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# The FERC's Discounted Cash Flow: A Compromise in the Wrong Direction

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# The FERC's Discounted Cash Flow: A Compromise in the Wrong Direction

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The Federal Energy Regulatory Commission has erred in its use of discounted cash flow models for calculating generic rate of return for public utilities. The FERC has failed to make the elementary distinction between nominal and effective annual interest rates when employing the discounted cash flow model. Instead of employing a quarterly discounted cash flow model, which would eliminate the necessity for a compromise, the commission has used two nominal continuous discounted cash flow models. These erroneous calculations have cost utility investors significant sums of money.

The discounted cash flow (DCF) method is the centerpiece of recent regulatory efforts to estimate utilities' cost-of-equity capital. It is regularly referenced by most regulatory commissions in their rate case orders, and it is almost universally employed in some fashion by rate of return witnesses, including the present authors. Because of a widespread misperception about proper applications, however, the DCF method is not being properly used at a basic level, and it is probably costing utility equity investors millions of dollars.

The irony of this serious situation is that the source of the DCF misuse, far from being complicated and technical in nature, is easily understood by anyone who has ever opened a savings account and observed the posted difference between nominal and effective annual interest rates. The problem, in fact, has arisen from the failure of many in the utility regulatory business to recognize the difference between such nominal and effective annual interest rates when applying the DCF.

This inability to distinguish between nominal and effective annual interest rates has reached its greatest visibility in recent Federal Energy Regulatory Commission actions. The FERC, in its recent Order Nos. 420, 442, and 461, has attempted to establish procedures for the generic determination of the rate of return for public utilities. We will use the FERC actions for illustration, not because the commission has made a unique error, but because through its comprehensive discussion of the subject it has provided a clear example of this error related to the DCF method.

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The FERC, in Order No. 420, relied heavily on the two simplest and most widely used of the various DCF models that had been presented for its consideration. The two differ only in the *assumed* timing of dividend payments. One, the "continuous" DCF, carries the assumption that dividend payments to investors are made in a continuous stream. The other, the "annual" DCF, assumes one annual dividend payment. (The continuous and annual DCF formulas are shown as equations 3 and 6, respectively, in the Appendix to this article.)

With a given set of input parameters, the FERC recognized the fact that under reasonable circumstances the continuous DCF gives a lower cost-of-equity figure than the annual DCF. Eschewing the use of more complicated models, and realizing that neither of these simple DCF models reflects utilities' actual practice of quarterly dividend payments, the FERC employed a compromise formula that gives a cost-of-equity figure between the two. In support of this compromise, the commission stated:

> On the review of the proposed models, the commission believes the "best" model to rely on for the purposes of this proceeding is model (2) [the compromise]. The commission is most persuaded by the

argument that the actual required rate of return is somewhere between the estimates derived from the continuous compounding and discrete annual DCF models.[1]

The error in this seemingly valid line of reasoning is that the FERC, in this order, dictated the use of a compromise between two *nominal* DCF models to calculate a supposedly *effective annual* rate of return.

The continuous DCF model that has been widely used and referenced by the FERC and other regulatory commissions is, in fact, a nominal formula, not unlike the nominal interest rates listed by a bank on its various types of customer accounts. However, while banks always translate an interest rate with multiple yearly compoundings into an effective annual rate for their customers, the effective annual rate corresponding to the continuous DCF has been ignored by the FERC.

Banks list the effective annual rate so that their customers have a standard for comparison between financial instruments with different compoundings.[2] More frequent compoundings raise the effective annual rate and yield to the customer. This is true also for dividend payments — the more frequently dividends are paid, everything else being equal, the higher the effective annual yield to shareholders.

Regulatory treatment errs when the continuous DCF model is used to represent the annual required return to equity investors. To see this, consider that given a set of parameters, the continuous DCF model used by the FERC and other regulators results in a lower cost-of-equity figure than the annual DCF model. Any passbook saver would question this result. Given the same parameters, more frequent dividend payments — i.e., compoundings — should result in *higher*, not lower, effective annual yields and hence cost-of-equity calculations.

[1]FERC Docket No. RM84-15-000, Order No. 420, Federal Energy Guidelines, paragraphs 30,644, page 31,349.

