

FORECASTING SHAREHOLDER RETURNS USING MONTE CARLO SIMULATION FOR CAPITAL STRUCTURE, SHARE REPURCHASES AND CONVERTIBLE CALLABLE BONDS

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Introduction

Monte Carlo Simulation has been used extensively to project a company's financials for various proposed capital structure (levering or de-levering) or corporate events (like acquisitions, spinoffs, etc). In this research we have extensively researched and discussed various models that are used to project various elements of company's financials like sales, EV/EBITDA, margins, EBITDA, etc which plays a pivotal role in calculating total share holder's returns for the projected period using Monte Carlo Simulation. With the advent of exotic derivatives, companies can now find innovative ways to reduce their weighted average cost of capital (WACC) and get better "Risk-Adjusted>Returns". Companies can now do strategic share buy backs, get derivatives to hedge interest risks in pensions, get bond hedge for callable convertible bonds and can find an optimal capital structure that maximizes shareholders return. Maximizing shareholder returns (SR) remain the main focus for the company's management and while making a strategy there are many assumptions that are put into the models. In this research we have exemplified the questions that need to be answered

¹ Both – qcfinance.in, India; more detailed presentation is at their first article.

for evaluating the right strategy to get the maximum share holder returns using correct configurations.

This research focuses on optimization of models used to project various elements of company's financials like sales, EV/EBITDA, margins, EBITDA, etc which plays a pivotal role in calculating share holders returns for the projected period. Monte Carlo Simulation can help us predict future financial statements (BS/IS/CF), and the choices of model play a very important role [26, 27]. With the advent of exotic derivatives, companies can find innovative ways to reduce their risks and get better Risk-Adjusted>Returns. Companies can now do strategic share buy backs, get derivatives to hedge (collars) interest risks in pensions, get bond hedge (and issue warrant to cheaper the cost) for callable convertible bonds. Each capital structure policy affects the returns to share holder and also the risks the company will face in the future. The dearth of research publication in this area also created challenges for the analysts but an opportunity for researchers to explore more.

Different analysis that analyst cover after reviewing company's financials (which are related to stock price) includes Opt capital structure, Target credit rating, Road to investment grade, Optimal leverage, Debt structure, etc. Seemingly in debt structure we can use just two stochastic processes to get to EBITDA (Sales and margin) but Debt runs in a normal way where we use Interest rate based on 10 UST which again is based on mean reverting stochastic process. Since EBITDA is before all adjustments and other calculations we can tweak the plain vanilla Debt¹ that is used to increase or decrease based on policy. IG will use sweep to pay off the debt and hence that would require all of our assumptions in the model to come into play, this is similar to ex-

¹ Fixed rate borrowing with no additional features such as convertibility rights or warrants.

cess repo. Acquisition capacity is the cash left with the leverage left to remain in the same zone where you can acquire other companies.

1. Literature Review

Monte Carlo Simulation has been used as the industry standard for capital structure for various debt options that a company can take [7, 10, 26 and 27]. Stochastic process has been used to predict optimal capital structure based on different leverage levels through projection of entire balance sheet, income statement and cash flows [4]. A comprehensive tutorial on valuation of share buyback is explained by non-stochastic calculation in [5]. Although the search for optimal capital structure is one that a company wants to achieve, there are views that the search cannot lead to something conclusive [9]. Trade-Off Theory (TOT) and Pecking-Order Theory (POT) to explain financing decisions has been explained in [13].

Recently stochastic financial model that select an optimal mix of fixed-rate debt instruments from different sources, with the objective of maximizing net present value (NPV) while limiting default risk to achieve best debt policy is used [14]. Timings of share repurchase depends on various strategies (price falls, P/E ratio or excess cash) that maximizes share holders return, but there is research that shows that buyback patterns also depends on idiosyncratic factors [1]. The company can do share repo based on various algorithms although some studies suggest aborted share repo is sometimes taken as negatively [6]. Additionally, the effects of share repo are suggested to be short term [8]. Evidences of insider trading during open market repurchases have made this option seem hazy [2]. The option of levered repo seems to be taken in different ways, although empirically it seems to increase the leverage and hence the returns, there are research that links this with managerial hubris [3]. Research also argues that share repurchase

may act as stimulus for undervalued shares of small companies [11]. Share buyback is also used as a deterrent against takeover [12].

