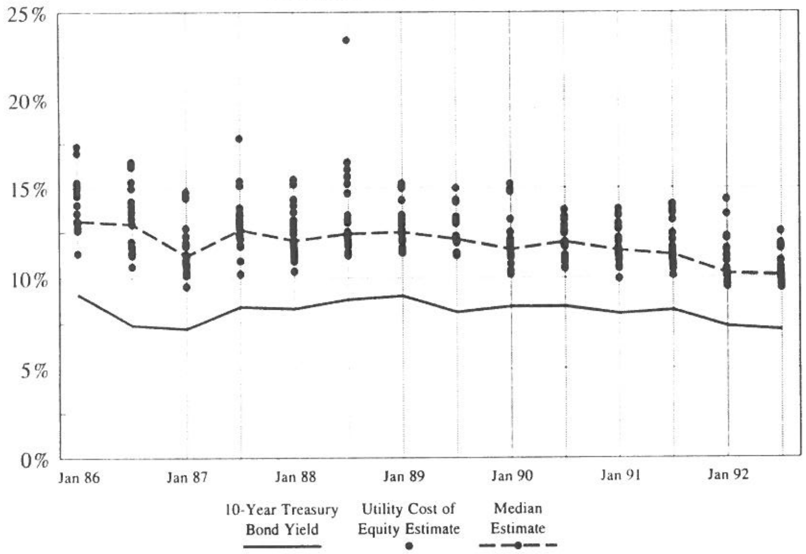


Figure 2: (c,d)

VG-IBES Cost of Equity Estimates
Comparable Utilities



VG-Q920 Cost of Equity Estimates
Comparable Utilities

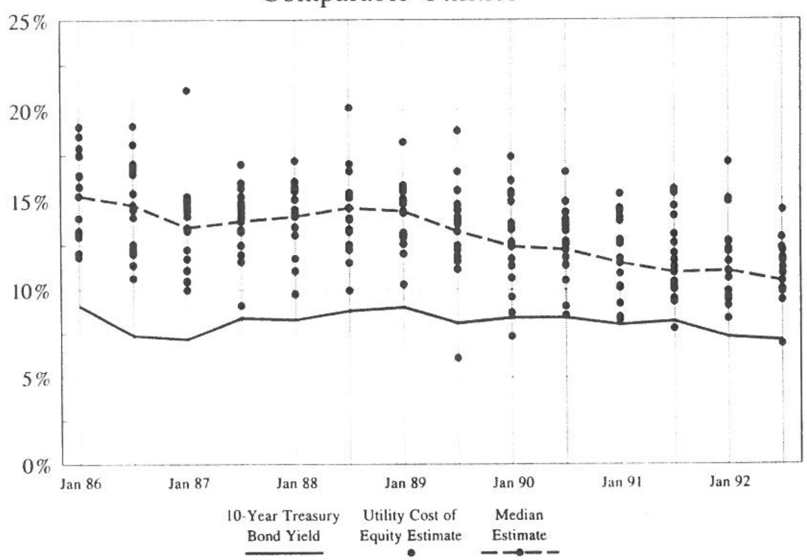


Figure 2: (e,f)