[2]As an additional example, as required by law, the APR (annual percentage rate), an effective annual rate, is provided on all loans by lenders to provide a basis for rate comparisons be borrowers.

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This seeming discrepancy is easily resolved because there are *two* different forms for the continuous DCF model, not just one as seems to be widely assumed. There is a *nominal* continuous DCF (the one used by the FERC and others) and an *effective annual* continuous DCF which translates the continuous dividend payments into an effective annual yield (this effective annual continuous DCF formula is derived and shown in the Appendix of this article as equation 11).

The effective annual continuous DCF model give, the intuitive result; which is, that with a given set of parameters, a greater number of dividend payments means a *higher* annual yield to shareholders. This can be demonstrated using a simple, intuitive example applied first to simple interest on a savings account, and second to the slightly more complicated example of a cost-of-equity calculation arising from the DCF model. The illustration points out the heart of the present discussion — the time value of money.

If a saver receives an annually compounded interest payment on $100 of savings of 10 per cent, at the end of the first year he or she has $110. For cases of yearly compounding, the nominal and effective annual rates by definition coincide at 10 per cent. However, if the interest is compounded and paid twice a year instead of once, the saver receives $5 at the end of the first six months. If that $5 is left in the account, the interest for the second six months will be based on a principle of $105. If not reinvested, the saver will still pocket this $5 six months sooner than under annual compounding. Either way, the saver is better off, and for multiple yearly compoundings the effective annual interest rate is greater than the nominal interest rate of 10 per cent.

The logic is the same for the common stockholders. If dividends are paid once a year, then the cost-of-equity figure that the DCF gives is, by definition, both a nominal and effective annual cost of equity. However, if the yearly dividend payment is split in half and paid semiannually the stockholder will get a chance either to reinvest the money or pocket it six months sooner than under the annual payment. Therefore, with a fixed set of DCF parameters, more frequent assumed compounding leads to greater cost-of-equity calculations as a result — exactly analogous to the savings account example.

The effective annual continuous DCF, which to the present authors' knowledge has never appeared in regulatory proceedings, allows this common sense result to hold; namely, that when viewed on a consistent annual basis, the assumption of continuous compounding produces a higher cost-of-equity result than the assumption of annual compounding. Suppose that an investor faces two stocks with the same price, the same dividend growth expectation, and the same risk. If one stock pays dividends once annually and the other pays dividends daily, the investor would require the annual payment to be greater than the sum of the daily payments to be indifferent between the two.

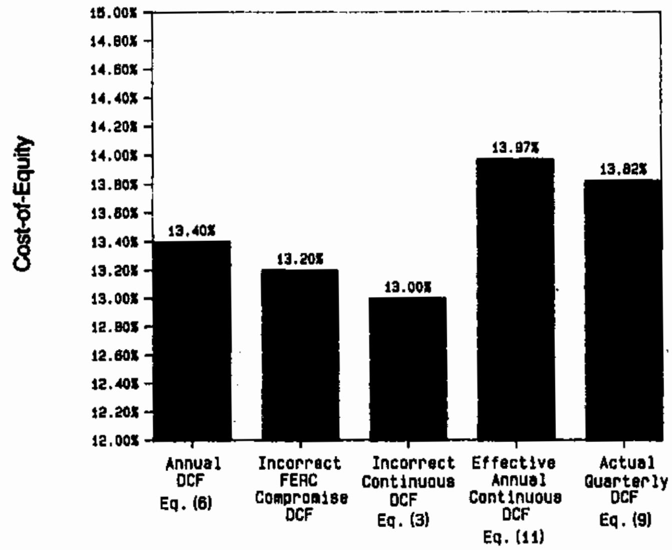
This comparison of effective annual yields is exactly what has been missed by regulatory commissions and rate of return witnesses when a compromise formula is used which falls between two nominal DCF versions for the purpose of approximating quarterly dividend payments. In fact, when the comparison of different DCF models is made on the correct effective annual basis, no such ad hoc compromise is necessary because real-world situations of quarterly dividend payments can be expressed exactly in a DCF model.

