BETA & It's Variants

ABSTRACT

Beta in finance often becomes confusing for its users. Several terminologies of beta and availability of umpteen literature on the same often create ambiguity in the mind of the users. This technical note on beta summarizes the complete concept of beta and its different variants/ terminologies. The note also explains how to compute beta manually along with some problems.

WHAT IS BETA

Beta (β) or Beta Coefficient in finance is the measure of risk that arises from the exposure due to general movements in the market as opposed to certain distinctive factors. Beta is the measure of systematic risk of the stock, and it measures the volatility of a stock or a stock portfolio in comparison with the benchmark index of a stock market. The capital asset pricing model (CAPM) is widely used to predict the expected return from the stock uses Beta as a key variable in the equation. The CAPM equation is –

$$Er = Rf + \boldsymbol{\beta} (ERm - Rf)$$

Where

- Er = expected return from a security
- Rf = Risk-Free return of security (normally the treasury rate or the government bond rates)
- ERm – Rf = market risk premium which is the difference between expected return from the market and risk-free rate.
- **β = Beta of the investment**

"Beta" measures the sensitivity of an individual or a portfolio of security to a benchmark market index or market-wide risk factors. It is defined and considered as the measure of volatility, or systematic risk of a stock or security or the portfolio of stock/security in comparison to the benchmark market performance (index) or the overall market. The beta of one indicates that the security will move along with the market, i.e., $\beta = 1$ exactly as volatile as the market, $\beta > 1$ more volatile than the market, $\beta < 1 > 0$ less volatile than the market, $\beta = 0$ uncorrelated to the market, $\beta < 0$ negatively correlated to the market. For individual security or portfolio, this value is related to how sensitive its underlying revenues and cash flows are too general economic conditions. For instance, securities in cyclical industries, where revenues tend to vary greatly over the normal business cycle, are likely to be more sensitive to systematic risk and are expected to have higher betas than stocks in less sensitive industries. **Example -** Beta of Edition International (utility

company) – 0.26[1]; Beta of Anheuser-Busch (a beer brewing company) – 1.23; [2] Beta of Kraft- Heinz (food and beverage company) – 0.70. The beta of these companies is relatively low as utility companies tend to be highly regulated and stable and thus are insensitive to fluctuations in the market. Similarly, food, brewing, beverage firms, and their products appear to be unrelated to the booms and busts in the economy. Likewise, the beta of technology has higher betas as whenever there are shocks in the economy, and these stocks have an amplified impact of the stock.

Beta sometimes is confused with standard deviation (SD) or variance. Although both are measures of risk, some basic difference is there in both and can be summarized as (a) Beta measures the market risk, whereas SD measures the individual security risk. (b) Beta measures total volatility, whereas SD is the measure of total risk, i.e., both systematic and unsystematic (c). Likewise, beta measures the market risk premium, and SD measures the total risk.

SYSTEMATIC AND UNSYSTEMATIC RISK

The concept of beta is better understood if we are clear with the concept of systematic and unsystematic risk. Macroeconomic factors are the reason for systematic risk, and such risks are likewise are termed as market risk or volatility risk or non-diversifiable risk. Unforeseen events that happen in everyday life of investors are part of such risks and are beyond the control of individual or firm. Investments and securities traded in the market suffer from systematic risk, and it is important to discover such risks are unavoidable by diversification of the portfolio. Its beta value can judge the systematic risk content from the historical data. We compare the systematic risk of the security traded in the market with the benchmark market index, and the outcome is beta. Systematic risks impact all the companies in the entire industry and not a single company. Unsystematic risk is related to uncertainty concerning a specific firm, stock, or industry, and diversification mitigates such issues.

Examples of systematic risks include interest rate changes or hike in interest rates, inflation, natural disasters, change to laws, tax reforms, political instability, changes in the foreign policy and change in the currency value, recession in the economy, failure of financial institutions, etc. All the companies in the market will be influenced by surprise about inflation to some extent. Suppose a stock tends to go up on the news due to exceeding expectations of inflation, we say that it is positively related to inflation, likewise, if the stock goes down in case of exceeding inflation expectation or when inflation falls short of expectations

[1] https://www.reuters.com/finance/stocks/overview/EIX assessed on 29-06-2019
[2] Ibid

then it is negatively related. The case when there is no correlation between the security price and inflation surprises, inflation has no impact on it.

SOURCE OF BETA

We can find from various financial websites (yahoo finance, Forbes money, etc.) or the financial database like Bloomberg, Thompson Reuters, etc. or also from the individual company website. At the same time, by using the firm-specific data and the benchmark index, we can compute the beta on our own. Computed beta available are of various years, viz. beta of one year, two-year, three years, and so on, but sometimes published betas are computed with time frames not known. The prime risk an investor takes by using the market published betas is, firstly, the variables used by these websites is unknown, and secondly, such beta may not be adaptive to the unique portfolio of the investor.

In measuring the portfolio risk, the penultimate users of beta encounter with a typical problem. An investor who wants to invest in the long-term securities wants to measure the risk over the long term as compared to an investor who typically is a trader and is frequently varying the portfolio. Similarly, the index used as the benchmark to compute beta by the financial website also varies as most of the developed and developing countries have numerous benchmark index. The beta of the security will vary with the use of different benchmark index, and thus, the readily available beta may be confusing to the investor. Even the method and the period used to compute beta by these finance websites are not known.

