

Discussion on Uncertainty and Bias in Enterprise Valuation Assessments using DCF Model

Pengxu Chen^{1*}, Kaiyuan Zhang¹

^{1*}The University of Melbourne

¹George Washington University

*pengxuc@student.unimelb.edu.au

ABSTRACT

This essay aims to discuss the potential problems that may occur when using the Discounted Cash Flow model to value publicly listed firms by discussing the uncertainties and biases embedded in the valuation model.

Through analyzing the literature and reviewing a valuation assessment that is done by the author, the article concludes that the appropriateness of discount rate and the accuracy of the free cash flow cannot be computed perfectly and thus the final valuation result should be assessed with caution.

Keywords: *enterprise valuation, DCF model, investment choices, financial assessments.*

1. INTRODUCTION

With the rapid development of the financial market, investors have begun to judge investment opportunities more rationally. When comparing tremendous investment choices, the most intuitive methodology for investors' evaluation would be to figure numerical expressions for each alternative. By comprehensively assess the future expected earnings and the cost performance of the investment decisions the optimal judgment would be executed. To address the value associated with investment decisions, various financial models can be used as references.

The most popular model when evaluating a firm is the Discounted Cash Flow (DCF) model. The core of the model is to discount the future cash flows and calculate the present value of the investment opportunity [4]. In reality, analysts would practice the valuation techniques based on financial information obtained extracted from financial statements and official announcements. Through the analyses of valuable information, forecasts and the final results would be computed.

However, uncertainties and biases can always be observed when processing the valuation models where those estimation errors may heavily distort the reliability of the final results and create inaccurate simulations [13]. Therefore, academics start to question whether the DCF model is competent to conduct valuation assessments [1][12]. For analysts who provide valuation services to

their client investors, it is vital to distinguish the error-prone procedures and avoid making mistakes when constructing the valuation models as any existence of imperfections could ruin the investment.

To address the concerns, this essay would first evaluate the DCF model from a general perspective by reviewing the literature that the model is based. Then, the essay would further evaluate the valuation model by analyzing a valuation case which is done by the author recently and discuss how errors can occur in reality. Finally, this essay would recapitulate the error that the DCF model suffers, and stress cautions needed when practicing valuation models. By illustrating the limitations, investors can focus on improving the model and making the model more precise and applicable.

2. LITERATURE REVIEW

The DCF model is widely used to produce a numerical presentation of the value of a company which would eventually become a key reference when investors evaluating their decisions)[6][14]. Berk & DeMarzo (2017) suggests 3 factors that influence the value of an asset, namely, the amount, timing and risk of its expected future cash flows which means if the expected future cash flows are discounted, the present value of the asset can be known[5].

Though critic of the DCF model continues, the flexibility and improved accuracy embedded in the model

should not be ignored[17]. Therefore, understand the model would be crucial for investors.

Based on Berk & DeMarzo (2017), the DCF model can be mathematically expressed as [5]:

$$V_0 = \sum_{t=1}^n \frac{C_t}{(1+r)^t} \quad (1)$$

Where V represents the current of the firm, r stands for the discount rate, C_t states that expected future cash flows.

This formula suggests three critical implications, namely, the correctness of C_t, the appropriateness of r and the corresponding relationship between cash flows and discount rates. If the two terms are imprecisely calculated or the discount rate is wrongly applied to the unmatched cashflow, the final result generated would be misleading.

The appropriateness of the discount rate r

The DCF model can be divided into multiple variants including the FCFE model, the DDM model, the FCFF model and more other variants which would theoretically produce comparable results if applied to the same target[1][5]. Nevertheless, the discount rate applied by these models can differ quite significantly according to their valuation emphasizes. For instance, the FCFE model (shown below in equation 1) would use the cost of equity k_e as the discount rate to value the present value of equity E₀ whereas FCF model prefers Standard WACC k_s as dominator (shown below in equation 2 [5])

$$E_0 = \sum_{t=1}^n \frac{FCFE_t}{(1 + k_e)^t}$$

$$V_0 = \sum_{t=1}^n \frac{FCF_t^u}{(1 + k_s)^t}$$

Though the formula seems efficient, the process of dealing with the discount rate is time consuming and extremely complicated. To value the firm value, model 2 should be complied and the corresponding discount rate, as the equation above indicates, should be approximated by k_s WACC model.

