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STRATEGY

March 16, 2006

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Common Errors in DCF Models

Do You Use Economically Sound and Transparent Models?

Discounted cash flow analysis is the most accurate and flexible method for valuing projects, divisions, and companies. Any analysis, however, is only as accurate as the forecasts it relies on. Errors in estimating the key ingredients of corporate value . . . can lead to mistakes in valuation.

Tim Koller, Marc Goedhart, and David Wessels
Valuation: Measuring and Managing the Value of Companies [1]

A Return to First Principles

Say you had to come up with a fair offer to buy your local dry cleaner and the seller limited the extent of your financial information to the answers to five questions. Which questions would you ask?

Chances are you wouldn't ask how the quarter is progressing or about last year's earnings, but you would focus on the prospects for cash coming in versus cash going out over time. Sole proprietors understand intimately that the value of their business hinges on the cash flow the business generates. No distributable cash, no value. Cash puts food on the table and pays the mortgage; earnings do not.

Equity investors are business buyers. While most shareholders own only a small fraction of a company, they are owners nonetheless. The source of shareholder value, and value changes, is no different than the sole proprietor's: it's all about the cash.

Most investors don't think this way. In part, this is because market exchanges readily allow investors to trade cash today for claims on future cash flows, and vice versa, encouraging them to forget they are evaluating, buying, and selling businesses. Yet investors, as opposed to speculators, should never lose sight of their objective: buying a stream of cash flows for less than what it is worth.

Given that cash inflows and outflows are the lifeblood of corporate value, you might expect investors to be intent on measuring and valuing cash flows. Indeed, valuation in the bond and commercial real estate markets is all about cash. In practice, however, very few equity investors dwell on cash. Proxies for value, like earnings and multiples, dominate Wall Street valuation work.

Because markets are mostly efficient, investors can get away with using value proxies without awareness of what the proxies actually represent. The result is complacency and a false sense of understanding. As a consequence most investors don't do fundamental valuation work; when they do, they often do the work incorrectly.

First principles tell us the right way to value a business is to estimate the present value of the future cash flows. While most Wall Street professionals learned about discounted cash flow (DCF) models in school, in practice the models they build and rely on are deeply flawed. Not surprisingly, the confidence level in these DCF models is very low. This faint confidence is not an indictment of analytical approach but rather of analytical methods.

DCF models should be economically sound and transparent. Economically sound means the company's return and growth patterns are consistent with the company's positioning and the ample empirical record supporting reversion to the mean. Transparent means you understand the economic implications of the method and assumptions you choose. Most DCF models fail to meet the standards of economic soundness and transparency.

The List

Here's our list of the most frequent errors we see in DCF models. We recommend you check your models, or the models you see, versus this list. If one or more of the errors appear, the model will do little to inform your business judgment.

1. *Forecast horizon that is too short.* One of the most common criticisms of DCF models is that any forecast beyond a couple of years is suspect. Investors, therefore, are alleged to be better off using more certain, near-term earnings forecasts.

Such reasoning makes no sense, for at least two reasons. First, a key element in understanding a business's attractiveness involves knowing the set of financial expectations the price represents. The market as a whole has historically traded at a price-to-earnings multiple in the mid-to-high teens. Simple math shows today's stock prices reflect expectations for value-creating earnings and cash flows many years in the future.

To make the point more concrete, imagine you are a restaurant industry executive in charge of finding new store locations. When assessing the attractiveness of a prospective site, would you consider only two years of earnings because "any beyond that is guessing"? Of course not. You'd base your judgment on the location, past results for similar sites, and other value-relevant factors. Intelligent capital allocators take a long-term view.

The mismatch between a short forecast horizon and asset prices that reflect long-term cash flows leads to the second problem: investors have to compensate for the undersized horizon by adding value elsewhere in the model. The prime candidate for the value dump is the continuing, or terminal, value. The result is often a completely non-economic continuing value. This value misallocation leaves both parts of the model—the forecast period and continuing value estimate—next to useless.

Some investors swear off the DCF model because of its myriad assumptions. Yet they readily embrace an approach that packs all of those same assumptions, without any transparency, into a single number: the multiple.[3] Multiples are not valuation; they represent shorthand for the valuation process. Like most forms of shorthand, multiples come with blind spots and biases that few investors take the time and care to understand.

