How Risky is your Project Really?

Corporate Finance Strategies for Assessing Risk

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1. Introduction

Risk is a vital concept to grasp when investing in a firm or project. It is a key ingredient required to evaluate the cost of capital and perform a valuation. The capital structure used to finance a firm or project and specifically the amount of leverage and debt financing employed must be accounted for to correctly assess a project's risk and perform an accurate valuation.

There are different measures of risk available to us to assess the risk. In this paper we review common risk measures used by practitioners and give an overview of the CAPM beta which measures a firm's systematic risk and assumes that investors are not rewarded for firm specific risk (Berk and DeMarzo, 2016). We review the CAPM model commonly used in corporate finance and show how to calculate beta. Furthermore we discuss how risk increases with leverage and the level of debt financing used to finance a company or project, which consequently increases expected returns (Brealey et al, 2014).

We discuss how CAPM beta can be calculated as the co-movement of returns with the market and/or equivalently as the slope of a regression analysis. For firms and projects that are illiquid and/or have no public data we can imply beta risk from comparable company data, however we are required to unlever and relever beta's to remove leverage effects from the comparables and introduce the leverage effects of the target to give a reliable indicator of beta risk (Koller et al, 2015).

Not only is CAPM beta useful to assess the risk of a firm or project, but it is essential to calculate the weighted average cost of capital (WACC). This is the expected return investors require to invest in a project and incorporate the correct level of risk. Consequently CAPM beta risk is a key ingredient required to value of a firm or project and perform a discounted cash flows (DCF) analysis, see (Burgess 2020a), (Burgess 2020b) and (Burgess 2020c).

2. Risk Measures

In liquid markets practitioners often measure a firm's risk as the volatility, σ or standard deviation of asset returns. Volatility incorporates both firm specific idiosyncratic risk and systemic risk. CAPM Beta, β is another popular measure of risk used by finance industry practitioners. It compares the volatility of a security relative to a market benchmark or index in order to measure a firm's level of systemic risk and exclude idiosyncratic or firm specific risk.

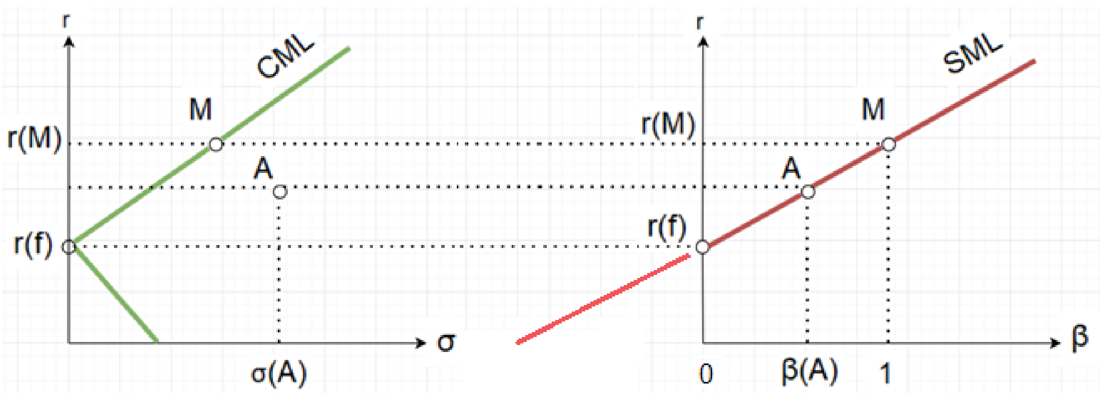
3. Capital Asset Pricing Model (CAPM)

The CAPM model assumes investors are only rewarded for systematic risk and that all other risk is idiosyncratic and can be eliminated and hedged away by holding a well-diversified market portfolio. Consequently CAPM assumes that investors are only rewarded for systemic risk.

The CAPM framework measures the return and volatility risk of a risk-free asset and the market (M). Typically in US markets one would assume that US Treasuries represent a risk-free asset and that the S&P 500 Index represents the market. CAPM creates a Capital Market Line (CML) joining the risk-free and market data points. All portfolios and individual securities not on the CML are considered sub-optimal and inefficient.