The WACC Model

The WACC model can be used not only to express the capital structure of the firm but also can be utilized to calculate a proxy of the discount rate which has been widely applied by professionals[11][21] For a listed firm, the standard WACC demonstrates the levered structure and reflects the cost of the capital. Brealey, Myers, & Allen (2017) proposed a mathematical expression of the WACC model:

$$\begin{aligned} \text{WACC} &= k_d(1 - T) \frac{D}{V} \\ &+ k_e \frac{E}{V} \end{aligned}$$

where debt together with equity forms the total value of the firm

$$D + E = V \quad (5)$$

Also, k_d represents the cost of debt and k_e represents the cost of equity. To further appreciate the WACC model, these two factors should be analyzed in detail.

cost of equity (k_e)

The cost of equity (k_e) reflects the operating risk and the financial risk faced by equity investors in a levered firm [15]. This factor can be seen as an indicator of the relationship between the return of the investment in equity form and the risk associated with the investment. To address the relationship between return and risk, the CAPM model should be applied [18].

Along with the work of Sharpe (1964) who proposed and enhanced the concept of CAPM, to calculate the cost of equity, the CAPM model can be expressed as follow[20] :

$$k_e = r_f + \beta_j * [E(r) - r_f] \quad (6)$$

Where r_f stands for risk-free rate, .β_j means the beta for the target company, [E(r) - r_f] means market risk premium.

Note that the effectiveness of the model stated above is still controversial as Fama & French (1992) points out more premia need to be included in the model to expand its applicability[8]. Therefore, the oversimplified formula suggested above which lack of realistic considerations could probably engender questionable result. The proposition is endorsed by Frank & Shen (2016) who argue that the cost of equity k_e approximated by the CAPM model is inaccurate and would give an erroneous proxy [10].

To conclude, the k_e approximated by the model may not be precise enough which would effectively cause errors and biases to the final result. Moreover, as Mullins (1982) points out that the simplified model would merely be a good start and solid foundation for valuation where other references should also be examined in accompany[16] .

cost of debt (k_d)

The debt financing part of a levered firm is extremely complicated where various factors need to be carefully addressed and examined Moreover, for a listed company, it is common that they had issued enormous forms of debt financing instruments including convertible bonds, bank

loans which are designed with complicated structures[22].

The major concern when the company is financed with various debt instruments is that they have a different maturity dates and interest rates which would further cause the valuation process to be complicated and could easily generate measurement errors. Brealey, Myers, & Allen (2017) argue that during the valuation process of the cost of debt, analysts occasionally ignore the importance of the short-term debt and put too much attention on long-term debt. Therefore, the whole debt-financing part would be valued with distortions.

Due to the complexity of the debt financing part of the company, the assessment of cost of debt k_d would be troublesome. Though the k_d can be calculated based on the CAPM model, to avoid similar biases occurred in processing the cost of equity k_e , other approaches should have the priority.

[3] Baule (2019) suggests a traditional approach to mimic the cost of debt when the default risk is low by approximating the yield to maturity of the company's debt securities. The mathematical expression of this approach is shown below in the textbook written by [5]:

$$P_0 = \sum_{t=1}^n \frac{C_t^P}{(1+y)^t} \quad (7)$$

where P_0 means the present value of the debt securities, C_t^P stands for the promised cash flow at time t , y means the yield to maturity. This model relied on a naïve assumption which assumes a low-default-risk business situation whereas in the reality the existence of speculative conducts cannot be ignored.

To revise the model, one possible justification is proposed by [5] Berk & DeMarzo (2017) who adjust the yield to maturity y with respect to the default risk.

The simplified expression of this approach is shown below:

$$y = r_f + CS \quad (8)$$

CS stands for the additional default risk which is defined by the credit rating agency. The core of the formula indicates that the cost of debt is equal to the sum of the corresponding risk-free rate and the margin for default risk. Note that though credit rating agency could estimate the default risk for the debt, the accuracy of the CS estimation still provokes uncertainties that would distort the true value of P_0 with huge ambiguities.

To conclude, the debt part of the listed company is extremely complex to measure due to the discrepancy between debt financing instruments.

To recapitulate, the general purpose of the WACC model is to weigh the cost of financing of the company based on the proportion it has been financed. When decomposing the model and analyzing the elements

contained separately it shows that the model contains tremendous uncertainty and biases which is due to the basis of the oversimplified prerequisites and the complexity of the financial instruments.

The correctness of the expected cash flow C_t

The expected cash flows should be carefully estimated and calculated to reflect certain concerns and focuses by investors. Due to the difficulties of manipulation, the Free Cash Flows (FCF) are accepted widely as the appropriate approximation of the expected cash flows [7].

Berk & DeMarzo (2017) proposed a model to calculate the FCF_t is the free cash flow generated in a certain time period t [5]:

$$FCF_t = EBIT_t + DEP_t - CAPEX_t - \Delta WC_t - TAX_t$$

Where $EBIT_t$ is the earnings before interest and tax, DEP_t means the depreciation and amortization, $CAPEX_t$ means capital expenditure, ΔWC_t stands for the variation of the working capital of the analyzing target, TAX_t represent the tax payments.

