Equity Valuation: Premium to Interest Rate Structure Model

Prof. Sandeep Keshava Rao

Abstract

Among the Equity Valuation models, the Discounting of cash flow (DCF) uses the cost of equity capital as a discounting rate in determining the value of equity. The cost of equity capital is usually calculated using the CAPM. The capital asset pricing model is backward looking as its components like beta and risk premium are based on the historical data. Most factor models used in academics and in practice consider historical data of stock returns and index to determine the cost of equity. The stock price which reflects the present value of future cash flows cannot be completely based on historical data for discounting. This paper proposes a modified model of DCF which takes into account a forward looking cost of equity capital. The model will include the time dynamic changes in the components of the cost of capital as opposed to those with time static components. It is proposed to use the forward looking risk free rate, obtained through bootstrapped spot curve, to which the forward looking time dynamic risk premium times the forward looking beta is added in order to arrive at the cost of equity. This forward looking cost of equity is then used for discounting of the estimated future cash flows to arrive at the value of the stock.

Keywords: *Equity Valuation, forward looking beta, forward looking Risk Premium*

Introduction

Valuation of equity using the discounting cash flow model (DCF) has been popular among academics and practitioners. The future cash flows from the equity is estimated and discounted with an appropriate discounting factor. The discounting factor is a function of the cost of equity capital, typically the cost of Equity (Ke).

$$V_o = \sum_{i=1}^{\infty} \frac{Cf_i}{(1+K_e)^i} \quad \text{------------ (1)}$$

These future cash flows from the Equity can be either the expected dividend E(Di) in the ith year, the free cash flows or the operating cash flows of the ith year of the company. Typically, these cash flows (Expected Dividends) are then discounted back using a single discounting rate, Cost of Equity (Ke). This approach considers that the equity investor's expected returns are same throughout the term of his investment. That is, all the future cash flows, even though occurring at different time periods are discounted at the same discounting rate. According to this model, the discounting rate is also the IRR (Cost of Equity in case of Equity

Valuation, Ke) over the period of the term which equates the present value of future cash flows to the current market value of the firm's equity Ve . Considering a capital structure of only equity, the firm's value V0 should be same as the value of the Equity Ve.

The discounting rate in the DCF model, Ke, is estimated using the Capital asset pricing model (CAPM) (Sharpe, 1964). CAPM describes the relationship between the expected returns and the risk of the security. It is given as follows

$$\bar{r}_a = r_f + \beta_a(\bar{r}_m - r_f)$$

Where:

r_f = Risk free rate

β_a = Beta of the security

$\bar{r}_m$ = Expected market return

CAPM considers historical beta and historical risk premiums. The assumption that the investor can borrow or lend at the risk-free rate and that the investors think in terms of a single period for the purpose of investment are major limitations of CAPM. There are various empirical evidences to support the argument that the CAPM as introduced by Sharpe has limitations. Ke estimates of high beta stock are very high and low beta stocks are very low (Friend and Blume, 1970). In case of the performance measurement of the portfolio, abnormal returns are produced even by portfolios which are managed passively if their investment tactics incline towards CAPM (Elton, Gruber, et.al., 1993). Empirical estimates also suggest that the cost of equity capital for specific industries using the CAPM are not very accurate as they have standard errors of more than three percent per year. (Fama and French, 1997).

Literature Review

Equity valuation took center stage with the revolutionary Capital Asset Pricing Model (Sharpe, 1964) which used the historical beta by taking the covariance between the returns on the security and the market returns and then dividing it by the market returns variance. Several empirical studies following the William Sharpe CAPM, used the historical sixty months' data to arrive at beta valuations (Black et.al, 1972) (Fama & French 1992) (Fama & French 2004). The CAPM model beta is a regression beta using the historical returns of the security and the market returns. Using this regression beta makes an implicit assumption that the beta will be stable in the future as well, and that the future systematic risk pattern of the security does not change. However, the beta is not stable due to changing risk. There is growing consensus among the research scholars that this backward looking beta may not be the appropriate measure to use for equity valuation. Models using betas with conditioning variables are able to capture systematic risk better (Mullins, D W., 1982) (Faff et.al., 2000) (Choudhry 2002, 2004) (Wang 2003). Other Parametrized models also show better abilities of beta estimation (Ferson, 1989) (Ferson and Harvey, 1993) (Ferson and Korajczyk 1995). Companies with high Beta values have highly negatively skewed risk-neutral distributions (Dennis and Mayhew, 2002) (Duan and Wei, 2005). Historical Beta based on CAPM fail to capture the characteristics of the current or the future risks associated with the security (Ramachandran, A, 2012) and these have high standard errors (Damodaran A, 2002). The backward looking beta requires historical data for estimation. Taking too many historical values for beta estimates may not be appropriate as the past performances may not continue into the future. The valuation of the equity under discounting cash flow technique uses the estimated future cash flows and therefore these cash flows need to be discounted using a discounting rate that will fit the time dimension of the cash flow as well. This discounting rate can provide a suitable measure for the changing future risk profile characteristic of the security.