Average Backcasted Cost of Equity Estimates
For New York Utilities

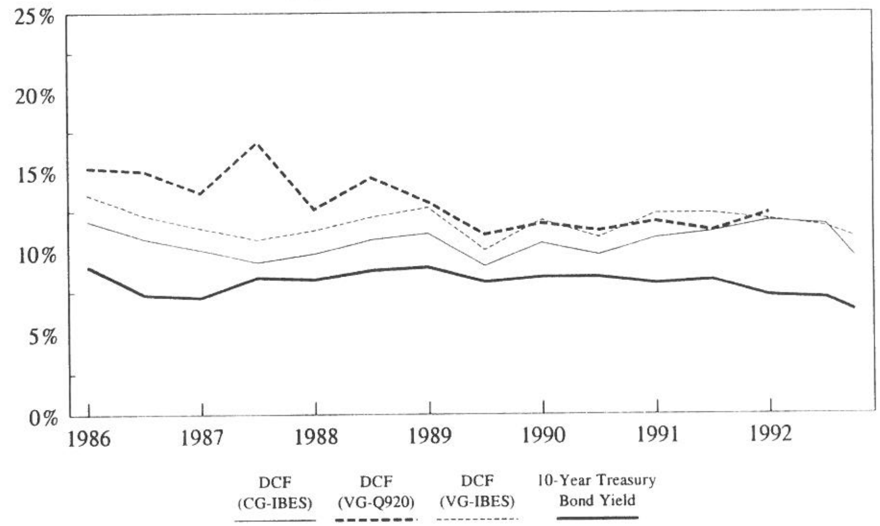


Figure 3:

Utility G: Backcasted Cost of Equity Estimates

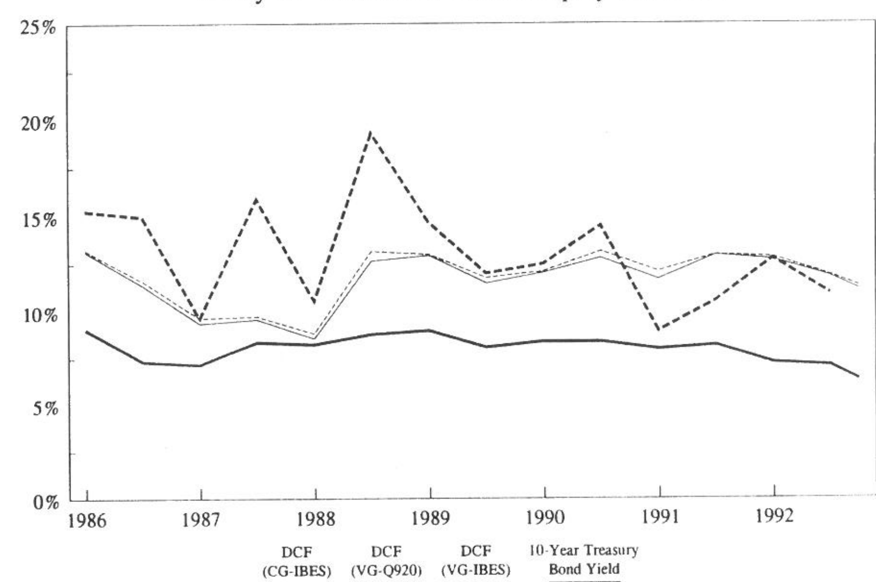


Figure 4: (a)

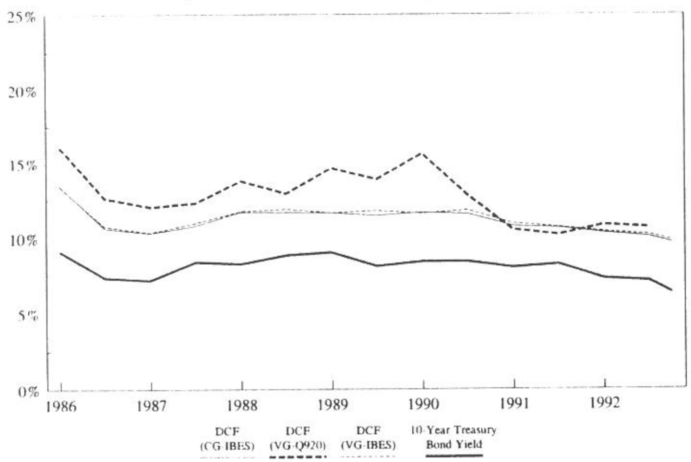


Figure 4: (b)

The scatter of the DCF estimates proves that DCF's simplifying assumptions are not satisfied in real life. That does not render the method useless, but does underline the importance of relying on benchmark averages, adjusted as necessary, rather than on single-company DCF estimates. Likewise, it underlines the importance of not locking into a single DCF formula, and the importance of not relying on DCF without confirmation from other methods.

APPENDIX

This Appendix contains a detailed description of inputs, models and results. We first describe data sources and sample selection, then the methodology for the constant- and variable-growth DCF models. The methodologies for backcasting and the leverage and SV adjustments are covered last.