Two arguments against share buyback includes insider trading by management and ineffectiveness during share repurchase (or when share is overpriced) [20]. To decide the quantum of share buyback in this proposal we take into consideration total historical returns and cost of debt (and the risk added) to company. It has been quite obvious that under levered and undervalued firms enjoy the greatest economic gains from a repurchase [19]. Firm specific factors should be modelled along with genetic models of capital theory [18]. How much capital does a company really need to support its business activities is discussed in [17], access to this can be used to repo. High cash, low growth, opportunity and low cost of capital give better returns from repo to companies [16]. Monte Carlo for cap structure with evolving options for capital structure has remained an issue of research since 1997 [22]. More than stochastic models inter-temporal access explains company's policy to capital structure [25]. Many argue that legal and financial traditions significantly correlate with firm adjustment speeds [24]. Arguable instruments like CCB and other converts remain the best alternative to reduce cost of capital for a company [23]. Contemporary research also suggests that no significant association between debt and firm characteristics and also that Monte Carlo and regression shows a weak picture [21].

Types of analysis will decide which assumptions and financials we need. We have inevitably calculated share price for: 1) Return on Capital, 2) Pension, 3) Convert, 4) M&A, 5) Levered repo, 6) Valuation or others.

In the projections that is done using MC simulation we should check line items: Dep (should match with sales directionally), Capex (should match along with CFO & Dep), Cash (to see if max cash is applied), foreign holdings of cash, repo can then be calculated correctly. We can further get Moody's Credit report and excel file and calculate the

adjusted Debt and EBITDA – example pension liabilities are added and other lease adjustments.

General diagnostic: If you get NA then check if Last number is working, last share price is pulled, missing quarters in the last few years (that brings NA into share price), every named range override for assumption is cleared, 0 pulled in the critical entry.

Our core engine is made of IRR where we should adjust future prices and contribute price increase due to dividends and repurchases as defined in our TSR scenarios (currently not used in this model). Output is based on path 0 which is the mean of all paths used in the model.

Calculated as IRR on share price where we buy today and sell it at the end of projected period.

When does it fail/ how to check the errors: Missing historic price or numbers, wrong TSR start date, number of shares diminishing to 0, are some problems that can occur.

Which strategy is expected to give highest result and why – Max repo gives highest return and build cash give the lowest return. Reason for high total return is decrease number of shares, cheaper debt and saving on the opportunity cost of cash.

Share repo has been controversial as there have been many reasons for the company's management to move ahead with it. At the same time it offers taking advantage of market mispricing. Although deferring dividends cannot increase shareholders value but strategy buyback can.

What would happen if we buy shares at price fall vs. constant buy? How much return do we give access to the share holders? These questions can be understood once we project price falls, and that Monte Carlo and changes in the share price can help us to get an idea for the exact points where to work out the share repurchase.

What would happen if we buy shares at price fall vs. when we are not able to buy them and take a hit of opportunity cost? This question can be understood once we project price falls, and Monte Carlo can

help us to understand the disturbances (through the paths) in the share price that can help us to get an idea for the exact points where would implement the share repurchases and save on opportunity costs. If the company's IRR is 18% and LIBOR is 3% and we keep the cash with us we get a hit of around 15% due to opportunity cost.

Repo policy selection changes quantum of repo, the more repo the more TSR. Repo tactics run repo for each path for each policy and finds out the repo strategy that gives the maximum result.

How policies on Assumptions flow through IRR using data tables? We change the repo policy using data tables, use join split we bring the financials of each repo strategy, we change the path numbers on the assumptions sheet to get the data for each path. Paths changed from 1-10 and the data tables run through IRR results which are captured.

Repo tactics run through data table on repos using Last number.