Forward looking beta can be a viable alternative to overcome the limitations of historical beta as discussed above. By using the stock options and index options one can arrive at the forward looking beta. These options contain information about the future values in them. Empirical study shows that this forward looking beta explains cross-sections variations on stock returns (Christoffersen et.al, 2007). In their paper the Forward-Looking Betas are calculated using the variance and skewness (Bakshi and Madan, 2000) (Bakshi, Kapadia and Madan, 2003). The Beta used for estimations must reflect the time varying uncertainty of future cash flows, thus a forward looking beta should be used. Empirical evidences from the emerging markets confirms superior forecasts using the forward looking beta (Onour I., 2009). Forward looking beta calculation models have been proposed in literature by Siegel (1995), Husmann and Stephan (2007), Chen et.al (2009) and Christoffersen et.al (2007).

Another important element of the CAPM Model is the risk free rate. For this purpose, the historical geometric mean of the risk free rate could be used or the current rate of an appropriate risk free seurity may be taken. This is again backward looking because for equity valuation we consider future cash flows and discounting them using a factor which has a backward looking component is not appropriate. If the spot rates of the future time periods are available, then it can be used to calculate the present value of the security by discounting the cashflows with these future rates (Gangadhar Darbha, 2003).

The Market risk premium is the additional return generated by a stock over and above the risk free rate. The CAPM used the historical returns data to calculate the market risk premium. Forward looking market risk premium was proposed by Duan and Zhang (2013). Their paper provided a method of constructing the forward looking premium along with some empirical data to support their theory. The Risk premium is linked to the investors' risk aversion and forward-looking volatility, kurtosis and skewness of cumulative return. Using the autoregressive conditional heteroscedasticity model they found that the forward-looking risk premiums estimated monthly over the sample period of 2001–2010 were to be positive.

The Rest of the Paper is divided into the following Section –Time dynamic Cost of Equity argument, Proposal of the Premium to interest rate structure model to calculate the value of an Equity and Conclusion.

Time Dynamic Cost of Equity Argument

The Equity valuation can be derived using the summation of the present value of the future cash flows, discounted using a certain expected rate, that is the cost of equity Ke. The Ke can be calculated using the CAPM.

$$Ve = \frac{Cf_1}{(1+K_e)^1} + \frac{Cf_2}{(1+K_e)^2} + \frac{Cf_3}{(1+K_e)^3} + \frac{Cf_4}{(1+K_e)^4} + \frac{Cf_5}{(1+K_e)^5} + \cdots + \frac{Cf_i}{(1+K_e)^i} \quad \text{--- (1)}$$

Considering the time value of money, the cash flow (Cf) in the equation (1) above represents the future value (FV) of the cash flows of the current investment Ve for each of the ith time period. The current investment is the total present value of all the future cash flows. Thus Ve is a summation of the present values (PV) of all the future cash flows. The equation can also be written as follows

$$V_e = PV_1 + PV_2 + PV_3 + PV_4 + PV_5 + \ldots\ldots + PV_i \text{ ------- (1.b)}$$

The regular DCF model considers a single discounting rate (IRR) represented by the cost of equity Ke in the equation (1). My argument is that each of these present value of the future cash flows (PV) must be invested for "i" years at a rate applicable each of the ith year to obtain the actual value of the cash flow (Cf). That is, to get a future value of one year from now (Cf1), the PV1 is invested at one-year rate, to get a FV of 5 years (Cf5) the PV5 is invested at five-year rate etc. Thus we can consider that the present value of each of the future cash flow is invested at a specific rate applicable for 'i' years. This is because of the opportunity cost for investment. For each maturity period, the lowest possible interest rate for investment is not same. Consider if we were to invest some amount today in a fixed deposit with maturity periods of one or five years, then we will be investing at different rate of FD for one-year maturity and five-year maturity. Typically, these rates of different maturity periods are not same and are determined by various macro factors.