DATA SOURCES

Stock prices are averages of closing stock prices for the period September 1–22, 1992, as reported by CompuServe. This time period coincides with the forecast period of the Institutional Brokers Estimate System (I/B/E/S) monthly *Earnings Estimate Report*.

Dividends are based on the last recorded dividend payments as reported by CompuServe, in most cases the third-quarter dividend. We assumed that the next dividend was to be paid at the start of the fourth quarter.

Growth rate estimates were obtained from several sources. Investment analysts' average earnings and growth rate forecasts were taken from the September I/B/E/S report. The I/B/E/S mean five-year annual earnings growth rate was employed directly in several models. The I/B/E/S earnings forecasts also allowed us to calculate annual growth rates for the remainder of fiscal year 1992, fiscal year 1993 and for fiscal years 1994 through 1996. That is, the I/B/E/S growth rate for year one, for year two and for years one through five inclusive, imply an average growth rate for years three through five.

We compared the I/B/E/S and Value Line earnings forecasts. Reported actual 1991 earnings per share differed substantially for some utilities. The differences are attributable to nonrecurring losses or gains included in I/B/E/S but excluded from Value Line. For purposes of estimating expected growth rates the nonrecurring charges should not be included. The actual 1991 earnings reported by I/B/E/S were adjusted to exclude the nonrecurring charges.

Growth rates were also derived from data reported in the most recent *Value Line Investment Survey* covering each company. For most utilities these editions were published in late September to mid-October. However, for a small number of utilities the most recent edition was July.

SAMPLE

DCF cost of equity estimates were obtained for the nine New York utilities, a sample of large utilities operating outside New York (the Comparable Utilities Sample) and for Matched Utilities for each of the nine New York utilities. The utilities in each sample are identified in Table A-1. Selection criteria are described below.

Comparable Utilities Sample. This is a sample of stable utilities for which the DCF method should work well. Large utilities with a history of smoothly growing earnings and dividend payments are most likely to meet the assumptions of the DCF model. The following criteria were used to select the utilities for the Comparable Utility Sample.

> *Long Term Stability*: The utilities chosen had steady growth in earnings and dividends for a period of at least 12 years.
> *Size*: The utility chosen had relatively large book assets compared to other utilities in the same geographical area.
> *Geography*: The utilities chosen represent a cross section of the entire country except New York. Value Line reports separate East, Central and West utilities. Equal numbers of utilities from each area were selected.
> *Other*: Utilities were screened for several other factors, including large recent cost disallowances, dividend cuts, extreme movements in stock price, problems with regulatory agencies, and large amounts of nuclear power

Table A-1: The samples.

New York Utilities	***Comparable Utilities***
A - National Fuel Gas Company	AA - Southwestern Public Service Company
B - Long Island Lighting Company	BB - Texas Utilities Company
C - Niagra Mohawk Power Corporation	CC - Wisconsin Energy Corporation
D - Consolidated Edison Company of New York, Inc.	DD - Public Service of Colorado
E - Orange & Rockland Utilities, Inc.	EE - Central Maine Power Company
F - Central Hudson Gas & Electric Corporation	FF - Pacific Gas & Electric Company
G - Rochester Gas & Electric Corporation	GG - Houston Industries, Inc.
H - Brooklyn Union Gas Company	HH - Northern States Power Company
I - New York State Electric & Gas Corporation	II - IPALCO Enterprises, Inc.
	JJ - Northeast Utilities
	KK - Puget Sound Power & Light Company
	LL - SCE Corp
	MM - Minnesota Power & Light Company
	NN - Duke Power Company
	OO - Potomac Electric Power Company
	PP - Allegheny Power System, Inc.
	QQ - Southern Company

Table A-1: (continued) The samples.