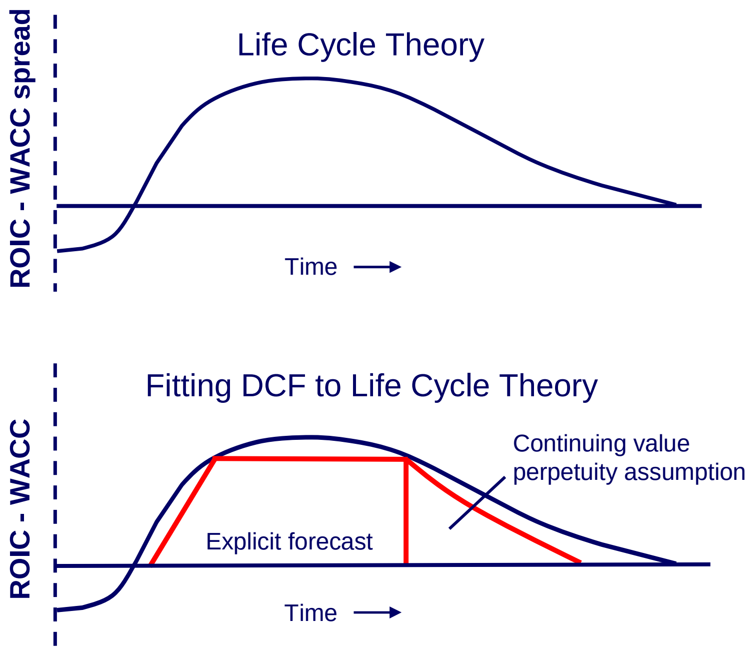
John Maynard Keynes famously said, "I'd rather be vaguely right than precisely wrong." His message applies here. We recommend explicit forecast periods of no less than five years, and note many companies require over ten years of value-creating cash flows to justify their stock prices. Ideally, the explicit forecast period should capture at least one-third of corporate value with clear assumptions about projected financial performance.

While the range of possible outcomes certainly widens with time, we have better analytical tools to deal with an ambiguous future than to place an uncertain multiple on a more certain near-term earnings per share figure. We address the uncertainty issue below.

2. *Uneconomic continuing value.* The continuing value component of a DCF model captures the firm's value for the time beyond the explicit forecast period, which can theoretically extend into perpetuity.

While developing a DCF model's structure, investors must mind one of microeconomics's most powerful lessons: competitive forces assure that return on investment will approximate the cost of capital over time. Numerous empirical studies document this reversion to the mean, and life cycle theories express the process. [2] Accordingly, one reasonable way to structure a DCF model uses the explicit forecast period to capture the excess returns on new investment (value creation) with the continuing value component reflecting value after the company exhausts its incremental value-creation opportunities. See Exhibit 1.

Exhibit 1: A DCF Model Should Be Economically Sound



Source: LMCM analysis.

We rarely see this structure in practice. Based on a sample of sell-side models we gathered, we observed forecast periods that are too short, generally five years or less. The crucial consequence of a too-short forecast period is the modeler has to heap the value burden on the continuing value estimate in order to have any consonance with the market price. As a consequence, the model fails to reflect a clear sense of the company's pattern or timing of value creation. In reality, most analysts understand little about the implications of their continuing value assumptions.

For instance, modelers commonly apply a multiple to ending-period earnings before interest, taxes, depreciation, and amortization (EBITDA) to estimate continuing value. The assigned multiple rarely has a solid economic foundation, and most analysts have no idea what the multiple implies about financial performance.

As an example, given certain assumptions a 13.0 times EBITDA multiple implies 6 percent earnings growth and a 150 percent return on incremental capital *in perpetuity*. [4] For the record, no company in the history of mankind has achieved such financial performance. A high percentage of value accorded to the continuing value almost always reflects an improper forecast period.

In contrast, segregating the model into a period of value creation and value neutrality not only makes sound economic sense, but allows for greater model clarity. We can capture the continuing value with a perpetuity assumption, capitalizing the last year's net operating profit after tax by the cost of capital. This value, even discounted to the present, often represents 60-70 percent of corporate value.