Knowing the limitation of published beta, we can calculate our beta, and thus, we can adjust for such differences, which enables us to create a more holistic view of the measure of risk. We can compute and customize our beta in several ways, depending upon our portfolio, the time horizon of investment, and other factors that we wish to consider. We can customize the beta and measure the reliability by computing the r squared (R^2) often acknowledged as the coefficient of determination. R^2 is the statistic whose range is zero to one, and it determines how well beta measures the risk level. The reliability of beta is measured using the value of $R^{2,}$ and if R^2 is close to one, it depicts the high reliability of beta. The computation of beta better explains the expected return of the stock as compared to the market published beta, as the investor decides the time frame, align with the portfolio, and then choose an appropriate index. Once the desired data is available, we can compute the beta of security or portfolio.

COMPUTATION OF BETA –

In the note we will discuss computing beta in two different ways, Firstly, we can compute by applying the statistical formula of **covariance[3] -** the following formula to compute beta –

$$Beta = \frac{covariance\ between\ returns\ from\ market\ portfolio\ and\ those\ from\ particular\ security}{variance\ of\ marekt\ portfolio}$$

OR

$$\beta_i = \frac{\sigma_{im}}{\sigma_m^2} = \frac{covariance\ with\ the\ market}{variance\ of\ market}$$

OR

$$\beta i = \frac{Covariance_{\ i,m}}{\sigma_m^2}\ i.e. Cov(X,Y) = \sum \frac{(X_i - \bar{X})(Y_j - \bar{Y})}{n-1}$$

Where

$\sigma_{im} = covariance\ between\ stock\ return\ and\ the\ marekt\ returns$

$\sigma_m^2 = variance\ of\ the\ returns\ on\ the\ market$

$X_i = the\ value\ of\ the\ X - variable$

$\bar{X} = the\ mean\ (average) of\ the\ X - variable$

$Y_j = the\ values\ of\ the\ Y - variable$

$\bar{Y} = the\ mean\ (average) of\ the\ Y - variable$

$n = the\ number\ of\ the\ data\ points$

In Microsoft – Excel beta can be computed using the slope coefficient function or the 'covar' and 'var' function. The note provides an example of beta computation in excel.

Table 1step-by-step illustrates the example to compute beta using the covariance method by applying the equation stated above.

EXAMPLE

[3]Statistical measure that measures the joint variation between the two variables. In finance and investment analysis this is used to value the co-movements form a portfolio of stock with the return from benchmark market index. The mean value of a variable is computed and if the mean value of other variable tends to be above the mean value of the variable it infers positive covariance between the two variables. Whereas if the other mean value trend is lower than the mean value of the first one, than it infers the negative covariance between the two variables. Unlike the correlation coefficient, whose range lies between ±1, the value of range of covariance is unrestricted.) $\frac{\Sigma xy}{n} where\ x\ is\ X - average\ value\ of\ X; y = Y - average\ value\ of\ Y$

Day	Market Rate of return	Return on Individual equity	Deviation from the average of the market rate of return	Deviation from the average of return on individual equity	Sum of the square of the deviation Column (d)	Sum of the square of deviation column (e)
	1	2	3	4	5	6
1	-7%	-12%	-9	-15	81	225
2	-8%	-7%	-10	-10	100	100
3	4%	7%	2	4	3	16
4	12%	9%	10	6	100	36
5	5%	19%	3	16	9	256
6	8%	12%	6	9	36	81
7	-6%	-11%	-8	-14	64	196
8	3%	2%	1	-1	1	1
9	7%	8%	5	5	25	25
10	2%	3%	0	0	0	0
	Average = 2%	Average = 3%			420	936

From the above tables and given data, Beta can be computed following the below six steps

1. Compute the average return on the market and the average return on individual equity as computed in column 1 and column 2.
2. For every class of the assets, we need to compute the deviation from each return from the asset's average return, as determined above. In our table above this is computed in column 3 and 4
3. Next, multiply the deviation of return from the security by the deviation of the return from the market. Column 5 depicts the computation.
4. Further, compute the squared deviation of the market's return. Column 6 depicts the same.
5. Further, we do the summation of columns 6 and 7.
6. Finally, we compute beta using the formula mentioned above – the sum of column 6 divided by the sum of column 7.

$$Variance = \ \sigma_m^2 = \frac{420}{10} = 42$$

$$covariance = \ \sigma_{im} = \frac{936}{10} = 93.6$$

$$Beta\ (\beta) = \frac{\sigma_{im}}{\sigma_m^2} = \frac{93.6}{42} = 2.23$$

The second method of computing beta is using beta is by using the slope coefficient through regression analysis.

Using the regression methodology, we can obtain the slope coefficient, termed as a beta. To compute the regression, we regress the return from the individual security against the benchmark market index return. The regression equation used to estimate the beta coefficient of the company is -

$$\Delta E_i = \alpha + \beta_i \times \Delta I + \varepsilon$$

Where

$\Delta E = change\ in\ the\ price\ of\ equity\ stock$

$\Delta I = change\ in\ benchmark\ index\ (market\ price)$

$\alpha = intercept\ value\ of\ the\ regression$

$\beta_i = beta\ of\ the\ \ i\ stock\ retrun$

$\varepsilon = the\ error\ term$

In the present technical note, we have computed beta using both the methods as stated above. We have considered Apple Inc. as the stock and S & P 500 as the benchmark index for the period July 2009 to July 2019. Annexure – 2 and Annexure – 3 of the note explains the computation of beta in excel.