Such an effective-annual quarterly DCF model is derived in the Appendix as equation 9. This particular formula is not new. It has been employed by a few witnesses in regulatory proceedings, including ourselves, for some time. It has not to our knowledge, however, been employed by regulatory commissions for the purpose of finding the cost of equity capital. The FERC moved in the direction of allowing the quarterly DCF formula derived in the computational Appendix to be used in its generic rate of return proceedings on Order 442, but backtracked in Order 442-A and Order 461, continuing to rely on the errant compromise between two nominal DCF formulas.

The accompanying figure demonstrates that, for a fixed set of inputs, the different DCF models discussed in this article can result in surprisingly different DCF results. Most striking is the difference between the two continuous DCF formulas. In the example shown, the nominal and effective annual continuous DCF models differ by 97 basis points. The figure also shows that the FERC compromise falls, as it is supposed to, exactly between the annual and nominal continuous DCF formula results. (The FERC compromise formula is shown in the Appendix.) The compromise, however, to be correct, should lie *above* the annual DCF, between the annual and effective annual DCF formula results. In practice, however, it is seen from the figure that such a compromise is unnecessary because the quarterly DCF model can be used instead. The quarterly DCF model falls right where it should, between the annual DCF and effective annual continuous DCF.

The errant FERC compromise falls 62 basis points below the quarterly DCF in our example. Any other reasonable example would produce a similarly serious understatement of the quarterly DCF result by the FERC compromise. To the extent that the DCF methodology is in any way useful, or relied upon, to derive the cost of equity, our results demonstrate that the FERC compromise biases the calculated results downward right from the start.

**How the FERC Compromise Understates The Actual Quarterly Formula**




**DCF Inputs:**

Price = $25.00
Yearly Dividend = $ 2.00
Growth Rate = 5.00%

We do not intend to specify here the proper techniques to employ to derive the final cost of equity for public utilities accurately in regulatory proceedings. Such is a topic for lengthy tomes, not short articles. What we do wish to communicate, however, is that if it is the intention of regulators to employ the DCF model as an input, or as a starting point, into their determination of the cost of equity, then at least they should begin with the correct, most real-world, version of the model. A model which reflects quarterly dividend payments *on an effective annual basis* is the correct starting point for a DCF analysis of the cost of equity. Once the proper starting point has been established, all the other various additions, subtractions, modifications, and judgement concerning the weight to be given to the calculated result can then be applied in the manner that each regulator sees fit.

## Appendix

The DCF methodology grew out of Professor Myron J. Gordon's work on stock valuation models, which was first published in complete form in 1962 (*The Investment, Financing and Valuation of the Corporation*, published by Irwin). The cost of equity is derived from his following stock valuation equation.

$$P_o = \int_0^{\infty} D_t e^{-kt} dt \qquad (1)$$

where: $P_o$ = stock price in the current period
$D_t$ = dividend paid at time t
$k$ = $k_e$ = investor required return (cost of equity)



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If we assume that the dividend grows at a constant rate, and perform the integration, we get:

$$P_o = \frac{D_o}{k_e - g} \qquad (2)$$

where: $D_o$ = last previous dividend
$k_e$ = cost of equity
$g$ = growth rate in dividends

Solving for $k_e$, we get the continuous DCF model:

$$k_e = \frac{D_o}{P_o} + g \qquad (3)$$

Dividends, however, are not received continuously and cannot be continuously reinvested by the investor. The rate of return represented by $k_e$ in this equation also suffers from being a continuous rate, not an annual rate which could be compared to other investments. Therefore, subsequent writers (including Gordon himself), modified this initial approach to reflect annual dividend payments. The resulting modification is known as the "periodic" DCF model.

The annual "periodic" DCF model is derived from the following stock valuation model which differs from equation (1) by the assumption that dividends are paid in annual lump sums:

$$P_o = \frac{D_1}{(1+k_e)} + \frac{D_2}{(1+k_e)^2} + \ldots + \frac{D_n}{(1+k_e)^n} + \ldots \qquad (4)$$

Where: $D_1, \ldots, D_n$ = expected dividends in periods 1 to n

If dividends are assumed to grow at a constant growth rate, g, we can rewrite equation (4) as:

$$P_o = \frac{D_o(1+g)}{(1+k_e)} + \frac{D_o(1+g)^2}{(1+k_e)^2} + \ldots + \frac{D_o(1+g)^n}{(1+k_e)^n} + \ldots$$