Moreover, a perpetuity assumption neatly captures the reversion-to-the-mean phenomenon. The approach assumes *incremental* returns on investment equal the cost of capital. Over time, naturally, depreciation of old investments and addition of new investments assure a company replaces its invested capital base. After the company depreciates all its old, value-creating investments, the remaining invested capital earns exactly the cost of capital. A company's asset life determines the length of this reversion process. A short-asset-life company will rapidly replace its invested capital base and revert to cost-of-capital returns quickly. The opposite is true for a long-asset-life company.

Many analysts incorrectly assume the perpetuity approach does not reflect growth beyond the explicit forecast period. This assumption is wrong. The perpetuity assumption does not rule out growth. But since growth has no necessary link to value creation, companies can continue to grow without creating any shareholder value. The essential assumption of the perpetuity approach relates to incremental value creation, not incremental growth. Appendix A demonstrates this point.

Most DCF models fail the economically sound and transparent test because of poor structure: the explicit forecast periods are too short and the continuing value estimates carry too much value. An investor should have a clear handle on the economic assumptions or implications behind whatever continuing value approach they choose.

3. *Cost of capital.* You'll rarely see a great equity investor point to an ability to judge the cost of capital better than others as the source of meaningful edge. But you do see many DCF models debilitated by a nonsensical cost of capital estimate.

The cost of capital is an estimate of the rate of return an investor demands to hold an asset or, said differently, an investor's opportunity cost. As such, the cost of capital is the proper rate for discounting future cash flows to a present value.

Most companies finance their operations largely through debt and equity. The cost of debt, especially for large companies, is generally transparent because companies have contractual obligations to make coupon payments and return principal on a timely basis. Some yield premium over risk-free securities is appropriate, with the size of the premium reflecting the company's creditworthiness. The large and generally liquid corporate bond market makes comparisons between fixed-income securities relatively straightforward.

Estimating the cost of equity is more challenging. Unlike debt's explicit cost, the cost of equity is implicit. The cost of equity is higher than the cost of debt because equity's claim is junior. But no simple method exists to estimate the cost of equity.

By far the most common approach to estimating the cost of equity is the capital asset pricing model (CAPM). The CAPM says a company's cost of equity equals the risk-free rate plus the product of the equity risk premium and beta. Government-issued notes generally provide a good proxy for the risk-free rate. Estimates for the equity risk premium and beta prove more challenging.

Let's start with beta, which attempts to reflect the sensitivity of a stock's price movement relative to the broader market. A beta of 1.0 means the stock tends to move in line with the market. A beta below 1.0 suggests a stock moves less than the market, while a beta above 1.0 implies moves greater than the market. All things equal, finance theory associates a higher beta with higher risk and reward.

Beta is wonderful theoretically but fails practically and empirically. The practical failure surrounds what beta to actually use in the CAPM. Ideally, we want forward-looking betas, which we cannot reliably estimate. Beta's empirical failure reflects studies showing beta does a poor job explaining returns. [5]

A visit to the Bloomberg terminal shows the problem with blithely using the CAPM. In mid-March 2006, General Motors had a beta of 1.3 while Yahoo! had a beta in excess of 1.6. It would be hard for a businessperson to argue that Yahoo is likely to be significantly more risky than General Motors over an appropriate forecast time horizon. Indeed, the implied option volatilities suggest more risk at GM than YHOO. While gauging the relative risks of businesses is clearly valuable, investors have to impose judgment on the figures the various services produce.

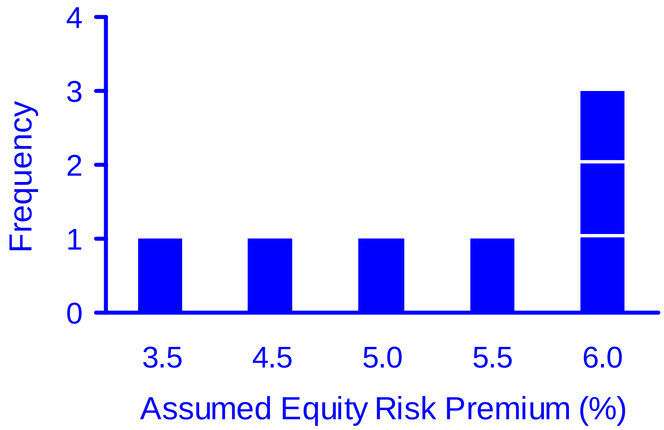
The second important input into the CAPM is the equity risk premium, the return above and beyond the risk-free rate an investor expects to earn as compensation for assuming greater risk. Like beta, the equity risk premium is ideally a forward-looking estimate. Most analysts rely on past equity risk premiums, which, depending on the time frame, may not give a reasonable sense of the return outlook.