BETA INTERPRETATION / INFERENCE

It is very important to understand the interpretation of beta. The beta of 1 of any security indicates that the security will move in the same direction in which the market benchmark index is moving. Likewise, the beta of the market is always one as the comparison is with the benchmark market index itself. If the computed value of beta is below one, the inference is that the volatility of the stock when compared with the benchmark market index is less volatile. Whereas, if the value of beta is more than one, it implies that the security or stock is more volatile as compared to the benchmark market index. Theoretically, it is possible to have a beta value of less than zero, i.e., negative beta. We observe the negative beta when the benchmark market index is continuously increasing, and the security price is decreasing (which is more likely), or the value of a stock is increasing with a decrease in the market (less likely). **Annexure – 1 of the technical notes illustrates in tabular form the interpretation of beta.**

EXAMPLE

The beta of a stock 1.50 implies that the security is likely to move by 1.5 percent if the benchmark market index varies by 1 percent. Thus, the stock as compared to the market will be treated as riskier because the expected change in the stock is greater as compared to the fluctuation in the benchmark market index.

The beta of the security, sensitive to the market, is also based on its revenue and cash flow concerning the general economic conditions in the market. In a market when the revenue and earnings of stock vary greatly in a business cycle, especially in the cyclical industries are expected to have higher betas as they are more sensitive to the systematic risk. In comparison to this beta of less sensitive industries (industries not impacted by the normal change in cyclical conditions) will likely have lower betas.

Example - Beta of Edition International (utility company) – 0.26[4]; Beta of Anheuser-Busch (a beer brewing company) – 1.23; [5] Beta of Kraft- Heinz (food and beverage company) – 0.70. The beta of these companies is relatively low as utility companies tend to be highly regulated and stable and thus are insensitive to fluctuations in the market. Similarly, food, brewing, beverage firms, and their products appear to be unrelated to the booms and busts in the economy. On the other hand, the beta of technology has higher betas as whenever there are shocks in the economy; these stocks have an amplified impact of the stock.

LEVERED BETA (EQUITY BETA)

"Levered beta," correspondingly termed as "equity beta," or "geared beta," compares the volatility of returns of stock of a company concerning the benchmark market performance. This measure of risk varies based on the capital structure of the company and the leverage. Equity beta enables the investor to measure how sensitive or risky the security be to the macroeconomic risk.

Leverage is the key determinant of beta, i.e., and leverage measures the component of the firm's debt compared to stockholders' equity. The systematic risk of the firm consists of several risks that may affect the performance of the stock. Such risk includes macroeconomic factors, political events, legal changes, etc., and the possibility of leveraging through diversification is not possible or difficult. Equity beta considers both the debt and equity in the capital structure of the firm. The capital structure of all the firms in the market will always be different. The risk associated with the assets of the firm irrespective of debt and equity proportion makes the analysts and investors interested. Higher the debts of the firm, the more the cash flow and profits will be required to serve the debts, which increases earnings uncertainty in the future. This increase surely impacts the security of the firm, but they are the result of the firm's policy and are not the industry/market risk. Thus, when we remove the impact of debt (financial leverage), we get the un-levered beta, which captures only the risk of a firm's assets. As the level of debt and capital structure are different for different firms, it is desirable to consider un-levered beta for effective comparison with the market.

Equity or levered beta allows investors to measure the sensitivity of security based on the macro market risk. The default beta figures, as displayed on the financial websites or database like Bloomberg, is always levered beta, which also reflects the debt of the firm. The capital structure of all the firms operating in the

[4] https://www.reuters.com/finance/stocks/overview/EIX assessed on 29-06-2019
[5] Ibid

market is different. The analyst whos wishes to only look at the riskiness of assets of the firm uses the beta irrespective of the debt and equity percentage of the firm.

UNLEVERED BETA

"Unlevered beta," also termed as "Assets Beta," is beta without the impact of debt of the firm. It shows the volatility of earnings by not taking into consideration the financial leverage of the firm. As it measures the volatility of the firm without considering the leverage, it is also termed as 'assets beta,' as it is a result of only its assets. The basic inference of un-levered beta is that it measures the risk of an un-levered firm to the risk of the market. Un-levering the beta surely removes the benefits received by the firm due to adding of debt in the capital structure, especially when the firm's debt is less than cash (net debt is negative).

METHOD OF COMPUTING LEVERED AND UNLEVERED BETA

- The formula for computing un-levered beta

$$Assets\ Beta\ (Unlevered\ beta) = \frac{Equity\ Beta\ (levered\ beta)}{\left[1 + (1 - tax\ rate)(\frac{debt}{equity})\right]}$$

- Formula for computing levered beta

$$equity\ beta\ (levered\ beta) = unlevered\ beta\ \times \left[1 + (1 - tax\ rate)(\frac{debt}{equity})\right]$$

Using the above two formulas, if we want to determine the risk of the firm not having any debt, we will remove the impact of the debt, i.e., we will un-lever the beta. Most of the databases like 'Bloomberg,' 'yahoo finance,' 'Thompson Reuters' etc. publish the beta (levered beta). Thus, using published/computed levered beta and the capital structure of the firm, we can compute the un-levered beta of the firm.