The CAPM model is a well-established model to calculate the Cost of Equity Ke. This is the discounting rate using for calculating the discounting factor in the DCF model. The cost of Equity itself can be calculated as a summation of two components, the Risk-free rate (Rf) and the risk premium (Rp), with βj being the slope of the regression of security (j) returns on the market returns (Rm).

$$K_e = R_f + \beta_j R_p \text{ ---------- (1.c)}$$

The above CAPM in Equation (1.c), considers a single value of the Risk free rate, beta calculated on the historical returns of the security and the market. Thus we arrive at a single value of Ke. If we use this single Ke value for discounting the expected cash flows, to derive the value of the equity using DCF model, we will be assuming that the expected returns on the equity does not change over time period or in other words Ke is "time static". This is a limitation of the current DCF model of equity valuation. The argument here, I would like to make, is that the cost of equity is not time static but the cost of equity need to be Kei which is "time dynamic". That is, we need to calculate a separate Ke for the each of the ith year for purpose of discounting using the DCF Model. By using the Kei for discounting the cash flows (Cf) of ith year, we can arrive at their respective present value. These present values will then reflect different expected rate of returns for each time period considered. Thus we can re-write the Equation

$$Ve = \frac{Cf_1}{(1+K_{e1})^1} + \frac{Cf_2}{(1+K_{e2})^2} + \frac{Cf_3}{(1+K_{e3})^3} + \frac{Cf_4}{(1+K_{e4})^4} + \frac{Cf_5}{(1+K_{e5})^5} --- + \frac{Cf_i}{(1+K_{ei})^i} \quad ---- (2)$$

If we consider the time static Ke for discounting as per the current DCF model, it will lead to an unrealistic assumption that the expected rates are uniform throughout the cash flow time period. To make this more realistic we need different discounting rates Kei for each year. By using the time dynamic rate of discounting as proposed above, and considering the Value of the firm V0 is same as value of the equity Ve, the modified discounting cash flow model can be stated as per equation (2.b)

$$V_o = \sum_{i=1}^{\infty} \frac{Cf_i}{(1+K_{ei})^i} \quad \text{------- (2.b)}$$

Premium to Interest rate structure model of Equity Valuation

In this section I propose a model to calculate the Kei and develop a "premium to interest rate structure" Equity valuation model. The proposal is to make a modification to the time static CAPM model in equation (1.c) into a time dynamic model. CAPM argues that the minimum expected return on any investment will be the risk-free rate of return. In CAPM however, a single period Rf is considered. The proposed equity valuation model considers real risk-free rates for each time period, forward looking beta and forward looking risk premium in order to estimate the Value of the Equity Ve.

Risk-free rate (R_{fi}) for K_{ei}

If we consider the Interest rate structure of the inflation protected AAA bonds, then any given point of time the minimum expected return with near zero risk is available for different maturity periods. Thus, any investor will require this minimum risk free returns (Rf) on his investment from each maturity period. To consider any security as risk-free it must be issued by an entity with no default risk and the security used to arrive at the risk-free rate will vary over the time horizon. (Damodaran. A, 2008). Thus it is argued that the minimum expected return from investment by an investor for a specific maturity will be equal to the risk free rate of return for that maturity.

The real risk free rate for the purpose of the CAPM model requires that there are no effects of inflation. The US government issued TIPS (Treasury inflation-protection securities) in 1997. The return on this security constituted real and risk-free returns. (Ehrhardt. M C and Brigham E. F, 2009). Long term capital will flow into those economies which can provide real risk free rate, and this is true with The United States. Therefore, the US government's Treasury inflation protected bonds can be considered as risk free (Damodaran. A, 2008). The Credit rating of the US sovereign bonds have been the highest (AAA by Moody's and Fitch) since 1941, as these bonds have the full faith and backing of the US treasury (Monaghan A, 2014). An empirical study on the treasury securities showed that treasury bills issued with one and five-year term do not have market risk (Mukherji. S, 2011).

From the above, if we extend the concept to valuation of equity, then it can be argued that the Rf in the Equation (1.c) for each maturity term must be equal to the risk-free rate as per inflation protected AAA bonds interest rate structure for that maturity period. AAA bonds are considered to be risk free and since they are inflation protected, the returns from these bonds are real risk-free rates. Thus, since each maturity period 'i' has a different real risk-free rate (Rfi), the cost of equity Ke will also keep changing with the maturity period and the Ke will become Kei for the ith period. The future spot rates can be used for present value of the bonds calculations (Gangadhar Darbha, 2003).