Most of the problems with the cost of capital come from stale inputs for beta and the equity risk premium. For example, the geometric average equity risk premium was 1.9 percentage points from 1982-2005, 3.7 percentage points from 1962-2005, and 6.2 percentage points from 1926-2005. [6] The arithmetic average equity risk premiums during the same time frames were higher. One area of debate in valuation is whether the geometric or arithmetic average is more appropriate. We favor geometric returns for long term models and arithmetic averages for short-term return forecasts. [7]

In addition, research suggests the equity risk premium is probably nonstationary, which means using past averages may be very misleading. Specifically, variables shaping the equity risk premium—like past stock returns, stock price volatility, and business conditions—clearly change, making it likely the ex-ante equity risk premium changes as well. [8]

Whether you add 200 or 600 basis points to the current risk-free rate of 4.7 percent (mid-March 2006) will make a significant difference in the model's output. Exhibit 2 shows a sample of equity risk premiums assumed in recent sell-side analyst reports. Our best advice is to settle on a cost of capital that makes business and economic sense. Some academics suggest the equity risk premium is in the 3 to 4 percentage point range, which strikes us as reasonable. [9] The midpoint of this range implies a market return of roughly 8 percent over time.

Exhibit 2: A Sample of Equity Risk Premiums in Recent Research Reports



Source: Various sellside reports.

Finally, while some sensitivity analysis around the cost of capital can be useful, we would argue investors are much better off considering alternative scenarios for the key operating value drivers (sales growth, margins, capital intensity). Sometimes asset mispricings do show up as high discount rates, as we saw in the high-yield bond market in late 2002. But even there, you could argue great investors have historically generated an edge by understanding the value drivers better than the market.

4. *Mismatch between assumed investment and earnings growth.* Companies invariably must invest in the business—via working capital, capital spending, acquisitions, R&D, etc.—in order to grow over an extended period. Return on investment (ROI) determines how efficiently a company translates its investments into earnings growth. Since ROI links investment and growth, and ROIs tend toward the cost of capital over time, investors must treat the relationship between investment and growth carefully.

DCF models commonly underestimate the investment necessary to achieve an assumed growth rate. This mistake often comes from two sources. First, analysts looking at companies that have been highly acquisitive in the past extrapolate an acquisition-enhanced growth rate while only reflecting capital spending and working capital needs for the current business. You can mitigate this error by carefully considering the growth likely to come from today's business—which will be less than an acquisition-fueled rate.

The second reason for underestimating investment stems from a simple failure to explicitly link growth and investments via ROI. Analysts frequently project growth (sales and margins) independent of investments. A simple way to check for this error is to add a ROI line in the model. If you see ROIs rising or dropping sharply without a thoughtful strategic underpinning, the model is likely unreliable. The vast majority of the models we see make no effort to reflect a link between growth and investment.

5. *Improper reflection of other liabilities.* In the widely-used free cash flow to enterprise approach, an analyst determines the corporate value based on the present value of future cash flows. The analyst then adds cash and any other nonoperating assets and subtracts debt and any other liabilities to arrive at shareholder value.

Most liabilities, including debt and many pension programs, are relatively straightforward to determine and reflect in the model. Some other liabilities, like employee stock options, are trickier to capture. Not surprisingly, most analysts do a very poor job capturing these liabilities in an economically sound way.

We would note that other liabilities tend to be important for only a handful of companies. For example, other postretirement employee benefit plans tend to concentrate in manufacturing industries (e.g., autos) while employee stock options occur most frequently in knowledge and service industries (e.g., technology and financial services). Investors must properly recognize other liabilities in the sectors where they have a large impact on corporate value.