Hamada's equation is the term used to separate the financial risk of a levered firm from the business risk. The basic assumptions of the capital asset pricing model and the Miller & Modigliani model is applied to develop the Hamada equation. It determines that the financial and operational risk of the firm determines the beta. Thus, even if the firms in the same industry sector may have the same operating risks, they may have different betas because of different capital structures. We term this as the pure-play beta or the un-levered beta. If the firm operating in the same industry sector are having no leverage or debt, they will not have any financial risk, and their beta may be the same as they will have similar operational risks.

EXAMPLE

We consider four firms here (AB Ltd., CD Ltd., EF Ltd., and GH Ltd.)

	1	2	3	4	5	6

	Equity Beta [6](Raw beta)	Total Debt [7]($)	The market value of equity[8]	Debt/ Market value of equity	Income tax rate	**Asset beta**
AB Ltd.	1.81	6154	63,443	9.70%	33%	**1.6995**
CD Ltd	1.63	7123	18,732	38.03%	33%	**1.299**
EF Ltd	0.73	3267	15,482	21.10%	33%	**0.6396**
GH Ltd	0.82	5232	8236	63.53%	33%	**0.5752**
Mean	1.2475	5444	26473.25	0.33088448	0.33	**1.0533**

Steps followed in computing the beta from levered to un-levered, i.e., from equity beta to asset beta.

Step 1 – beta of the four firms taken from a database along with the debt (if the market value of debt is available that should be considered), the market value of equity and the tax rate applicable — column one, two, three, and five, respectively contains the information.

Step 2 – we computed the debt-equity ratio using the formula debt/market value of equity. Column four computes the same.

Step 3 – the asset/ un-levered beta was computed using the following formula

$$Beta\ (Unlevered\ beta) = \frac{Equity\ Beta\ (levered\ beta)}{\left[1 + (1 - tax\ rate)(\frac{debt}{equity})\right]}$$

OVERALL BETA

We may also calculate the overall beta of the firm referred to as the firm beta or overall beta or Asset beta. It indicates the expected change in return from the firm when the return from market portfolios varies by 1 percent. Overall, beta is a weighted average of equity beta and debt beta.

$$Overall\ beta\ (if\ tax\ ignored) = Debt\ Beta\ \times \frac{D}{D+E} + Equity\ Beta\ \times \frac{E}{D+E}$$

$$Overall\ bera\ (tax\ considered) = Debt\ Beta\ \times \frac{D(1-t)}{D(1-t)+E} + Equity\ Beta\ \times \frac{E}{D(1-t)+E}$$

The Miller-Modigliani approach (MM approach) believes that the overall beta of the firm is not affected by the change in the capital structure.

ADJUSTED BETA –

[6] Equity beta as provided on the financial website or published data.

[7] Total debt of the firm as per the balance sheet/ statement of financial position

[8] Market value of equity can be computed using the market price of security or stock on a given day multiplied by number of equity stock outstanding.

Sometimes the beta is adjusted. When we compute the beta or the beta, which are available on most of the financial websites are based purely on the historical data and are unadjusted betas. The beta of the security based on the historical return and index may not be a decent indicator of the future. Typically in finance, it is termed as "beta instability problem." Over time, statistically, the beta may exhibit the mean-reverting properties, i.e., the beta seems to revert to mean, which means that the higher beta will tend to fall back to 1, and the lower beta will tend to rise to 1. Analysts in such cases to compute the predicted returns from the security create an adjustment calculation for the historical beta and compute the "Adjusted Beta." Bloomberg exhibits both the historical (raw) beta and the adjusted beta. By using the past data of the stock, we assume that over time the beta of the security will tend to move towards the average market, and thus, beta needs to be adjusted. Following formula is used to adjust the beta –

Adjusted beta = (.67) * Raw beta + (.33) * 1.0.

Beta has the mean-reverting property, this interest that the adjusted beta will move closer to 1. The value of adjusted beta will be less than unadjusted beta if the unadjusted or historical beta is greater than one, and it will be more than unadjusted or historical beta if the historical beta (unadjusted) is less than 1. In the above example, we can adjust the beta using the suggested practice in the finance literature. The literature suggests that equity beta is provided 67% of weightage and 33% weightage to one, which is the market average. The assumption considered by the adjusted beta is that a security's true beta will tend to move towards 1, which is the market average over time.

Example

The table below shows the computation of beta considering adjusted beta rather than raw equity beta.