Utility A Matched Sample		***Utility B Matched Sample***		***Utility C Matched Sample***	
Montana Power Company	A1	Niagra Mohawk Power Corporation	B1	Pennsylvania Power & Light Company	C1
NICOR, Inc.	A2	Centerior Energy Corporation	B2	General Public Utilities Corporation	C2
MCN Corporation	A3	Pennsylvania Power & Light Company	B3	Baltimore Gas & Electric Company	C3
Peoples Energy Corporation	A4	Consolidated Edison Company of New York, Inc.	B4	Northeast Utilities	C4
Brooklyn Union Gas Company	A5	Carolina Power & Light Company	B5		
WICOR, Inc.	A6				
Utility D Matched Sample		***Utility E Matched Sample***		***Utility F Matched Sample***	
FPL Group, Inc.	D1	Central Louisiana Electric Company, Inc.	E1	Sierra Pacific Resources	F1
Detroit Edison Company	D2	Sierra Pacific Resources	E2	Orange & Rockland Utilities, Inc.	F2
Houston Industries, Inc.	D3	Wisconsin Public Service Corporation	E3	MDU Resources Group, Inc.	F3
Philadelphia Electric Company	D4	Central Hudson Gas & Electric Corporation	E4	Nevada Power Company	F4
American Electric Power Company, Inc.	D5	MDU Resources Group, Inc.	E5	TNP Enterprises, Inc.	F5
Public Service Enterprise Group, Inc.	D6	Nevada Power Company	E6		
Utility G Matched Sample		***Utility H Matched Sample***		***Utility I Matched Sample***	
Utilicorp United, Inc.	G1	MCN Corporation	H1	Hawaiian Electric Industries, Inc.	I1
Idaho Power Company	G2	Northwest Natural Gas Company	H2	New England Electric System	I2
LG&E Energy Corporation	G3	NICOR, Inc.	H3	DQE	I3
CIPSCO, Inc.	G4	San Diego Gas & Electric Company	H4	Florida Progress Corporation	I4
Atlantic Energy, Inc.	G5	Peoples Energy Corporation	H5	Northeast Utilities	I5
Delmarva Power & Light Company	G6	National Fuel Gas Company	H6		
		Montana Power Company	H7		

liabilities. If a utility had one of these problems it was excluded from further examination.

Matched Utility Sample. We selected a set of matched utilities for each New York utility. First, a purely statistical screen was performed. Each New York utility was compared to all publicly-traded United States utilities for which data were available from Lotus OneSource. Each utility was screened for total value of assets, market-to-book ratio, and beta, in that order. This gave eight to ten utilities for each New York utility. These matched utilities were then checked for qualitative factors such as large recent cost disallowances, large nuclear power exposure, substantially different power generation mixes, and problems with regulatory commissions. Utilities failing any of these criteria were eliminated from the portfolio.

CONSTANT-GROWTH DCF MODEL

For the nine New York utilities we estimated the constant-growth DCF model using three different estimates of the growth rate, g_{DIV}.

CG-IBES Model: I/B/E/S five-year annual earnings forecasted growth rate

CG-VL Model: Implied Value Line long-run average earnings growth rate[1]
Growth Rate = $(EPS_{95-97}/EPS_{92})^{1/4} - 1$

CG-SG Model: Sustainable growth rate implied from long-term Value Line forecasts; retention growth plus the SV adjustment[2]
Growth Rate = $ROE_{95-97} \times (1 - \text{Payout Ratio}_{95-97}) + \text{SV adjustment}$

The three constant-growth DCF models were estimated for the New York utilities, for the Comparable Utility Sample and for the three matched samples. Only the constant-growth model using the I/B/E/S five-year annual earnings forecasted growth rate was estimated for the remaining six matched portfolios.

VARIABLE-GROWTH DCF MODEL

The variable-growth DCF models make use of the year-by-year growth rate information available from I/B/E/S. The variable-growth model is premised on the same present value relationship as the constant-growth model. It assumes that the market price of a stock equals the present value of forecasted dividends per share. This present value can be calculated by the standard formula for the present value

[1] If the Value Line report indicated that 1992 earnings were unusual, due to mild weather for example, the long-term earnings growth rate was estimated from 1993 instead.