Employee stock options are a good illustration of this common shortcoming. Most DCF models simply reflect past option grants through fully diluted shares. Of course, since fully diluted shares only reflect in-the-money options, the solution does an awful job of capturing the magnitude of the liability.[10] While accounting standards now require companies to expense options, we have found few DCF models that explicitly treat future option grants as an expense. Often, analyst models show rising shares outstanding (dilution) and models sometimes include option proceeds without reflecting any dilution.

We can deal with ESOs appropriately by treating already-granted options as a contingent liability, using basic shares outstanding, and reflecting future option grants as an expense. This approach allows for a dynamic appraisal of past option grants and considers future grants as an economic expense.

6. *Discount to private market value.* In what we'd characterize as an unfortunate hangover from the 1980s and 1990s investment-banker mentality, we still see DCF models that calculate a value, only to modify the amount by a "public market discount" of 20-25 percent. This practice seems most prevalent in the telecommunications industry.

This practice fails the transparency test. To see the point, we have to invert the discount mindset and ask why a private (strategic or financial) buyer would pay a *premium* to public market value. Perhaps the private buyer believes the stock is undervalued (in which case the premium wipes out the benefit). More likely, the buyer believes it can generate a higher stream of cash flows from the acquired assets than the target company can by itself.

Synergies, the benefits of putting two companies together, often justify most if not all of the premium. Alternatively, a buyer may allocate capital differently or use financial leverage to enhance after-tax cash flows.

To be sensible, a DCF model reflecting a public market discount must already incorporate synergies or some other catalyst for higher cash flows the company cannot achieve on its own. Modeling possible deal synergies is fine, though the exercise should remain separate from valuing the standalone business. The discount-to-private-market-value model lacks sufficient transparency because it conflates the base and synergy cash flows.

7. *Double counting.* Models should not count a dollar of value (or liability) more than once. Unwittingly, DCF models often double count the same source of value.

Take share repurchase, for instance. Companies generating strong free cash flow often have a record of buying back stock that is likely to continue. Analysts, recognizing both a proclivity toward buybacks and strong cash flow, sometimes build buybacks into their models by assuming the company uses free cash flow to shrink shares outstanding over time. This double counts because the model values the cash flow (once) and the model uses the same cash flow to reduce shares outstanding (twice). This error of double counting leaves aside the analytical challenge of judging the future stock price (the only way to properly determine how much stock a company might buy).

Another less frequent example of double counting involves the practice of including interest income in the cash flow calculation and adding the cash balance to corporate value. Alternatively, some analysts subtract financing costs from cash flow and then deduct debt from corporate value to come up with shareholder value.

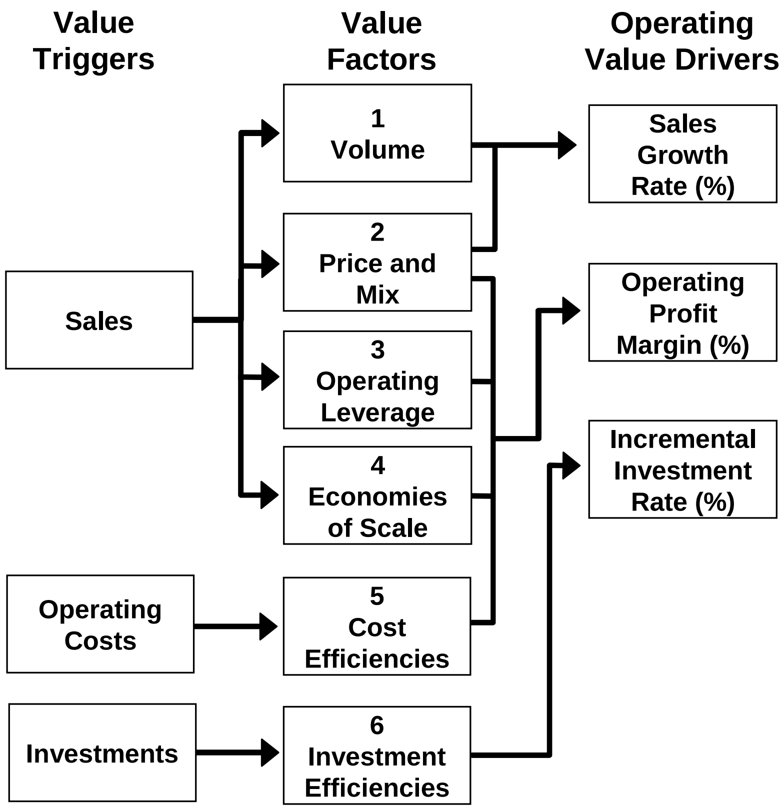
8. *Scenarios.* Probably the most-often-cited criticism of a DCF model is that small changes in assumptions can lead to large changes in the value. We addressed part of that concern, which can be mitigated by lengthening the forecast horizon, in our discussion of the first two errors.