	Equity Beta (Raw beta)	Total Debt ($)	Market value of equity	Debt/ Market value of equity	Income tax rate	Adjusted Beta [(Equity beta*0.67) +(market beta 1*0.33)]	**Asset beta ***
AB Ltd.	1.81	6154	63,443	9.70%	33%	1.5427	**1.371**
CD Ltd	1.63	7123	18,732	38.03%	33%	1.4221	**1.133**
EF Ltd	0.73	3267	15,482	21.10%	33%	0.8191	**0.640**
GH Ltd	0.82	5232	8236	63.53%	33%	0.8794	**0.576**
Mean	1.2475	5444	26473.25	0.33088448	0.33	1.1658	**0.93**

** we compute the assets beta with adjusted beta following the same procedure as in the previous example*

Both the levered and un-levered beta are critical and important; however, the firm's capital structure is an important consideration before coming to any conclusion and needs to be understood. We shall make the appropriate adjustments to come up with the beta associated with the respective firm.

COMPUTATION OF BETA OF A PRIVATE FIRM –

We can derive beta of the private firm using the comparable public company data – The process of computing beta mentioned above is appropriate for publicly listed companies whose historical stock price are available. As the data of the private company are difficult to find or the data is not available in the public domain, it becomes difficult to estimate the beta of such firms. Thus, we must compute or estimate the beta of private companies using the data of public company which is of similar type or comparable with the private company for which we are computing the beta. The approach we follow for this is –

Firstly, we compute the beta/average beta/weighted average beta of the publicly traded firms that operate in similar operations and generates income from similar operations as of the private company. This beta acts as the proxy for the industry average equity or levered beta. Further, we un-lever the beta by the average debt-equity ratio of these comparable firms. And finally, we re-lever the beta by using the target debt-equity ratio of the private company.

EXAMPLE

Suppose we wish to compute the beta of a company into the IT sector with a debt-equity target ratio of 0.6, and we can identify the following firms which are the most comparable:

Comparable firms 31.12.2018	Beta (β)	Debt	Equity	Debt/Equity
X Ltd.	1.6	15,680	32,534	0.48
Y Ltd.	1.65	21,130	75,700	0.28
Z Ltd.	1.71	1,046	3,306	0.32
A Ltd.	1.69	3,256	8,156	0.40
		41,112	119,696	
Average Beta	**1.6625**			
Weighted average beta	**1.64***			
Weighted average debt/equity	**0.34****			

** (1.6*32,534) + (1.65*75,700) + (1.71*3,306) + (1.69*8,156)]/4*

***41112/119696*

As seen in the table, the average beta is 1.6625, and the weighted average beta is 1.64. The choice of method, whether simple average or weighted average, depends on the data and range of comparable companies. If in the comparable firms, we have a few small companies and one very big company than a beta will be biased towards the large company. In the example cited above, as the weighted average beta is close towards the average beta, we can consider the weighted average beta giving equal weight to equity of

each company. Using the formula cited above, we un-lever the beta. To do this, we compute the average debt-equity ratio, which is 0.34 in the above example.

$$\beta_u = \frac{\beta_l}{1 + (1 - t) \times \frac{D}{E}} = \frac{1.64}{1 + (1 - 0.35) \times 0.34} = 1.343$$

Further, in the next process, we re-lever this beta using the target debt-equity ratio of the private company which in our case is 0.6

$$\beta_l = \beta_u \times (1 + (1 - t) \times \frac{D}{E} = 1.343 \times (1 + (1 - 0.35) \times 0.6) = 1.86677$$

In the present example, the beta of this private company is higher than the average beta of comparable companies due to the target higher debt-equity ratio.

"EARNINGS BETA APPROACH - Deriving beta of the private firm

The comparable method used above sometimes has certain drawbacks. It disregards the difference between the size of a public company and the private company, and the majority of the times, publicly traded firms are of bigger size as compared to the private firms. In place of the above, we can use the "earnings beta approach to compute the beta of private firms. Firms like Apple Inc., which are diversified and are huge, will be biased comparable to the private firm in question. In such cases, we can use the earnings beta as a proxy for the levered beta of the firm. In the earning beta approach, we regress the earnings of the private firm against the benchmark index operating in the same market where the firm operates. Once we identify the, we can adjust the beta to reflect the firm's future performance. The explanation of the beta adjustment method is enumerated earlier in the note.

BOTTOM UP-BETA

When the firm is diversified into various businesses and has numerous segments, then firstly, beta is computed for all the segments, and secondly, we compute the weighted average of all the beta. We perform the following steps to compute the bottom-up beta –

(a) Divide the company into the segments in which the firm operates. For example, GE operates in approximately 25 segments as compared to Amazon, which operates in a single segment.

(b) By estimating the risk of each segment separately, the beta of each business is computed, which is an asset or un-levered beta.

(c) We compute the weighted average of all the beta of various segments by assigning the weights of value derived from each independent segment. These are the market value weights of each segment and are estimated. (such estimations generally based on revenues, various multiples of revenue derived from comparable firms, etc.)

(d) Finally, the un-levered beta is adjusted using the debt-equity ratio of the firm (Financial leverage) Bottom-up beta can overtime change for the company if the mix of business changes or the leverage of the firm changes. Bottom-up beta not based on historical data, and the literature suggests such betas are comparatively better than the regression beta, and they are more precise.