If we do repo at low multiple or when price falls we achieve the most value of our investment and gets the highest number of shares, although the repo amount changes which we try to match manually to keep it all apples-to-apples.

IRR scenarios we often deal with repo with excess cash, repo with increased leverage, pay pension debt, different type of debt, etc.

Risk due to idiosyncratic factors: Calculates the contribution of standard deviation of share prices due to volatilities in sales, margin, and other factors. The sum of all volatilities is not the total volatility hence we have the diversification benefit. We change just one factor example sales and keep all others same and check the standard deviation in share price.

2. Developments in Capital Structure Strategy to Maximize Share-Holders Wealth

1. Monte Carlo simulation is used to project a company's balance sheet for various proposed capital structure or corporate events (like acquisitions, spinoffs, etc).
2. Evaluating the capital structure policy to get the highest share holder returns remains the main focus for the company's management.
 - ✓ Optimal capital structure is the one that maximizes total return to the share holders [7-10, 13-25].
3. Exotic debt options in Callable convertible bonds remains a favorite candidate as the best financing option.
4. Interest rate derivatives are extensively used for managing pension risk which helps in keeping an optimum net-funded-status.
5. Financing acquisition and its effect on EV/EBITDA multiple impacts total returns.
6. Systematic share repo is expected to have quantified effects on share price, number of share outstanding and EPS.

Which out of the three has volatilities that would affect a company most? This answer can help a company control that part, example if its Share price, they can do repo, if its margin, they can research the past and mistakes, if it is Sales then company can look at that. Although the general idea is to focus on scales and margin is a particular way to keep sales high and margin low, this might back fire and increase the volatility, so long term stability should be in focus.

Beyond the three – which matters most in projections?

1. CFO projection
2. Dividend Projection
3. Remaining is cash that accrues?
4. Dep – Capex – PPE can be ignored.

Projection of EV/EBITDA and EBITDA post acquisition, will market add the growth factor in your multiple?

Repo vs. Acquisition

- ✓ The Minimum elements needed for projection of the company we acquire?
- ✓ Post acquisition will market change our multiple?
- ✓ Doing repo will cut our future growth prospectus?
- ✓ Which sensitivities must we take?

Would a multiple regression help on multiple help? If the multiple is correlated with growth of sales and capex the next acquisition will reward us with better multiple, also if it is negatively correlated with growth it will reward us (spending cash is a good idea) but if things are reverse the acquisition will not help us.

Discretionary cash at use can be used for many things which are like dividends (which should be paid), capex to keep PPE intact and other things. If we can get the NI Margin we can then get the NI and then the cash after reducing FCI and FCF and then use the cash as excess cash. The extra cash is a trouble for company in many ways and they look for options to remove that cash, but from a modelling sense, reaching their require lot too many assumptions.

3. Monte Carlo Simulation, Share Repurchase and Multiple Assumption

Stochastic process AR-1 is used for sales figures on past quarterly data. Another methodology suggests that we should match our projections with the consensus but relying on either (stochastic model or the consensus) can create errors in the projections. As we know that past volatility play a very important role in the path generation we should

always use sales after removing the seasonality. Hence a judicious role here is important.

Share repo has been controversial at the same time it offers advantage of taking profits from market mispricing. Our research suggests that although deferring dividends cannot increase holder's value but strategic share buyback can increase shareholder returns.

Dual effects of share repurchase offers features that are not offered in conventional ways to return to shareholders which are:

- 1) Volatility / Volumes of share are affected. High volumes bring in our shares in some good index and thus increase trade and liquidity of our stock. We can control volatility of the shares by controlling the down side of the shares using 'buy on low share price'.
- 2) Best way to give back to shareholders as you kill the number of shares after repo may be dividend or retained money will not show that much effect over share prices which market don't react to.

Share repurchase mechanisms: this could work when we buy shares based on some logic like P/E fall or just the price falls. Price falls and ratio are two different styles where one method is based on input from the market and other is a passive strategy.