In terms of measuring risk and reward individual assets are benchmarked firstly against the CML to measure their systemic returns and secondly against a Security Market Line (SML) to measure their beta or systemic risk as demonstrated in figure 1 for an asset A. For a full review of the CAPM Model see (Berk and DeMarzo, 2016) and (Brealey et al, 2014)

Figure 1: CAPM Capital Market Line (CML) and Security Market Line (SML)



For an asset A the Capital Market Line (CML) measures its systemic return and maps this to the Security Market Line (SML) to measure its systemic risk beta. We note that volatilities σ cannot be negative, whilst betas β can indeed be negative, which we often observe for the insurance sector.

The CAPM formula is quoted below and is equivalent to linear interpolation of the Security Market Line (SML).

Formula 1 CAPM Formula

$$\boldsymbol{r_A = r_f + \beta_A(r_M - r_F)}$$

where r(A) is the return of asset A, r(f) the risk-free rate, beta A the systemic risk of asset A, r(M) the return of the market portfolio and (r(M) – r(F)) is often referred to as the market risk premium.

4. Beta Risk

CAPM beta assumes investors are only rewarded for systemic risk. It can be measured in several ways as shown below. Firstly it can be calculated by rearranging the CAPM formula as follows,

Formula 2 CAPM Beta

$$\boldsymbol{\beta_A = \frac{(r_A - r_f)}{(r_M - r_f)}}$$

Secondly as Beta measures the co-movement of the asset with the market it can be estimated from raw market data as shown in formula 3 below. We highlight that in Excel we can measure covariance and variance using the functions COVAR and VARP respectively.

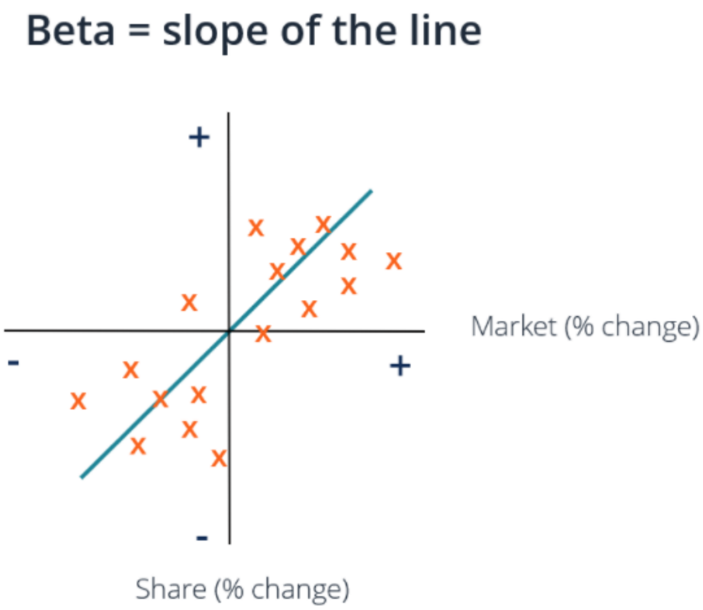
Formula 3 Beta from Raw Market Data

$$\beta = \frac{Covar(A, M)}{Var(M)}$$

where Covar(A,M) is the covariance of asset A with the market M and Var(M) is the variance of the market.

Thirdly can also model and estimate beta as a regression. This can be done by plotting asset returns against market returns and plotting the line of best fit as shown below and calculating the slope. In Excel the slope can be calculated using the SLOPE function.