Project Beta

Project beta is an important concept in corporate finance, and we compute it using the "pure-play method." In the pure-play method, we compute the beta of a publicly-traded company, and such a company should be purely in that specific business only. We follow three steps to compute the Pure play beta

Step 1: shortlist those publicly traded companies which are comparable

Step 2: compute the comparable assets beta or un-levered beta for the project using the comparable firm's D/E and the tax using the following formula

$$\beta_{asset} = \beta_{equity} \times \frac{1}{1 + \frac{(1-t)D}{E}}$$

Step 3: further the levered equity beta for the project is computed using the project-specific D/E and the tax using the following formula

$$\beta_{equity} = \beta_{asset} \times \frac{1}{1 + \frac{(1-t)D}{E}}$$

Example:

XYZ Inc., a large multinational firm operating in several segments wish to determine the beta for its chemical segment. The debt-equity ratio is 0.7 of the division, and the rate of tax is 40%. The equity beta of the comparable firms operating in the segment is 1.2, with a debt-equity ratio of 0.5. Compute the beta of XYZ Inc.

By using the pure-play method, we will compute the beta of the chemical division of XYZ Inc. as follows:

- Unlevered beta of a comparable public trading company (chemical division) = $1.2 \times \frac{1}{1+0.6(0.5)} = 0.923$
- Levered equity or project beta of XYZ Inc. chemical division = 0.923[1+0.6 x 0.7] = 1.31

We can explain the higher beta of XYX Inc. as the debt of the chemical division of the company is higher than the comparable public companies, and thus it is riskier with a high beta vale.

Example and explanation of project beta

Suppose a company wants to enter the food sector, and as an analyst, you must decide whether to undertake that project or not. As an analyst, we would compute the beta of only those companies which are dealing in the food sector. Then we will un-lever all the beta as every company might have different debt proportions in their capital structure. Once we un-lever, we will get the asset beta, which shows the systematic risk for the business without any leverage, and finally, we will leverage the un-levered beta and use this levered beta as the asset or project beta for the project. The same project beta we use in computing the cost of equity. Using the same cost of equity, we further compute the cost of capital, and this cost of capital will be further compared with the IRR of the project or use to compute the NPV of the project to make the final decision.

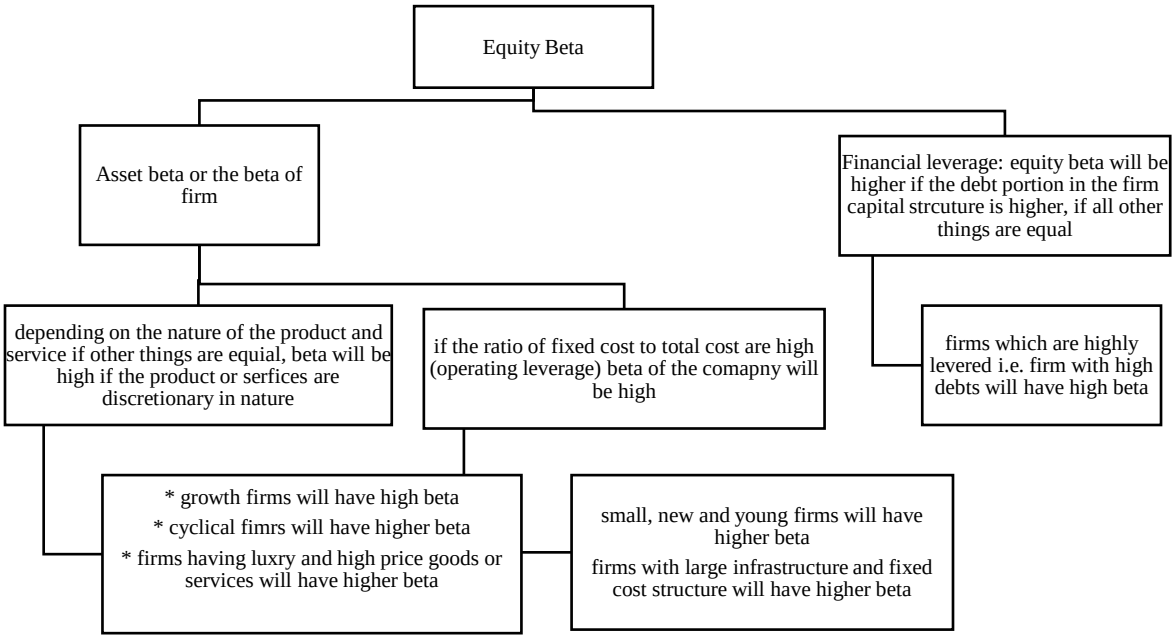
The problem arises at this point, and most of the finance community makes a mistake here. When we compare the IRR of the project with the cost of capital, we consider the cost of capital of the entire company. Whereas, we shall compare it with the cost of capital of that specific project only.

As a Finance officer of the company, you must make some final decisions about one project. The information available to you is (a) the cost of the capital of the whole company is 12%. The company operates mainly in two business segments, namely, the Food & Petrochemical refinery division and the textile division.

The food & petrochemical division has a lower beta and provides a lower but safe return on investments. The textile division provides higher returns but has high risk and high beta. If you compare the IRR of the different projects with the cost of capital of the whole firm, you are punishing the safer business and encouraging the risky business, and eventually, an investor will choose all the textile projects and start ignoring the petrochemical projects. Suppose the cost of capital for the petrochemical project is on an average of 10%, and the textile project is 14%. If a textile project comes with an IRR of 13% to you and we compare it with the cost of capital of the firm, which is 12%, you are going to accept the project, whereas we should not have accepted considering the project's standalone cost of capital. At the same time, we will reject a project in petrochemical having an IRR of 11%, though we should have accepted it. When we keep on doing this for several/various projects, the question arises of what will happen to the cost of capital, and it will shoot up to 14%, bringing the firm into an awkward situation leading to a distressed financial situation.