Using the arguments as above, for the purpose of calculating the risk free rate for each period, we use the spot rate curve of the Inflation protected AAA bond, also known as the zero curve, referred to the yield curve constructed using the sport rates. An inflation protected AAA bond is suggested as it will not have risks like credit or liquidity risk, will not have any embedded options inbuilt in them nor will have any pricing anomalies. Using on-the-run treasuries or the treasury coupon strips we can construct a spot rate curve with the help of bootstrapping technique. For the time periods where the yield is not available we will have to interpolate using the immediately available yields of higher and lower time periods. Interpolation technique may not yield accurate values so a bootstrapping method to calculate the spot rates is superior. These spot rate are then used in place of the risk free rates (Rfi) for each ith period under consideration.

The table 1 is an example for the purpose of explaining how Kei can be calculated using spot rates for the ith period. For this purpose, I have considered a hypothetical inflation protected AAA bond spot rates to construct the cost of equity Kei for 5 years.

Thus from the example in the table 1 we can generalize the model for Kei to replace the general Ke in Equation (1.c) as follows

$K_{ei} = R_{fi} + \beta_i R_P$ ------------- (2.c)

TABLE 1 : Calculation of Forward looking Cost of Equity using Bootstrapped Risk Free Rate

Time period	Spot rate (R_{fi})	$K_{ei} = Rfi + (\beta_i \times R_P)$
1	R_{f1} =2.0%	$K_{e1} = R_{f1} + \beta_i R_P = 2.0\% + \beta_i R_P$
2	R_{f2} =2.5%	$K_{e2} = R_{f2} + \beta_i R_P = 2.5\% + \beta_i R_P$
3	R_{f3} =3.0%	$K_{e3} = R_{f3} + \beta_i R_P = 3.0\% + \beta_i R_P$
4	R_{f4} =3.2%	$K_{e4} = R_{f4} + \beta_i R_P = 3.2\% + \beta_i R_P$
5	R_{f5} =2.8%	$K_{e5} = R_{f5} + \beta_i R_P = 2.8\% + \beta_i R_P$

Thus the model in the equation (1.b) requires the PV of cash flow to be compounded using the Kei as per the equation (2.c), which in turn uses Rfi. If we had invested in an inflation protected AAA Bond today the yield on the various maturity periods would have been guaranteed. So the risk free rate considered here is a guaranteed minimum return for the specific period.

Another perspective may be to view the (2.c) considering the forward rates of interest rather than the current interest rate structure.

Forward Looking Beta (β_j^{FL})

Accurate measurement of market beta is critical for cost of capital estimation, performance measurement and the detection of abnormal returns. (Christoffersen et.al, 2007). Estimation of risk premium and the beta in the CAPM is backward looking as it is based on historical data and has an assumption that, such calculated values will be applicable for the stock in the future as well. However, this may not be a good assumption due to the poor empirical support in their predictive abilities.

The forward looking Beta has better forecasting performance than the historical beta. The forward looking beta literature has been around for a while now. Calculation of beta implicit in an exchange option contract using at-the-money process, stock price and index option contracts was proposed by Siegel (Siegel, 1995). These option-implied betas are referred to as the forward looking beta. Siegel's model requires the creation of the new derivative called the exchange option and which are not yet traded, and hence this beta cannot be calculated in practice. Beta estimation proposed by Husmann and Stephan (2007) have a disadvantage as they do no rely on the risk neutral valuation.

Christoffersen in his paper calculated forward looking beta using the equity price and index options. As the option prices are forward looking the beta under this method contain information about the future rather than the past (Christoffersen et.al, 2007). He also shows through empirical study that a new derivative creation is not required in order to compute the market beta which is calculated using the forward looking skewness and kurtosis of the stock returns using the methods proposed by Bakshi and Madan (2000), Britten-Jones and Neuberger (2000), Jiang and Tian (2005).

I propose the calculation of Kie for the security 'j' must thus include a Forward looking Beta – βjFL. My proposed forward looking beta βjFL is modeled based on Christoffersen et.al, (2007). Thus the forward looking beta is calculated using the equation (3) below

$$\beta_j^{FL} = \left(\frac{SKEW_j}{SKEW_m}\right)^{1/3} \left(\frac{VAR_j}{VAR_m}\right)^{1/2} \quad \text{-------- (3)}$$

In the equation (3) above SKEWj is the skewness of the security j, SKEWm is the non-zero skewness of market returns. VARj and VARm indicates the variance of the security returns and market returns respectively.