[2] The Value Line end-of-year ROE estimate was divided by one minus the retention growth rate to derive a beginning-of-year ROE estimate.

of a cash flow stream:

$$P = \frac{DIV_1}{(1+r)} + \frac{DIV_2}{(1+r)^2} + \cdots + \frac{DIV_T + P_{TERM}}{(1+r)^T},$$

where P is the market price of the stock; DIV_t is the dividend expected at the end of period t; r is the cost of equity; T is the last period for which dividends are explicitly forecasted, and P_{TERM} is the expected stock price at which the stock is assumed to be sold. The cost of equity can be calculated given the current stock price, forecasts for dividends, and P_{TERM}.

The variable-growth model assumes that the third-quarter 1992 dividend is the first dividend to be received.[3] Since our price data coincides with the end of the third quarter, but is prior to the ex-dividend date, the dividend is not discounted. The fourth-quarter dividend is equal to the third-quarter dividend increased by one quarter's growth at the growth rate in earnings forecasted by I/B/E/S for fiscal year 1991 to 1992. For 1993, the dividends increase by the growth rate in earnings forecasted by I/B/E/S for fiscal year 1992 to 1993. Dividends for the years 1994 through 1996 increase at the implied quarter nine to 20 earnings growth rate.

The terminal price, P_{TERM}, is estimated as

$$P_{TERM} = \frac{DIV_{T+1}}{(r - g_{TERM})},$$

where DIV_{T+1} is the last period dividend increased at the quarter nine to 20 growth rate and g_{TERM} is the expected long-term growth rate.

We considered three long-term growth rates:

VG-Q920 Model: Derived I/B/E/S quarter nine to 20 earnings growth rate

VG-IBES Model: I/B/E/S mean five-year earnings growth rate forecast

VG-SG Model: Sustainable growth rate implied from Value Line forecasts, equal to retention growth plus the SV adjustment. This is the same growth rate used in model CG-SG.

These variable-growth models were estimated for the nine New York utilities, the Comparable Utility Sample and the three matched samples. Only the variable-growth models using the I/B/E/S mean five-year earnings growth rate forecast and the derived quarter nine to 20 growth rate were estimated for the remaining six matched samples.

BACKCASTING

The constant- and variable-growth models using the I/B/E/S mean five-year earnings growth forecast and the variable-growth model using the derived quarter nine

[3] For utilities with the fiscal year ending in September, the first dividend is the fourth-quarter dividend.

to 20 growth rate were also estimated semi-annually from 1986 to 1992. The models were backcasted only for the New York and Comparable Utilities.

I/B/E/S data were made available to us on a monthly basis for this period. Dividend data were retrieved from CompuServe. The fourth-quarter dividend from the prior year was the first dividend for the January models. The second quarter of the current year was the first dividend for the June estimates. Stock prices are monthly averages of closing stock prices for January and June, as reported by CompuServe.

ADJUSTMENTS

Leverage. Cost of equity estimates for the Comparable Utilities and Matched Samples were adjusted for differences in financial leverage. We started by assuming that the *overall* cost of capital does not depend on capital structure.[4]

$$\text{Overall cost of capital} = r_D \frac{D}{V} + r \frac{E}{V}.$$

The leverage adjustment required two steps. First, the cost of equity estimate r, the cost of debt r_D, and the actual market debt-to-value (D/V) and equity-to-value (E/V) ratios were used to calculate each company's overall cost of capital. Then this overall cost of capital was "relevered" to obtain a cost of equity at a debt ratio matching the New York utilities. The Comparable Utilities' costs of equity were relevered to the average debt-to-equity ratio of the New York utilities. Estimates for the utilities in each matched sample were relevered to the debt ratio of the respective New York utility.

The cost of debt for each utility was determined by its bond rating as reported in *Standard & Poor's Corporation Bond Guide* for September 1992. Corporate bond yields are averages for the week of September 18–24, 1992 from *Moody's Bond Survey*.

The SV Adjustment. The following two examples illustrate when and why an "SV adjustment" to a forecasted sustainable growth rate is necessary. The adjustment is

$$\text{SV Adjustment} = \frac{g_{SHARES} M}{B}\left(\frac{M - B}{M}\right),$$

where g_{SHARES} is the growth rate of outstanding shares, M is the market value of common equity and B is the book value of common equity.