DETERMINANTS OF BETA – SUMMARY

the following chart summarizes the basic determinants of Beta (Damodaran, 2002)



Annexure – 1

Interpretation of Beta

β<→ stock is less risky β>→ stock is riskier	We compare the beta of a single stock with the return from the benchmark market index. A beta of lower than 1 means the stock is less risky than the index and the bet higher than one indicates that the stock is riskier than the index
High risk = high reward Low risk = low reward	The stock which has low beta will go down not as much as the benchmark index when it falls, and similarly, the stock will not gain as much as the increase in the benchmark index. Whereas the beta higher than one will increase more than the increase in the benchmark index and will go down more when the index goes down.
β = 1	If the beta of the stock you computed is 1, it indicates the if the benchmark index goes up by certain percentage, the stock will also go up by the same percentage, and if the benchmark index goes down by some percentage, the stock will also go down by the same percentage.
Diversified portfolio	An investor should make sure that they put both the high and low beta stocks in their portfolio sot that adequate diversification is present. A decent mix of high and low beta stock in the portfolio will save the investor from any drastic downturn in the market. As the portfolio will have stock with low beta; also, the investor will not be able to have high profits in good times of the market.
β measures the past volatility of a stock.	We must always keep in mind that beta merely measures the violability of stock in the past and, thus, cannot reliably predict the future. The stock beta keeps on changing with time, and thus, it is not a very reliable predictive tool.

Annexure – 2

Computation of beta using the slope function

Instruction of computation of beta in excel using the slope function

(1) In excel, cells use the "=slope" function formula in the cell after selecting the series inserted in the excel columns.

(2) The other function which we can use in excel to compute beta directly is to insert "=covar" & "=var" in the cell after selecting the series inserted in the excel columns then the covar is divided by the variance to arrive at the beta figure

(3) We can also compute beta using the regression procedure in excel. In "tools" when we click on data analysis and then regression, we enter the benchmark market index return as X and the return from individual security as Y, and we arrive at the complete regression solution, which depicts beta of the security also.

(4) We can finally use the chart function to compute beta in excel. Beta is a slope function in a regression analysis where we depict the market returns on X-axis, and we depict the return from individual security on Y-axis. We create the chart using the "chart" function – "X-Y scatterplot" in the new sheet, and then we add the trendline on the chart using the "add trendline" function. Further, we click on display equation and R square, which gives the complete solution as regression.

Annexure – 3

Computation of Beta using Excel

- Process of computing Beta in excel – (we have provided the computation of beta in excel along with the technical note. We considered the stock price of Apple Inc from 13/07/2009 to 12/07/2019, and the S&P 500 index as the benchmark index for the same period.)

- For the computation of beta of Apple Inc., we followed the following step is followed for computation of beta of Apple Inc.

- Step 1 – we need five columns for the computation of beta in excel. In step – 1, we download the data of stock for which we wish to compute the beta. At the same time, we should also download the data of the benchmark index against which we will compute the beta of security. It depends on the investor/person, regarding the period for which we need to compute the beta. Data for any period daily, monthly, quarterly, yearly must be entered in the excel sheet. The longer the period, the more accurate beta prediction.
    - In our example, we have taken into consideration Apple Inc.'s share price from 13/07/2009 to 12/07/2019. We compute the beta of apple, considering the S & P 500 benchmark index. The tentative proforma of columns in the excel is as below.
    - In the first column we put date, the second column in the adjusted stock price of apple for the desired period, the third column is the historical closing value of the S & P 500 index.

1	2	3	4	5
Date	Apple Inc. Adj Close	S & P 500 Index	Return from apple security	Return from index
13-07-2009	17.81342	901.049988		
14-07-2009	17.80467	905.840027	-0.000491315	0.005316064
15-07-2009	18.38159	932.679993	0.032402684	0.029629918
16-07-2009	18.46169	940.73999	0.004357676	0.00864176
17-07-2009	18.99106	940.380005	0.028674248	-0.000382662
20-07-2009	19.13623	951.130005	0.007643859	0.011431549
. . .				
12-07/2019	203.300003	3013.77002	0.007682791	0.004620175

- Step 2 – from the data downloaded, we calculate the daily return from security and return from the index. We compute the return from security in excel in column four and return from the index in column