Forward looking Risk premium (R_{Pi}^{FL})

Similar to forward looking beta, the risk premium also need to be time dynamic. When the market price movements are volatile the returns are also extreme, the investor will require a higher market risk premium for such stock due to higher uncertainty. Thus the forward looking risk premium should be larger compared to the historical risk premium which fails to account the effects of market risks. (Merton, 1980)

Various models have been developed in literature for deriving the forward looking risk premium. The forward looking risk premium is linked to forward-looking physical volatility, skewness and kurtosis. With a risk aversion parameter estimate, forward-looking physical moments, forward-looking risk premium for any horizon of interest can be derived (Jin-Chuan Duan and Weiqi Zhang, 2013), parametric models using volatility and jump intensity were used to derive the risk premium (Santa-Clara and Yan 2010), models based on implied risk premium using present value were developed (Schroder. D, 2005), prospective market multiples specifically the ratio of enterprise value to EBIT were used to measure the forward looking risk premiums (Richards, Paul H, 2010).

In the CAPM risk premium is backward looking and is based on historical data. Thus it is required to use forward looking risk premium for the purpose of arriving at the forward looking cost of equity capital. I propose that the risk premium for each period 'i' can be calculated using the difference between the expected market returns for the ith period E(Rmi) and the risk free rate (Rfi) estimated for that period. Thus the Forward looking Risk Premium (RPiFL) for each future period can be calculated by using the equation (4), where RPiFL is the forward looking risk premium for each of the ith period.

$$R_{Pi}^{FL} = E(R_{mi}) - R_{fi} \quad \text{-----} (4)$$

Therefore, the Equation (2.c) can be re-written to arrive at the Forward Looking Cost of Equity Capital for each future period 'i' under consideration to reflect the forward looking beta and forward looking risk premium for each period as below

$$K_{ei} = R_{fi} + (\beta_{ji}^{FL} * R_{Pi}^{FL}) \quad \text{------} (5)$$

Using the equation (5) we can now develop the 'Premium to Interest Rate Structure Model' for equity valuation. The Estimated future cash flows for each period is discounted using the forward looking cost of capital as in equation (5) and summation of these present values of the cash flows are taken. The equation (2.b) can be rewritten as below

$$V_o = \sum_{i=1}^{\infty} \frac{Cf_i}{(1+(R_{fi} + \beta_j^{FL} * R_{Pi}^{FL}))^i} \quad \text{------} (6)$$

Generalized Premium to Interest Rate Structure Model is given below

$$V_0 = \sum_{i=1}^{\infty} \frac{\text{Cash flows in time period i}}{(1+(\text{Rfi} + \text{Forward looking Beta} \times \text{Forward looking Risk Premium for the time period i}))^i} \quad \text{----} (7)$$

In the Above model, the Rfi is the risk free rate taken from the current existing interest rate structure of an inflation protected AAA Bond. The interest rates for all time periods can be estimated using the bootstrapping method. For time periods beyond 30 years, the Rf can be considered to be equivalent to the 30 year Rf since the present value of the cash flows beyond this time period usually does not have significant impact on the valuation.

Conclusion

Given the significance of the role played by the cost of equity capital as a discounting rate in the valuation of the equity; it is necessary that the discounting rates are forward looking, as the valuation is based on the expected future cash flows. Using historical discounting rates which are assumed to be same for all the periods in the future is a major limitation in current DCF models. The Premium to Interest rate structure model proposed in this paper tries to remove this gap, by adopting the forward looking cost of equity capital, and also keeping the discounting factor dynamic for each period. The proposed model (7) bases valuation more closely linked to the current interest rate structure with a risk premium and beta which are both forward looking. This proposed model can be extended to evaluate assets other than equity as well. The Forward-looking betas are more difficult to compute than implied volatilities which may be the main reason why it has not yet been used in the academic literature and in industry practice (Christoffersen et.al 2007). This provides a scope for further research and investigation to develop such models. There is a further scope of empirically testing this proposed model.

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About the Author

Prof. Sandeep Keshava Rao is a Visiting Professor of Finance and Economics at various Business Schools in Bangalore. His areas of research include Market Contagion, Spillover effects in Emerging Markets, Macro-Economic Impacts and Migration Studies. He can be reached at sandeepkrao@outlook.com