Although all these variables can be acquired by assessing the accounting report of the company hidden dangers cannot be disregarded.

The above model may be inferred as when the figures are correctly computed based on certain formulae or the discount rate is matched with the cash flow, the final result would be accurate and absolute, Brealey, Myers, & Allen (2017) argue, however, that different analyst would give a different estimation about the current value of the firm through the statistics inputs are identical[24]. Therefore, the model itself may suffer from insecurities where even professionals cannot reach a consensus. One possible explanation was proposed by Mullins (1982) who suggests that the model relies on oversimplified assumptions that would rather be naïve in the reality and professionals would take other elements that do not contain in the model into consideration [16].

The authors believe that the inconsistency between the valuation result produced by different analysts could be due to estimation error. When calculating the present value of the firm all the key variable mentioned above needs to be projected based on the current statistics. The estimations, by definition, would always be accompanied by ambiguities error which means analysts cannot eliminate all the uncertainties and risks from the unforeseeable future. Thus, the projected value will eventually be inexact to the true value. Though by applying ideal statistical approaches, predictions would theoretically converge to the "true value", with different degrees of tolerance of risks, analysts would give distinct results.

To conclude, when projecting the expected cash flow by using the statistical models, estimation errors which

associated with risks would be the key variants that analysts should consider.

To justify the proposition, a case which is recently done by the author would be demonstrate and discussed in detail.

3.CASE REVIEW

The following case was derived by the authors. The target company is a famous investment bank in China that provides various financial products and services through multiple segments including investment banking, brokerage, trading, and asset management. The company was listed with all the financial information being audited and accessible on their official website.

To calculate the present value of this company, the author applied WACC as the discount rate and estimated the future cash flows according to past statistics. After encountering applicability dilemma and data scarcity the authors have noticed imperfections in the denominator and the numerator of the DCF model.

Applicability error

Recall the CAPM model which are used to compute the cost of equity:

$$k_e = r_f + \beta_j * [E(r) - r_f]$$

Besides the theoretical constraints discussed above, in reality, more uncertainties occur in the calculation. Ferson & Locke (1998) claims that the exogenous variables β_j , $E(r)$ and r_f are not precise and contain additional errors which would cause inaccuracy. The most serious problem is the inconsistency between the theory and reality [9].

For instance, Zhang & Meng (2013) argue that the applicability of the CAPM model in China, where the firm is located, is until controversial[23]. Though it is a common practice for analysts to deem the yield of government-issued Treasury bond as the risk-free rate. However, ASIFMA (2013) states that the government issued bonds in China has low liquidity and poor risk-control management which means the holder of the Government debt tend to maintain the possession rather than trade them frequently[2]. Therefore, the risk-free rate in China may be inappropriate for the valuation.

Furthermore, as the equation $[E(r) - r_f]$ suggests the market risk premium also got influenced.

To conclude, as the common practice which deemed government bonds as the risk-free rate may not be a realistic approximation, applying the traditional CAPM model to value a Chinese enterprise would be an unsatisfactory approach.

Statistical errors

When conducting forecast of the estimated statistics of variable required by the DCF model, the authors find huge uncertainty on the estimated cash flow. The difficulty is mainly due to the data scarcity.

Recall the FCF model:

$$FCF_t = EBIT_t + DEP_t - CAPEX_t - \Delta WC_t - TAX_t$$

One approach to estimate future financial statistics is to construct a regression model. However, not all the company can provide enough past parameters to support the proposition. The target company which the authors focused on was listed in 2004 that means only 17 financial statements can be used as the database. Therefore, a low fitness indicator R^2 had been observed along with a volatile standard deviation. In other words, the regression model approach cannot perform well in this case.

Even if the company has adequate statistics to construct a regression model, it is questionable whether the company would perform in accordance with the forecasting model under the rapidly changing financial markets conditions. Also, exogenous factors like war, public health disasters would heavily impact the operations of the company thus the cash-flows. Therefore, the final result projected would be also dubious. For instance, under the Covid-19 pandemic, the target company performed poorly and faced a huge decrease in the earnings before interest and tax shields $EBIT_t$ which deviates heavily from the prediction is based on the statistics before the pandemic.

To conclude the prediction of the variable leads to huge uncertainties which may not reflect the true operational ability and the value of the company.

4.CONCLUSION

To recapitulate, the article reviewed the ambiguities of applying DCF as an instrument of valuing a firm by examine the underlying literatures. Tremendous distortions can be found of the model as it relies on over-simplified assumptions.