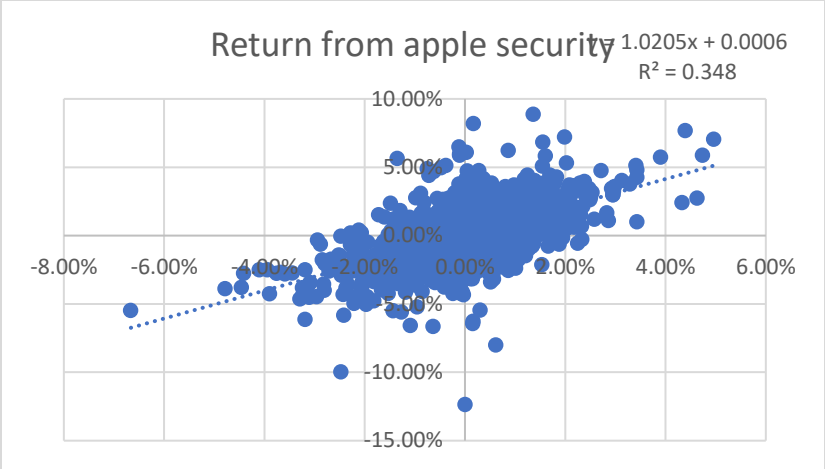
five. We compute the return from respective security and index by subtracting return by the price of the current day minus the return of previous day divided by the price of the current day, and the same process for benchmark index to compute the return. (We leave the first column because to compute the return, you need two data points. In this computation, we are subtracting the recent value with the old value, and then we divide the result by old value to compute the return). We have computed this in the excel in columns four and five using the formula. The formula used is =(B3-B2)/B2 in column four to compute return from security and =(C3-C2)/C2 for computation of S & P return in column five.

  - We have to compute the return over time, and thus our first cell shall be empty. Two data points are required to compute the return, and thus the computation is started from the difference between the second column and the first column. We are subtracting the current value from the immediately previous value and dividing by the current value to compute the profit or loss for that period. Your equation for the return's column might look something like this: =(B3-B2)/B2

- Step 3 – the copy function is used to repeat the process above for the index price column at all the data points. By clicking the small square on the respective cell, we drag the complete column till the last data point. We follow the same process in all the cells. – the formula is copied in all the cells rather than inserting the formula in each cell.

- Step 4 – in the same way, the same process is repeated for computing the returns. We have two additional columns after completing the process in steps 2 and 3 named columns 4 and 5, which we format further as a percentage. The result is the return from individual security and the return from the benchmark market index.

- Step 5 – by selecting the scatter chart from the option in the excel sheet, we can draw a scatter chart. In the chart, we select the two return columns (columns 4 and 5). Normally, the x-axis is always the benchmark index, and on the y-axis individual security. In our example, apple inc. Will be plotted on the y-axis, and the S&P market index on the x-axis. We will get a scatter chart, as depicted in the figure below.
- Step 6 – we further add a trendline on the scatter chart by clicking add trendline in the newer versions of excel or manually → add trendline function. You should also display the equation of the chart and the value of R^2. We shall choose linear trendline not the moving average or polynomial



- In the next step, we shall find the coefficient for the value of x in the equation of the trendline. This equation shall be $y = \beta x + a$. beta is the coefficient of the value of x in our equation, whereas R^2 is the relationship between security return variance and the benchmark market return variance. A small number indicates that the variance between the two is less related.

Annexure – 4

Assignment Questions

Question – 1

1	2	3
Year	**Security X**	**Market portfolio Y**
2011	15	16
2012	14	12
2013	17	19
2014	16	18
2015	13	15
Total	**75**	**80**

Question – 2

1	2	3	4	5	6	7
Year	**Security X**	**Market portfolio Y**	**x**	**y**	**xy**	**x^2**
2011	15	16	0	0	0	0
2012	14	12	-1	-4	4	1
2013	17	19	2	+3	6	4
2014	16	18	1	+2	2	1
2015	13	15	-2	-1	2	4
Total	**75**	**80**	**0**	**0**	**14**	**10**

Question 3 - assume tax rate to be 35% in all the cases

	Equity Beta (Raw beta)	Total Debt ($)	The market value of equity
X Ltd.	2.34	3334	5134
Y Ltd	1.23	1967	8,732
Z Ltd	1.67	2131	5,482
M Ltd	0.42	7216	1,936
N Ltd	0.91	4187	12,371

Question 4

.

	Equity Beta	Tax Rate	Debt ($M)	Equity ($M)
Equity 1	1.32	34%	535	2376
Equity 2	1.19	32%	0	14,293
Equity 3	0.98	27%	-246	3,376
Equity 4	1.69	33%	763	1023
Equity 5	1.46	29%	1023	9134

Question 5

Estimate the beta of a private company who is into home appliance manufacturing using pure play. Other home appliance manufacturing companies that are public have the following beta, debt, and equity…

Company	Beta	Debt	Equity
Black and Decker	1.40	$2,500	$3,000
Fedders	1.20	$5	$200
Maytag	1.20	$540	$2,250
National Presto	0.70	$8	$300
Whirlpool	1.50	$2,900	$4,000

a. Estimate the beta of a private company with a debt-equity ratio of 25% and a tax rate of 40%. These firms also have a tax rate of 40%.
b. What are your concerns about using this approach?

Question 6

Look at the following information about the company and estimate its beta based on the industry. You know that the regression estimate of the beta is 0.75, and the standard error for the beta is 0.50. You also note that the average un-levered beta of comparable specialty retailing firms is 1.15.

a. If the company has a D/E ratio of 20%, estimate the beta for the company based on comparable firms using a 40% tax rate
b. Estimate a range for the beta from the regression.
c. Assume Company has a triple B rating, and the spread is 1 percent above the T-bond rate of 6.5%. Estimate the cost of capital for the company. Assume the market risk premium at 5.5%.