TERMINAL GROWTH RATE CALIBRATION IN DCF VALUATION: RETROSPECTIVE EVIDENCE FROM S&P 500 FIRMS

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Abstract

Discounted Cash Flow (DCF) valuation remains one of the most widely used methods for estimating enterprise value, but its outcomes are highly sensitive to long-term growth assumptions. This paper examines how terminal growth rate calibration affects DCF valuation accuracy. Using a retrospective empirical design, DCF valuations are applied to S&P 500 firms and compared with realized enterprise values observed five years later. The analysis isolates the role of the terminal growth rate by holding free cash flow and the weighted average cost of capital constant, while systematically varying growth assumptions within a predefined sensitivity range.

The findings show that DCF accuracy is not uniform across sectors or market periods. Terminal growth rate assumptions materially influence whether estimated enterprise values fall within a realistic range of realized outcomes. The results also suggest that sectoral characteristics and macroeconomic conditions affect valuation reliability, with more stable environments producing more consistent results.

The paper contributes to valuation research by providing retrospective evidence on terminal growth rate calibration and its practical relevance for DCF-based decision-making.

Key words: Discounted Cash Flow, terminal growth rate, enterprise value, valuation accuracy, sensitivity analysis

JEL Code: G32, G17, C52

Introduction

Valuation is a central component of financial decision-making because it supports investment appraisal, capital allocation, mergers and acquisitions, and corporate finance decisions. Among valuation approaches, DCF valuation remains widely used because it links firm value to expected future cash flows and the time value of money. Unlike relative valuation, which depends on comparable firms and market pricing, DCF seeks to estimate intrinsic value based on the economic fundamentals of the firm (Damodaran, 2012; Koller et al., 2020).

Despite this theoretical foundation, DCF valuation is highly sensitive to input assumptions. The terminal value component often represents a substantial share of total enterprise value, and even small changes in the terminal growth rate can materially affect the valuation result. This problem becomes particularly important when the terminal growth rate approaches the discount rate, because the estimated terminal value increases disproportionately (Ashton & Wang, 2013; Green et al., 2016).

The issue is well recognized in the valuation literature, but retrospective empirical evidence remains limited. Existing studies provide important insights into DCF valuation accuracy in specific contexts, such as leveraged buyouts or bankrupt firms (Kaplan & Ruback, 1995; Gilson et al., 2000). However, less is known about how terminal growth rate assumptions affect DCF accuracy across a broader cross-section of firms, sectors, and market periods.

This paper addresses this gap by examining terminal growth rate calibration in DCF valuation using retrospective evidence from S&P 500 firms. The study applies a controlled sensitivity analysis in which the terminal growth rate is systematically varied, while free cash flow and WACC are held constant. Estimated enterprise values are then compared with realized enterprise values observed five years later. The contribution of the paper is to provide evidence on when DCF estimates are more or less likely to align with realized market outcomes and to support more informed growth-rate calibration in applied valuation practice.

1 Literature Background

1.1 DCF Valuation and Terminal Growth Assumptions

DCF valuation is an intrinsic valuation method based on the present value of expected future cash flows. Its appeal lies in the explicit connection between firm value, operating performance, risk, and long-term growth. Unlike relative valuation methods, which depend on market comparables and prevailing pricing conditions, DCF seeks to estimate intrinsic value based on the economic fundamentals of the firm (Damodaran, 2012; Koller et al., 2020; Penman, 2013).

At the same time, DCF depends heavily on assumptions that cannot be observed directly, especially those used to estimate terminal value. Terminal value captures cash flows beyond the explicit forecast horizon and often accounts for a large share of total enterprise value. As a result, assumptions about terminal growth can substantially affect valuation outcomes (Cassia & Vismara, 2009; Damodaran, 2012; Koller et al., 2020; Petersen & Plenborg, 2009).

The terminal growth rate is particularly sensitive because it enters the Gordon Growth Model through the denominator WACC minus g. When g increases, the denominator decreases and terminal value rises. This creates a nonlinear relationship between growth assumptions and estimated enterprise value. For this reason, terminal growth cannot be treated as a mechanical input. It should be economically sustainable and consistent with long-run business, sectoral, and macroeconomic conditions (Ashton & Wang, 2013).

1.2 Valuation Accuracy and Sensitivity to Model Inputs

Valuation accuracy can be examined from both ex-ante and ex-post perspectives. Ex-ante analysis evaluates how valuation estimates respond to changes in assumptions, while ex-post validation compares estimated values with realized outcomes. Both approaches are relevant for assessing DCF performance. Sensitivity analysis helps identify which assumptions drive valuation results, while retrospective validation shows whether estimated values align with observed market outcomes (Borgonovo et al., 2010; Francis et al., 2000). In this respect, the use of sensitivity analysis in DCF valuation is consistent with broader investment decision-making practice, where sensitivity and scenario analyses are used to support the assessment of risk and uncertainty in project appraisal (Švecová et al., 2012). Since long-term assumptions are particularly influential in DCF valuation, sensitivity analysis is important for understanding how changes in terminal growth affect valuation outputs (Cassia et al., 2007). Valuation errors may arise not only from the theoretical structure of the model, but also from inconsistent assumptions, model specification, and practical implementation choices (Fernández, 2005; Green et al., 2016).