Moreover, beside the theoretical imperfections, when applying the theoretical model to the reality estimation error and data scarcity also cause difficulty to produce an accurate approximation of the present value of the company. The exogenous uncertainties and biases deteriorate the reliability of the DCF model thus the final consequences engendered should be consulted with cautions.

Furthermore, Sayed (2017) argues that instead of using DCF as the valuation model, in emerging economies, PE analysis are more preferred. The change shows the reliability of the DCF model is under challenges[19]. Therefore, for investors, to construct a comprehensive understanding of the worth of the

investment opportunities needs cautions and loads of information as much as possible as additional references.

REFERENCES

- [1] Adamczyk, P., & Zbroszczyk, A. (2017). A key factor of the DCF model coherency. *Journal of Economics and Management*, 5-22.
- [2] . (2013). *China Government Bond Market Roadmap*. Hong Kong.
- [3] Baule, R. (2019). The cost of debt capital revisited. *Business Research*, 721-753.
- [4] Benninga, S., & Sarig, O. (1997). *Corporate finance : a valuation approach*. New York: McGraw-Hill.
- [5] Berk, J. B., & DeMarzo, P. M. (2017). *Corporate Finance: The Core*, 4th Edition. Pearson.
- [6] Edsinger, M., & Stenberg, C. (2008). An empirical study of the discounted cash flow model. Master's thesis in Accounting and Financial Management .
- [7] Estridge, J., & Lougee, B. (2007). Measuring Free Cash Flows for Equity Valuation: Pitfalls and Possible Solutions. *Journal of Applied Corporate Finance*, 60-71.
- [8] Fama, E. F., & French, K. R. (1992). The Cross-Section of Expected Stock Returns. *The Journal of Finance*, 427-465.
- [9] Ferson, W. E., & Locke, D. H. (1998). Estimating the Cost of Capital Through Time: An Analysis of the Sources of Error. *Management Science*, 485-500.
- [10] Frank, M. Z., & Shen, T. (2016). Investment and the weighted average cost of capital. *Journal of Financial Economics*, 300-315.
- [11] Glova, J. (2015). Time-varying CAPM and its Applicability in Cost of Equity Determination. *Procedia Economics and Finance*, 60-67.
- [12] Hamadi, H., & Hamadeh, M. (2012). EQUITY VALUATION: A COMPARISON BETWEEN THE DISCOUNTED CASH FLOW MODELS AND THE RESIDUAL INCOME MODELS. *International Journal of Business, Accounting, & Finance*, 104-115.
- [13] Linke, C. M., & Zumwalt, J. (1972). Estimation Biases in Discounted Cash Flow Analyses of Equity Capital Cost in Rate Regulation. *Financial Management*, 15-21.
- [14] Lundholm, R., & O'Keefe, T. (2001). Reconciling Value Estimates from the Discounted Cash Flow Model and the Residual Income Model. *Contemporary Accounting Research*, 311-335.
- [15] Miles, J. A., & Ezzell, J. R. (1980). THE WEIGHTED AVERAGE COST OF CAPITAL, PERFECT CAPITAL MARKETS, AND PROJECT LIFE: A CLARIFICATION. *Journal of Financial & Quantitative Analysis*, 719-730.
- [16] Mullins, D. (1982, January). Does the Capital Asset Pricing Model Work? *Harvard Business Review*, pp. 105-114.
- [17] O'Brien, T. J. (2003). A Simple and Flexible DCF Valuation Formula. *Journal of Applied Finance*, 54-62.
- [18] Perold, A. F. (2004). The Capital Asset Pricing Model. *The Journal of Economic Perspectives*, 3-24.
- [19] Sayed, S. A. (2017). How much does valuation model choice matter? Target price accuracy of PE and DCF model in Asian emerging markets. *Journal of Accounting in Emerging Economies*, 90-107.
- [20] Sharpe, W. F. (1964). CAPITAL ASSET PRICES: A THEORY OF MARKET EQUILIBRIUM UNDER CONDITIONS OF RISK. *Journal of Finance* , 425-442.
- [21] Situm, M. (2021). Determination of expected cost of equity with the CAPM: Theoretical extension using the law of error propagation. *Managerial and decision economics.*, 77-84.
- [22] van Binsbergen, J. H., Graham, J. R., & Yang, J. (2010). The Cost of Debt. *The Journal of Finance*, 2089-2136.
- [23] Zhang, P., & Meng, X. (2013, August). The market application analysis of CAPM model in China's securities. *Applied Mechanics and Materials*, pp. 4422-4425.
- [24] Brealey, R. A., Myers, S. C., & Allen, F. (2017). *Principles of corporate finance*. New York: McGraw-Hill/Irwin.