P/E and price falls makes the most sense because we can buy the share when market or other quant indexes are short whereas as a company we believe on our own fundamentals. In most of the research we have observed that P/E shows the best result because we buy undervalued and strategically ignore overvalued shares, thus we reduce the number of shares that shoots the value of our shares toward the upper side. Finally we would also increase the EPS by doing strategic buy back.

Get share repo strategy gives an instant return to the share holder but may harm the company's balance sheet in the long term. It will increase beta, cost of debt, worsen credit rating and have other effects although increase pricing due to volumes and demand-supply will off-

set this. This is the reason that in spite many disadvantages, companies prefer share repo as compared to any other step.

If you add a debt then you have to add cash so that you can net things out, but if you add debt and you are doing repo after that, you don't need to worry about cash and calculate things without worrying about the balancing.

If you take more debt than your market cap would not fall and an increase in debt without increase of cash takes up the EV. The thing that stops you to do this is D/EBITDA multiple which is used by the rating agency to rate your debt and hence calculate the cost of debt, and this would also affect your levered beta.

Modelling considerations: We have used the last number and the grid for finding which repo amount we will flow through the model. In the grids we have used last number function to get the desired amount.

Let us take a simple example to understand the build-up of the model using three parameters:

Assume that we have: 100 shares, market price of \$10/share which gives us a market cap of \$1000. Furthermore let us assume that the debt is \$100 debts, the current multiple is 11 and the EBTIDA is \$10.

Hence $EV/EBTIDA * multiple = 1100$

Now, if the company takes a debt of \$200 its EV increase to 1300 (if it doesn't keep it as cash). In our model we have kept the EV constant which means that the new multiple which should have been $1300/10 = 13$ to keep the EV to 1300 comes back to 11. The assumption is that share price will react.

Why did the multiple moves and how will this happen in the real market?

Interestingly, in the case above the EV/EBITDA will not move, so that hit will be on Equity which will reduce by 200 that is the amount of new debt taken. In reality this reduction of MV will come as reduction

of debt and MC the multiple will again hover close to the old value of 11 (which was the long term multiple). Thus either our debt value decreases or equity decreases or both decreases to keep the multiple close to long term average, thereby in real markets we can assume a combined effect of both on the multiple.

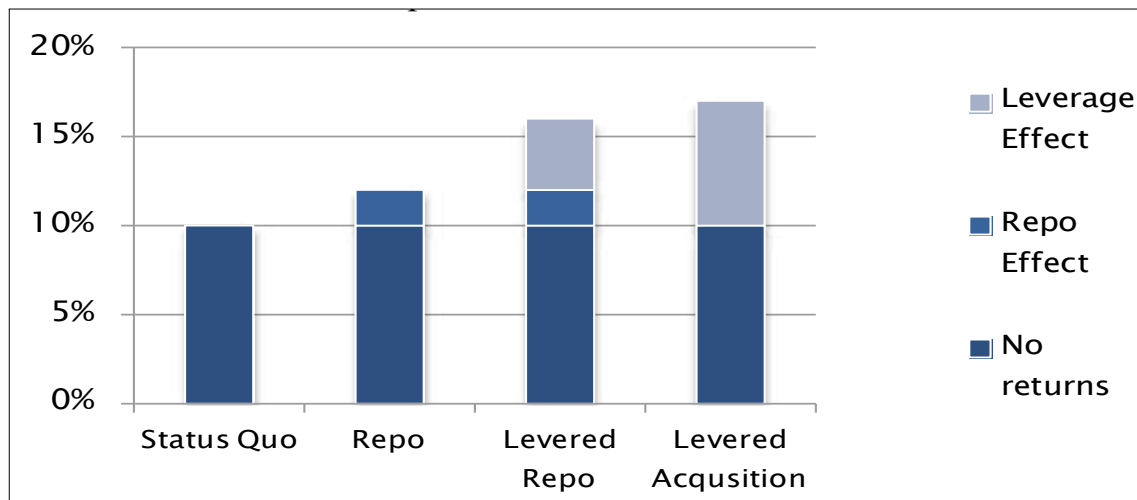


Figure 1. Expected Returns for various distribution policy assuming EV/
Multiple remains constant (illustrative example with dummy data)