Going one step further, the large majority of reports we see offer *one* DCF scenario, and analysts often peg their target prices on that scenario. Given investing is inherently probabilistic, one scenario—often backed by shaky assumptions—does not constitute thorough analysis. An intelligent investor needs to consider multiple scenarios.

Though many DCF models do incorporate sensitivity analysis (typically a grid of values driven by alternative cost of capital, growth, or terminal valuation assumptions), these grids provide little relevant information for anyone trying to understand the prospects of the business. Investors should look to the value drivers—sales, margins, and investment needs—as sources of variant perception.

Even sensitivity analysis based on the value drivers is generally flawed because it fails to consider the *interactivity* between value drivers. Proper scenario analysis considers how changes in sales, costs, and investments lead to varying value driver outcomes. [11] See Exhibit 3.

Exhibit 3: Expectations Infrastructure



Source: Alfred Rappaport and Michael J. Mauboussin, *Expectations Investing: Reading Stock Prices for Better Returns* (Boston, MA: Harvard Business School Press, 2001), 41.

Scenario analysis also addresses concerns about an uncertain future. By considering "if, then" scenarios and insisting on a proper discount to expected value—or margin of safety—an investor can safely and thoughtfully weigh various outcomes.

Conclusion

Theory and practice tell us the value of a company is the present value of future cash flows. Investors primarily seek to buy a stream of cash flow for less than it's worth—or sell a stream for more than it's worth. Accordingly, an investor needs to be able to model cash flows intelligently and identify a variant perception: a well-founded belief the market has placed an incorrect value on a company.

Business school students learn all about DCF models, and they often practice building them in a classroom setting. But when applying the models to the real world, an investor must ensure the models are economically sound and transparent. In practice, very few models pass these tests. We have tried to identify the key areas of failure, and offer some thoughts about how to address the shortcomings.

Appendix A: Why Growth Doesn't Equate to Value

Here's the standard method for calculating continuing value, or value beyond the explicit forecast period:

$$\text{Value} = \frac{NOPAT_{CAP+1} * (1 - \text{growth}/ROIIC)}{WACC - g}$$

Where:

$NOPAT_{CAP+1}$	=	Normalized NOPAT in the first year after the forecast period
Growth	=	Growth in NOPAT
ROIIC	=	Return on incremental investment
WACC	=	Weighted average cost of capital

NOPAT is an acronym for net operating profit after tax.

This method is identical to the free cash flow (FCF) in perpetuity approach when the underlying assumptions are the same. Here's the FCF in perpetuity approach:

$$\text{Value} = \frac{FCF_{CAP+1}}{WACC - g}$$

Let's plug in some numbers to demonstrate the equivalence. Assume:

$NOPAT_{CAP+1}$	=	\$100
Growth	=	5%
ROIIC	=	12%
WACC	=	9%

The standard formula:

$$\text{Value} = \frac{100 * (1 - (5\%/12\%))}{9\% - 5\%} = \frac{58.33}{4\%} = \underline{\underline{1{,}458.3}}$$

In order to calculate the value using the FCF method, we need to know the magnitude of investment. Note that FCF equals NOPAT – Investment.