Previous empirical studies show that DCF can be useful, but their evidence is often based on specific transaction, IPO, or restructuring settings (Berkman et al., 2000; Gilson et al., 2000; Kaplan & Ruback, 1995). Berkman et al. (2000) examine the accuracy of discounted cash flow and price-earnings methods in IPO equity valuation, Kaplan and Ruback (1995) focus on leveraged buyout valuations, and Gilson et al. (2000) analyze bankrupt firms. This creates space for broader retrospective analysis focused on a large sample of firms and multiple economic

periods. In this paper, ex-ante sensitivity analysis is combined with ex-post comparison to evaluate how alternative terminal growth assumptions affect DCF valuation accuracy.

2 Data and Methodology

2.1 Dataset and Sample Construction

The empirical analysis is based on firms included in the S&P 500 index over the period 2002-2018. The S&P 500 provides a broad cross-section of large publicly traded firms across sectors and industries. For each firm-year observation, the DCF valuation is constructed using information available in the input year and compared with realized enterprise value observed five years later. For example, a valuation based on 2002 inputs is evaluated against enterprise value in 2007. After applying feasibility filters, the final dataset contained 2,253 firm-year observations, representing approximately 42% of the initial 5,355 firm-year observations. Final retention varied substantially across sectors, from 13% in Utilities to 60% in Communication.

The analysis uses firm-level free cash flow data and sector or industry-level estimates of WACC and long-term growth rates. The dataset is filtered to ensure consistent application of the DCF model. Observations with missing or negative free cash flow are excluded, as are cases where the terminal growth rate is equal to or higher than WACC. These filters improve model consistency but reduce the sample and may bias the results toward financially more stable firms. A simplified overview of the empirical design is presented in Table 1.

Tab. 1: Overview of the empirical design

Item	Description
Sample	S&P 500 firms
Input period	2002–2018
Evaluation horizon	Five years
Valuation method	Discounted Cash Flow
Benchmark	Realized enterprise value
Key variable	Terminal growth rate
Sensitivity range	±3 percentage points
Step size	0.5 percentage points
Main metrics	Valuation error, valuation multiple, in-band outcome
Aggregation levels	Period, sector, industry

Source: authors

2.2 DCF Model and Sensitivity Design

The paper applies a two-stage DCF model. Enterprise value is calculated as the present value of projected free cash flows over a five-year explicit forecast period plus discounted terminal value:

$$EV = \sum_{t=1}^{5} \frac{FCF_t}{(1+WACC)^t} + \frac{TV}{(1+WACC)^5} \quad (1)$$

where (EV) represents enterprise value, (FCF_t) is free cash flow in year (t), ($WACC$) is the weighted average cost of capital, and (TV) is terminal value.

Terminal value is estimated using the Gordon Growth Model:

$$TV = \frac{FCF_5 \times (1+g)}{WACC-g} \quad (2)$$

where (FCF_5) is free cash flow in the final forecast year and (g) is the terminal growth rate.

The terminal growth rate is the central variable of interest. To isolate its effect, free cash flow and $WACC$ are held constant within each firm-year valuation, while (g) is systematically varied. The sensitivity analysis applies a range of ±3 percentage points around the baseline growth rate, using increments of 0.5 percentage points. This design allows the analysis to compare conservative, baseline, and more optimistic growth assumptions under otherwise identical valuation conditions.

DCF valuation accuracy is assessed by comparing the estimated enterprise value with the realized enterprise value observed five years later. The percentage valuation error is defined as:

$$DCF\ Error = \left(\frac{EV_{actual}-EV_{DCF}}{EV_{actual}}\right) \quad (3)$$

where (EV_{actual}) is the realized enterprise value and (EV_{DCF}) is the enterprise value estimated by the DCF model. This metric preserves both the size and direction of the valuation error. A positive value indicates that the DCF estimate is below the realized enterprise value, implying undervaluation. A negative value indicates that the DCF estimate is above the realized enterprise value, implying overvaluation. Valuation outcomes are also expressed as multiples of estimated to realized enterprise value:

$$Valuation\ multiple = \frac{EV_{DCF}}{EV_{actual}} \quad (4)$$

A multiple of 1.0 indicates exact alignment. Values between 0.75x and 1.5x are treated as falling within a realistic range. Values below 0.75x indicate undervaluation and values above 1.5x indicate overvaluation. At the period and sector levels, the analysis focuses on the incidence of in-band outcomes and data retention. At the industry level, average valuation errors and their standard deviation are used to evaluate both direction and stability of valuation outcomes.

3 Results

3.1 Sensitivity to Terminal Growth Rate

The results confirm that terminal growth rate calibration materially affects DCF valuation accuracy. Across the sample, changes in g influence whether DCF-implied enterprise values fall within the realistic range of realized enterprise values. Baseline growth assumptions often produce valuations below realized enterprise values, while upward recalibration frequently moves estimates closer to the in-band range. This suggests that, for a substantial part of the sample, baseline terminal growth assumptions may understate subsequent market outcomes.