Exploring Trends in EV/EBITDA Multiple

1. Defines price in the plain vanilla models by the formula: $EV - Debt = MC$ (used to calculate projected price with the help of projected EBITDA).
2. EBITDA needs to have industry specific adjustments before projecting MC.
3. What explains multiple and how to incorporate that in multiple projections? Growth and Industry defines multiple (what can cause the multiple downturns?) How does multiple drags with industry and growth? Effected by growth, scale and sector on multiple.
4. Multiple's correlations with various financials and external data (Pearson, Spearman's and other).
 1. What is difference between Pearson and Spearman correlation?
 2. Is correlation relevant to find out which inputs affect multiple?

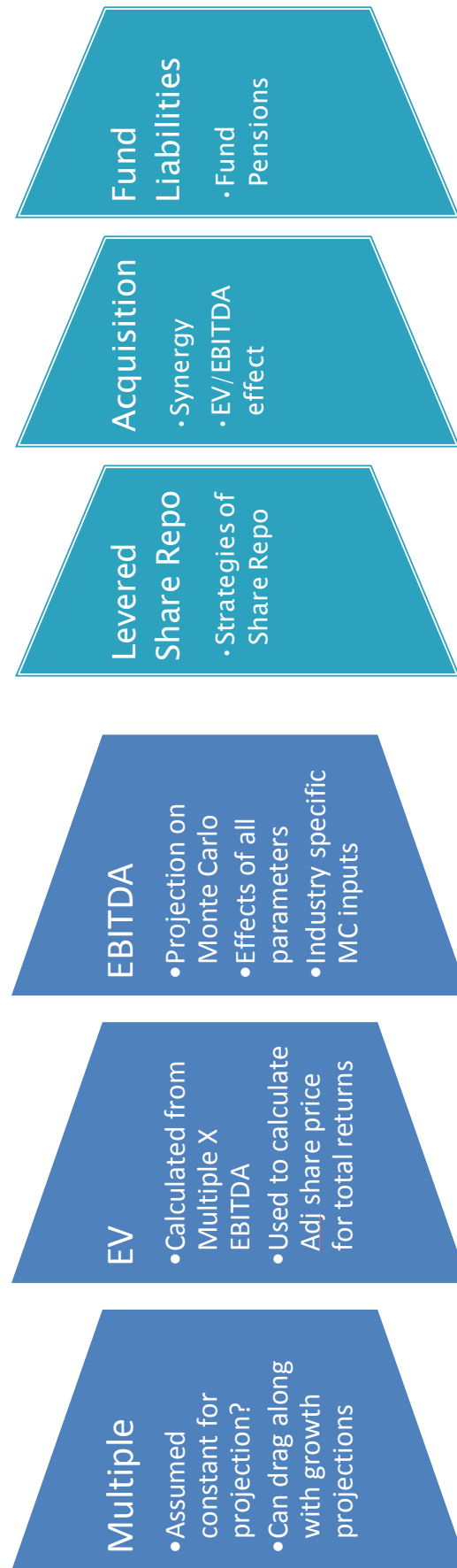


Figure 2. Factors to be considered for EV/EBITDA multiple and various corporate events

3. With consensus EBITDA can we re-engineer share price, but can we predict both using the correct MC models?

Spearman vs. correlations analysis how can outliers effect and mis-deal the analysis.

Spearman (Rank) vs. Pearson's correlations - rank correlation gives a good idea where extreme values would affect correlations, does this mean that our effect would be magnified and less trusted?

Proposed Methodology:

- ✓ *Search for correlation of multiple and other factors (Pearson vs. spearman correlation).*
- ✓ *Find all parameters that explain multiple.*
- ✓ *Different types of correlations, which works for multiple?*
- ✓ *How do multiple projections affect optimum Capital Structure?*

Consensus Estimates: How to incorporate them in the analysis

1. Drawn as a median of analysts.
2. Can we question consensus and draw our lines relative to the consensus based on historical accuracy of consensus? Changes are required for the MC paths of the projections (adding disturbance mean of paths – consensus to each path).
3. Are their sector biases for consensus that has to be changed before running MC Sim?