Where: $D_o$ = the last previous dividend payment (5)

Equation (A.4) can be solved for $k_e$ to obtain:

$$k_e = \frac{D_o(1+g)}{P_o} + g \qquad (6)$$

Equation (6) is the familiar equation for the annual DCF cost of equity.*

*The FERC compromise we criticize in this article is an ad hoc variation of equations (3) and (6):

$$k_e = \frac{D_o(1+g/2)}{P_o} + g$$

The above DCF model, equation (6), assumes annual dividend payments and a constant annual growth rate. It is also the model most commonly used in regulatory proceedings. However, if dividends are paid quarterly, rather than annually, equation (6) can understate the cost of equity. Because there is a time value of money, annual and quarterly dividend payments are not perfect substitutes. An effective annual quarterly DCF could start with the relationship:

$$P_o = \frac{D_o^*(1+g)^{.25}}{(1+k_e)^{.25}} + \frac{D_o^*(1+g)^{.5}}{(1+k_e)^{.5}} + \frac{D_o^*(1+g)^{.75}}{(1+k_e)^{.75}} + \ldots \qquad (7)$$

Where: $D_o^*$ = last quarterly dividend payment.

This DCF model would be an acceptable quarterly model except for the assumption that dividend payments grow each quarter. A variant of equation (7) which allows the quarterly dividends to increase only once a year is shown in equation (A.7).

$$P_o = \frac{D_{o1}^*(1+g)}{(1+k_e)^{.25}} + \frac{D_{o2}^*(1+g)}{(1+k_e)^{.5}} + \frac{D_{o3}^*(1+g)}{(1+k_e)^{.75}} + \frac{D_{o4}^*(1+g)}{(1+k_e)^{1.00}} +$$

$$\frac{D_{o1}^*(1+g)^2}{(1+k_e)^{1.25}} + \frac{D_{o2}^*(1+g)^2}{(1+k_e)^{1.5}} + \frac{D_{o3}^*(1+g)^2}{(1+k_e)^{1.75}} + \frac{D_{o4}^*(1+g)^2}{(1+k_2)^{2.00}}$$

$$+ \frac{D_{o1}^*(1+g)^3}{(1+k_e)^{2.25}} + \frac{D_{o2}^*(1+g)^3}{(1+k_e)^{2.5}} + \ldots \qquad (8)$$

Where: $D_{o1}^*, \ldots, D_{o4}^*$ = last four previous quarterly dividend payments.

This model is a more accurate extension of equation (7). The DCF formula presented as equation (8) can be reduced to:

$$k_e = \frac{D_{o1}^*(1+k_e)^{.75} + D_{o2}^*(1+k_e)^{.5}}{P_o} + \frac{D_{o3}^*(1+k_e)^{.25} + D_{o4}^*}{P_o}(1+g) + g \qquad (9)$$

In this model, the last four dividend payments are specified explicitly. It is also assumed that each of the dividend payments is reinvested to years' end at the cost of equity. The model is, therefore, very attractive for the purpose of calculating the cost-of-equity capital for firms which pay dividends quarterly.

Equations (6) and (9) are DCF models that differ only in the assumption of the timing of dividend payments.

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As such, they are both special cases of the more general DCF formula:

$$k_{em} = \frac{D_o(1/m)\sum_{j=o}^{m-1} (1+k_{em})^{j/m}}{P_o} (1+g) + g \qquad (10)$$

Where: m = number of dividend payments per year
$k_{em}$ = cost of equity assuming m dividend payments per year
$D_o$ = last previous full year dividend

This equation yields both the annual and quarterly DCF formulas for the cases where m = 1 and m = 4, respectively. The effective annual continuous DCF is derived by taking:

$$\lim_{m \to \infty} k_{em}$$

Taking the limit of (11) as m (the number of yearly dividend payments) approaches infinity, employing L'Hospital's rule yields:

$$k_e = \frac{D_o[k_e/\ln(1+k_e)]}{P_o} (1+g) + g \qquad (11)$$

Equation (4) is the effective annual continuous DCF formula. It is the effective annual version of equation (2).