However, the evidence does not support a universal rule that higher terminal growth rates always improve DCF accuracy. In some sectors and periods, more optimistic assumptions lead to better alignment, while in others conservative or central assumptions produce more realistic outcomes. Terminal growth rate calibration should therefore be interpreted as an empirical and context-dependent decision rather than as a mechanical adjustment.

3.2 Period and Sector-Level Patterns

The period-level analysis shows that DCF accuracy is affected by macroeconomic conditions. During stress periods, especially 2002-2003 and 2008-2009, valuation outcomes are more sensitive to changes in terminal growth assumptions. In these periods, higher growth-rate assumptions are often associated with stronger alignment between estimated and realized enterprise values. This may reflect the fact that valuations constructed during crisis years are compared with realized values five years later, after market recovery has influenced enterprise values.

Expansion periods show a more heterogeneous pattern. In some years, growth-rate adjustments have a weaker effect, while in others sector-specific valuation dynamics dominate. The results therefore suggest that DCF does not become unusable during market stress, but its reliability becomes more dependent on careful calibration of long-term assumptions.

Sector-level results confirm that DCF sensitivity to terminal growth assumptions is not homogeneous. At the sector level, upward growth-rate calibration improved valuation alignment in 7 out of 11 sectors. Growth assumptions approximately 2–3 percentage points above baseline produced the highest concentration of in-band outcomes in Communication, Consumer Staples, Industrials, and Materials, while Financials, Real Estate, and Healthcare showed the best alignment under more moderate upward adjustments. By contrast, Consumer Discretionary was concentrated around baseline assumptions, Energy showed better alignment

under lower growth assumptions, and Information Technology and Utilities did not display a stable directional pattern.

3.3 Industry-Level Heterogeneity

Industry-level evidence provides a more granular view and shows that sector-level patterns may hide substantial internal heterogeneity. Some industries show repeated alignment under central to optimistic growth assumptions and relatively stable firm-level outcomes. Other industries reach in-band valuation only under optimistic assumptions, but with higher dispersion across firms. A third group achieves more realistic outcomes under conservative or central assumptions. These differences indicate that growth-rate calibration should be performed at the most relevant level of business comparability (see Tab. 2).

Tab. 2: Summary of empirical patterns

Level of analysis	Main finding	Implication
Growth-rate sensitivity	DCF accuracy changes with alternative *g* assumptions	Terminal growth rate is a central valuation input
Stress periods	Valuation outcomes are more sensitive to *g*	Calibration is especially important under uncertainty
Expansion periods	Patterns are more heterogeneous	Sector-specific interpretation is needed
Sectors	No uniform optimal growth-rate direction	Uniform assumptions should be avoided
Industries	Sector averages hide internal heterogeneity	Calibration should reflect business comparability

Source: authors

Overall, the results show that DCF should not be interpreted as mechanically reliable or unreliable. Its accuracy depends on the calibration of key assumptions, especially the terminal growth rate, and on the sectoral, industry-level, and macroeconomic context in which the valuation is applied.

Conclusion

The results have several implications for DCF valuation. First, they confirm that terminal growth rate calibration is not a secondary technical issue, but a central component of valuation accuracy. Since terminal value often represents a substantial share of enterprise value, small changes in g can shift estimated values into or out of the realistic valuation range. A single baseline DCF estimate may therefore create a misleading impression of precision if sensitivity to terminal growth is not explicitly tested.

Second, the findings show that DCF accuracy is context-dependent. The same growth-rate adjustment does not produce comparable outcomes across all sectors, industries, or market periods. In several cases, higher terminal growth assumptions improve alignment between estimated and realized enterprise values. In other cases, conservative or central assumptions are more appropriate. For valuation practice, this means that terminal growth rates should be justified with respect to sectoral and industry-specific conditions rather than applied uniformly across firms.

Third, retrospective evidence can improve valuation discipline. Historical alignment does not guarantee future accuracy, but it provides a benchmark for assessing whether a selected terminal growth rate is plausible in a given sector or market environment. This is relevant for investment appraisal, mergers and acquisitions, and corporate finance decisions, where small changes in terminal assumptions may materially influence the implied value of a firm.

The paper contributes to valuation research by providing retrospective empirical evidence on terminal growth rate calibration in DCF valuation. It does not propose a new valuation model. Instead, it evaluates how a standard DCF framework behaves under alternative growth assumptions and under different market conditions. The findings suggest that DCF can provide useful valuation benchmarks, but its reliability depends strongly on the empirical plausibility and contextual justification of its assumptions.

Several limitations should be acknowledged. The analysis is based on large publicly traded S&P 500 firms and may not be directly transferable to private, smaller, or early-stage firms. The filtering process excludes firms with negative free cash flow or infeasible growth assumptions, which may bias the sample toward more stable firms. The retrospective design evaluates historical alignment with realized enterprise values, but it does not establish causal relationships between sectoral characteristics and valuation accuracy. Future research could apply econometric methods to test which firm-level, sector-level, or macroeconomic factors explain differences in DCF performance.

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