The SV adjustment is positive when the market-to-book ratio exceeds one, and is proportional to the fraction of equity financing from new issues of common stock. Thus, the adjustment is often attributed to the ability to issue shares at above book price. That is not correct, because the adjustment is needed only when the funds raised by stock issues are invested at a rate of return above the cost of equity capital.

The example in Table A-2 revisits Company 3—see Table 2. Company 3 is on a perfect steady growth path, exactly matching the assumptions of the constant-growth DCF method. Suppose it expands its capital investment program, and finances an additional investment of \$200 million entirely with common stock. (Part of the earnings on these new assets is then plowed back to maintain Company 3's 7.0% growth rate.) The new stock is issued at \$25.45, well above the book value per share of \$20.40. However, no SV adjustment is needed because the new assets are forecasted to earn only the cost of equity capital (12.5%). Notice that the stock price, dividend yield, and sustainable growth rate are unaffected by the new investment and financing. Therefore the unadjusted constant-growth DCF formula gives the right answer.

Table A-2 demonstrates that no value or additional return is created just by issuing stock at prices above book. For this demonstration one stock issue is sufficient. More complex examples, in which stock is issued in several future periods, give *exactly* the same result, *provided* that the proceeds are invested at the cost of equity. The constant-growth DCF model will work in these examples so long as the other assumptions of the model are satisfied.

When current or future investments earn more than the cost of equity, stockholders gain regardless of how the investment is financed. However, the constant-growth DCF method will miss part of the return to investors when sustainable growth rates are used and investment is financed partly by stock issues. The SV adjustment is intended to pick up the missing return.

The SV adjustment assumes stock issues in every future period, each issue financing the same fraction of new investment. The example in Table A-3 incorporates that assumption.

The example assumes that 20% of Company 3's original investment program, which is forecasted to earn 14%, 1.5% above the cost of equity, is financed by stock issues. The issues continue year after year. Issue prices are above book values. The beginning stock price is unchanged, but dividend yield is up because the common stock financing allows higher payout. The sustainable growth rate, which is based on the retention rate, falls, and a 0.3% SV adjustment is necessary to obtain the correct 12.5% cost of equity.

The example in Table A-3 is the more natural case in the constant-growth DCF model, which assumes that future ROE is constant and ascribes any stock price above book to current and future ROEs above the cost of equity. Of course, these DCF assumptions are not usually satisfied in real life, for the several reasons given in the text of this paper.

[4] This implies that the after-tax weighted average cost of capital declines as D/V increases, but that the risk of the present value of interest tax-shields is the same as the asset and operating risk of the company. However, if interest tax shields are safe, debt-equivalent cash flows, then a tax adjustment enters the unlevering and relevering. *See* Taggart (1991) for a review of alternative treatments of taxes in cost of capital calculations.

Table A-2: No SV adjustment is required when stock issue proceeds are invested at the cost of equity. Example based on Company 3, with a one-shot stock issue.

Period	1	2	3	4	5	6
Original Assets	\$2,000	\$2,140	\$2,290	\$2,450	\$2,622	\$2,805
Earnings on Original Assets at 14%	280	300	321	343	367	393
Retention on Original Assets	140	150	160	172	184	196
New Assets	200	214	229	245	262	281
Earnings on New Assets at 12.5%	25	27	29	31	33	35
Retention on New Assets	14	15	16	17	18	20
Total Dividends	151	162	173	185	198	212
Book Value per Share	\$20.40	\$21.83	\$23.35	\$24.99	\$26.74	\$28.61
Earnings per Share	2.83	3.03	3.24	3.46	3.71	3.97
Dividends per Share	1.40	1.50	1.60	1.72	1.84	1.96
Stock Price	25.45	27.24	29.14	31.18	33.37	35.70
Dividend Yield (%)	5.5	5.5	5.5	5.5	5.5	5.5
Average ROE (%)	13.9	13.9	13.9	13.9	13.9	13.9
Retention Ratio (%)	50.5	50.5	50.5	50.5	50.5	50.5
Sustainable Growth Rate (%)	7.0	7.0	7.0	7.0	7.0	7.0
DCF Cost of Equity Estimate (%)	12.5	12.5	12.5	12.5	12.5	12.5

Notes: All figures in millions except for per share values. All flows are assumed to be received at the end of the period. Stock price and book value per share are as of the beginning of the period. Stock prices are present values of subsequent dividends and the terminal price in year 5. The terminal price is calculated from the constant-growth DCF formula using the year-6 dividend and a 7% long-term growth rate. Company 3 starts with 100 million outstanding shares. 7.9 million new shares are issued at the beginning of period one at \$25.45 per share to finance \$200 million of new assets.