Since we know the starting NOPAT, growth, and ROIIC, we can calculate investment:

$ROIIC * \text{investment}_1 = \Delta NOPAT_{2-1}$

A 5% NOPAT growth rate tells us that NOPAT is going from 100 to 105. So the change in NOPAT is 5. [Year 2 NOPAT of 105 minus Year 1 NOPAT of 100 = 5]. We also know ROIIC is 12%. So:

12% * investment = 5

Investment = 5/12% = $\underline{\underline{41.67}}$

Now, we know that FCF = 58.33. [NOPAT of 100 minus Investment of 41.67 = 58.33].

So the FCF in perpetuity model gives:

$$\text{Value} = \frac{58.33}{9\% - 5\%} = \frac{58.33}{4\%} = \underline{\underline{1{,}458.3}}$$

So the standard formula and the FCF in perpetuity approaches give the exact same answer provided your assumptions are consistent.

Both the standard formula and the FCF in perpetuity collapse to the perpetuity assumption when ROIIC equals WACC; that is, when incremental returns equal the cost of capital or, equivalently, incremental investments have a zero net present value.

Let's hold all of our assumptions constant except ROIIC, which we'll set equal to the cost of capital:

$NOPAT_{CAP+1}$	=	$100
Growth	=	5%
ROIIC	=	9%
WACC	=	9%

The standard formula now yields:

$$\text{Value} = \frac{100 * (1- (5\%/9\%))}{9\% - 5\%} = \frac{44.44}{4\%} = \underline{\underline{1,111.1}}$$

The same is true for the FCF in perpetuity model. First, we need to recalculate the investment:

9% * investment = 5

Investment = 5/9% = <u>55.56</u>

So,

FCF = 44.44. [100 – 55.56 = 44.44].

and

$$\text{Value} = \frac{44.44}{9\% - 5\%} = \frac{44.44}{4\%} = \underline{\underline{1,111.1}}$$

The straight perpetuity assumption is simply:

$$\text{Value} = \frac{NOPAT_{CAP+1}}{WACC}$$

Or:

$$\text{Value} = \frac{100}{9\%} = \underline{\underline{1,111.1}}$$

All continuing value methods collapse to the same value as a perpetuity if you assume ROIIC equals WACC. *Growth beyond the forecast period does not matter in and of itself.*

Endnotes

[1] Tim Koller, Marc Goedhart, and David Wessels, *Valuation: Measuring and Managing the Value of Companies*, 4th ed., (New York: John Wiley & Sons, 2005), 361.
[2] Krishna G. Palepu, Paul M. Healy and Victor L. Bernard, *Business Analysis & Valuation* (Cincinnati: South-Western College Publishing, 2000), 10-6; Pankaj Ghemawat, *Commitment: The Dynamic of Strategy* (New York: Free Press, 1991), 82.
[3] Here's a quotation from a recent sell-side research report, "Discounted cash flow is often touted as the preferred approach; however, present values are often terribly sensitive to the most minute tweak of one's terminal value assumptions. So, we keep coming back to the simple but effective method of applying multiples to the earnings of future periods."
[4] We assumed that depreciation equals 20 percent of EBITA and a 35 percent tax rate. We then selected the six percent growth rate and solved for the ROIC.
[5] Eugene F. Fama and Kenneth R. French, "The Cross-section of Expected Stock Returns," *Journal of Finance* 47, 1992, 427-465; and Eugene F. Fama and Kenneth R. French, "The Capital Asset Pricing Model: Theory and Evidence," *The Journal of Economic Perspectives*, Vol. 18, 3, Summer 2004, 25-46.
[6] See www.jeremysiegel.com.
[7] Aswath Damodaran, *Investment Valuation: Tools and Techniques for Determining the Value of Any Asset, 2nd ed*. (New York: John Wiley & Sons, 2002), 161-162. Also, Bradford Cornell, *The Equity Risk Premium: The Long-Run Future of the Stock Market* (New York: John Wiley & Sons, 1999), 36-39.
[8] Cornell, 45-53.
[9] Daniel Altman, "Why Do Stocks Pay So Much More Than Bonds?" *The New York Times*, February 26, 2006.
[10] Michael J. Mauboussin, "Employee Stock Options: Theory and Practice," *Mauboussin on Strategy*, September 7, 2004.
[12] Alfred Rappaport and Michael J. Mauboussin, *Expectations Investing: Reading Stock Prices for Better Returns* (Boston, MA: Harvard Business School Press, 2001), 40-46.