Figure 2: Beta Regression



Source: Corporate Finance Institute

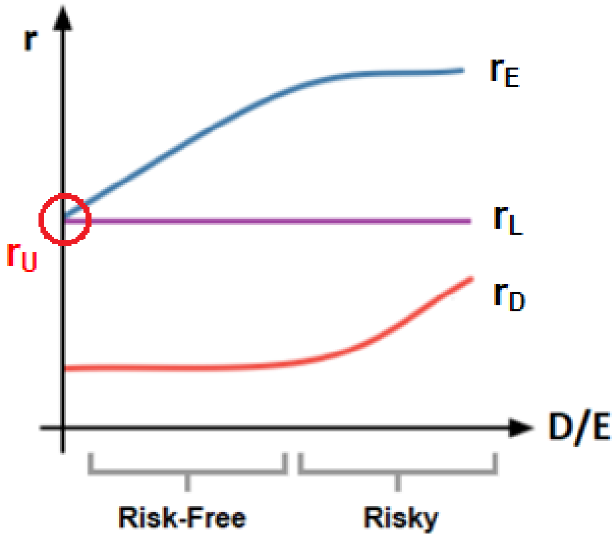
5. Risk & Leverage

Modigliani-Miller Proposition II tells us that the cost of capital or WACC of a firm or project remains constant regardless of capital structure and how much debt leverage is employed (Sheridan 2002). However we also know that equity and debt cost of capital increase as we issue more debt and increase leverage (Koller et al, 2015).

A firm's debt repayments must be repaid with priority. Equity dividends can only be paid if there are sufficient funds to do so after paying debt holder coupons. Hence equity holders expect a higher rate of return to compensate for increasing levels of leverage as debt to equity ratios increase, as shown in figure 3.

The CAPM model tells us that beta increases monotonically with returns i.e. the cost of capital. Consequently equity and debt beta risk must also increase as D/E ratios and debt financing levels increase in a similar way to the cost of capital shown in figure 3.

Figure 3: **Leverage Effects on the Cost of Capital**



***Source**: Adapted from SSRN (Burgess, 2020c) with* $r_D \leq r_{WACC} \leq r_E$ and where *r(L) is the WACC and r represents the cost of capital for projects that are r(U) unlevered, r(L) levered, r(E) equity r(E) debt financed.*

6. Comparable Company Risk Proxies

When assessing the risk of a private firm or project sometimes the best we can do is to use proxy data and assume the risk of a private company is comparable to that of a liquid publically traded company where the beta risk is known and transparent.

Remembering that a firm's Debt and Equity risk as measured by CAPM beta increases with leverage and debt to equity ratios reminds us that a firm's capital structure and debt levels can uniquely elevate its level of risk. Therefore when using proxy betas from comparable companies to estimate private company risk we must unlever the proxy betas to remove capital structure distortions and relever such betas to that of the target company.

6.1 Unlevered Beta

As per (Koller et al, 2015) to compare the betas of two companies it is necessary to unlever them. We can unlever a company's beta using formula 4 below as shown example 1.

Formula 4: **Unlevered Beta, B(U)**

$$\beta_U = \left(\frac{D(1-\tau)}{D(1-\tau)+E}\right)\beta_D + \left(\frac{E}{D(1-\tau)+E}\right)\beta_E$$

or equivalently,

$$\beta_U = \left(\frac{D/E(1-\tau)}{1+D/E(1-\tau)}\right)\beta_D + \left(\frac{1}{1+D/E(1-\tau)}\right)\beta_E$$

where D = debt level, τ = tax rate, E = equity level, β(D) = debt beta, β(E) = equity beta and β(U) = unlevered beta

Example 1: **How to Unlever Comparable Company Betas**

Kohler Co. is a large private company with disparate business divisions specializing primarily in kitchen & baths but also in power generator manufacturing. The company analyst identifies American Woodmark and Cummins Engine as suitable comparable companies for the respective business divisions. She assumes both companies have a debt beta of 0.06.

The comparable companies have the following financial data,

Business Type	Kitchens & Baths	Power Systems
Comparable Companies	American Woodmark	Cummins Engine
Equity Beta	0.760	1.090
Debt	13.40	1,250.00
Equity	236.30	2,285.70
Debt/Equity Ratio	5.67%	54.69%
EBITDA	37.60	487.00
Post-tax EBITDA (EBIDA)	27.40	390.20
Tax	10.20	96.80
Tax Rate %	27.13%	19.88%

Q: Calculate the unlevered equity betas for American Woodmark & Cummins Engine.