Table A-3: SV adjustment is required when stock issue proceeds are not invested at the cost of capital. Example based on Company 3, with continuous stock issues.

Period	1	2	3	4	5	6
Assets	\$2,000	\$2,140	\$2,290	\$2,450	\$2,622	\$2,805
Earnings on Original Assets at 14%	280	300	321	343	367	393
New Investment	140	150	160	172	184	196
Total Dividends	168	180	192	206	220	236
Equity Shortfall	28	30	32	34	37	39
Number of New Shares Issued	1.0	1.0	1.1	1.1	1.1	1.1
Book Value per Share	\$20.00	\$21.18	\$22.43	\$23.75	\$25.15	\$26.64
Earnings per Share	2.80	2.97	3.14	3.33	3.52	3.73
Dividends per Share	1.68	1.78	1.88	2.00	2.11	2.24
Stock Price	25.45	26.96	28.55	30.23	32.01	33.90
Dividend Yield (%)	6.6	6.6	6.6	6.6	6.6	6.6
Retention Ratio (%)	40.0	40.0	40.0	40.0	40.0	40.0
ROE (%)	14.0	14.0	14.0	14.0	14.0	14.0
Sustainable Growth Rate (%)	5.6	5.6	5.6	5.6	5.6	5.6
SV Adjustment (%)	0.3	0.3	0.3	0.3	0.3	—
DCF Cost of Equity Estimate (%) (without SV Adjustment)	12.2	12.2	12.2	12.2	12.2	—
DCF Cost of Equity Estimate (%) (with SV Adjustment)	12.5	12.5	12.5	12.5	12.5	—

Notes: All figures in millions except for per share values. All flows are assumed to be received at the end of the period. Stock price and book value per share are as of the beginning of the period. Stock prices are present values of subsequent dividends and the terminal price in year 5. The terminal price is calculated from the constant-growth DCF formula using the year-6 dividend and the 5.9% long-term growth rate in dividends. The payout ratio is assumed to be 60%. Company 3 has 100 million outstanding shares at the beginning of period one. New shares are issued at the end of each period. The number of shares issued is sufficient to meet the shortfall created by maintaining a 60% payout ratio and maintain the value of the company in each period.

Table A-4: Company 1—Financial performance data.

Period	1	2	3	4	5	6
Book Value Per Share	$20.00	$21.80	$23.67	$25.58	$27.51	$29.44
ROE (%)	14	14	14	14	14	14
Earnings Per Share	2.80	3.05	3.31	3.58	3.85	4.12
Payout Ratio (%)	36	39	42	46	50	50
Dividends Per Share	1.00	1.19	1.40	1.65	1.93	2.06
Stock Price	25.70	27.91	30.21	32.59	35.02	37.47
Dividend Yield (%)	3.9	4.2	4.6	5.1	5.5	5.5
GROWTH RATES (%)						Five-Year Average
Sustainable Growth Rate	9.0	8.6	8.1	7.6	7.0	8.0
Earnings Per Share	9.0	8.6	8.1	7.6	7.0	8.0
Dividends Per Share	18.6	18.1	17.6	17.0	7.0	15.6
Stock Price	8.6	8.3	7.9	7.4	7.0	7.8

Notes: The cost of equity is assumed to be 12.5%. All flows are assumed to be received at the end of the period. Stock price and book value per share are as of the beginning of the period. Stock prices are present values of subsequent dividends and the terminal price in year 5. The terminal price is calculated from the constant-growth DCF formula using the year-6 dividend and a 7% long-term growth rate.

COMPANY EXAMPLES

Table A-4 shows backup calculations for Company 1 figures shown in Table 2.

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