Using formula 4 we can calculate unlevered beta as follows,

$$\beta_U = \left(\frac{D/E(1-\tau)}{1+D/E(1-\tau)}\right)\beta_D + \left(\frac{1}{1+D/E(1-\tau)}\right)\beta_E$$

Debt Beta, B(D)	0.060	0.060
Levered Beta, B(L)	0.760	1.090
(1 - Tax)	72.87%	80.12%
D/E Ratio	5.67%	54.69%
Unlevered Beta, B(U)	**0.732**	**0.776**

6.2 Relevered Beta

Similarly as per (Koller et al, 2015) we must relever proxy beta(s) to reflect the capital structure and leverage of the target company using formula 5 below. We give an example of how to relever beta in example 2.

Formula 5: **Levered Beta, B(L)**

$$\beta_L = \beta_U + \frac{D(1-\tau)}{E}(\beta_U - \beta_D)$$

where D = debt level, τ = tax rate, E = equity level, β(D) = debt beta, β(E) = equity beta and β(U) = unlevered beta

Example 2: How to Relever Beta to Incorporate a Target Company's Leverage

Following on from example 1, the company analyst knows that Kohler Co generates 73.33% of its sales from its Kitchen and Bath business and 26.67% from its power generator manufacturing business. Furthermore the analyst implies the tax rate for Kohler Co. from the company income statement as 43.50%, the debt-to-equity D/E ratio of 32.94% from the balance sheet statement and has calculated Kohler's debt beta as 0.06 using the CAPM formula, risk-free rate and market risk premium assumptions.

Q: Calculate the unlevered and levered equity betas of the Kohler Co group?

Firstly the unlevered beta is the weighted average of the comparable unlevered betas from example 1 as shown below.

Kohler Equity Beta			
Business Type	Kitchens & Baths	Power Systems	Total
Group Weights by Sales	73.33%	26.67%	100.00%
Group Unlevered Beta, B(U)	0.732	0.776	
Kohler Unlevered Beta, B(U)	0.744		

Secondly to calculate the levered beta for Kohler Co. we apply formula 5 as shown below,

$$\beta_L = \beta_U + \frac{D(1-\tau)}{E}(\beta_U - \beta_D)$$

Kohler Unlevered Beta, B(U)	0.744	
Kohler Tax	43.50%	from Income Statement
(1 - Tax Rate)	56.50%	
D/E Ratio	32.94%	from Balance Sheet
Debt Beta, B(D)	0.060	from CAPM
Levered Equity Beta, B(E)	**0.871**	Kohler Equity Beta (Levered)

Finally we check the consistency of the beta results. We expect that debt beta is greater than the risk free beta of zero as shown in figure 1. Moreover, as shown in figure 3 we observe cost of capital relationships, namely that r(debt) < r(average) < r(equity). Likewise CAPM shows us that beta increases monotonically with return or cost of capital and consequently observes the same criteria, namely beta(debt) < beta(average) < beta(equity), which we see holds true.

Beta Check	
B(D) < B(U) < B(E)	0.06 < 0.744 < 0.871

7. Conclusion

In summary we introduced the importance of risk and that it is a key requirement to evaluate capital costs and perform an accurate company or project valuation. After considering the main risk measures used by practitioners in financial markets we turned our attention to CAPM beta, which measures systematic risk. We reviewed the CAPM model and discussed the different ways to compute beta, including measuring the co-movement of returns to the market and by performing a regression analysis.

However a key question remains. How should we measure beta risk for firms and projects that are illiquid and/or have no public information? Firstly we select suitable comparable firms to proxy for the risk of our firm or project, however in answering this question we need to consider how firm specific debt financing and leverage distort risk and returns. We are required to unlever comparable betas to remove distortions due to firm specific leverage and to then relever the resulting beta to incorporate the appropriate leverage of the target firm or project to reflect the target's capital structure.

In this paper we provide examples of how to calculate beta and how to unlever and relever beta for private firms and projects. For a copy of the associated Excel workbook outlining the calculations used kindly email the author.

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