Proposed Methodology:

- ✓ *Do Simulation using classical MC.*
- ✓ *Adjust the results using consensus on the mean of the results.*
- ✓ *Analyze whether the consensus has been effective in general.*

Consensus story (how to imbibe equity research reports)

A lot of equity research analysts put down future projections based on various inputs and the mathematical aspects of projections should be cordially tied with the projections. However it re-

mains important to note that volatilities, correlations, and the effects of multiple / share and margin would help that qualitative analysis add another dimension. Hence for all the paths, we can decide the mean of paths from consensus and use those adjustments in each path. This would ensure that we are using only the projections but not the volatilities.

Questions and Proposed Changes in Methodology of Monte Carlo Simulations:

1. Consensus; do they matter (pulling from free resources)? How to get inputs? Can we question consensus and draw our lines relative to the consensus?
2. Linear and Log linear regression is never a good option vs. testing stochastic methods work, selection of distribution and methods (which stands better for predicting imp projection parameters?).
3. Decoding Yield curve (it contains hidden information).
4. What to do with Residual? Correlated random numbers (for ARIMA 1).
5. Considering Cholesky residuals and why they become important? How to find “Cholesky residuals matrix” for residuals where all residuals are assumed correlated?
6. Which correlations should be used, what are options for crisis time when correlation are non-relevant?

Cholesky Residuals

The over simplification of models by keeping them AR1 on many things may cause many errors in the projections, and these projections are then causing wrong policy decisions. The errors are accumulated in the residuals for the projections hence making sure that the past residuals and the future residuals of AR1 are same & could greatly enhance our projections. To calculate the Cholesky residuals we can create relation between stock price and other things, falling AR1 and then use it. In this case we can use stock price as related with S&P

and exchange rates / bond returns or others. The residuals would then help to make the right mix between AR 1 models.

It is not just about implementation of residuals but also about the effect of using different residual policy and back testing the data.

Various Paths that EBITDA can take depends on stochastic model chosen and could affect the D/EBTIDA multiple:

- ✓ Consensus + past volatility AR1
- ✓ Pure AR1
- ✓ Jump + AR1
- ✓ Mean Reversion
- ✓ Multiple regression and then taking AR1 for each factor that the EBTIDA depends on, for example if there are four factors like Margin, Sales, Capex... find the AR1 model / applicable model and then draw EBITDA from there.
- ✓ Logistic regression on growth (Yes/ No) if yes how much.
- ✓ Along with these, many more.

Based on the above factors for the company or the sectors we can predict the EBITDA and take current Debt to find out where the D/ EBITDA multiple would move. Seemingly wrong model can give us an overvalued projection.

Debt that a company takes is callable convertible and hence it has an option to convert and call. In that case the cost of debt would differ and the IRR for the company would change.

Debt option in convertible is many, but it is interesting to note that share price may trigger convert whereas dividend or other ways to return capital don't. Getting cash would require making BS and NI, both of which would move into accounting. Once the ratio is checked we need to check the dilution using Black Scholes Model, where a company would hedge its risk on a convertible bond (not keeping it callable or keeping it callable for duration). If the conversion is optional

at the end and the price is reached, than conversion causing dilution should be checked with hedges that are taken. In this regard both MC on stock price, E/EBTIDA, and BS for pricing of call option (that a company would purchase needs to be calculated). BS model would land us with price of the hedge moreover since our analysis is focused on share price and we keep the volatility same we can use the Merton model to find out the bond pricing as well as the PoD would change as stock price will move away, again the volatility of the stock would be calculated on a daily basis whereas the price using our MC simulation. This would give us the implied PoD which can be used to model cost of debt. *The other way to see if the multiple falls beyond a range where it would be tough for us to maintain the rating. (change this line).*

4. Proposed Strategies to work ahead and consider for Share Buybacks:

1. Current literature questions SB as an efficient also sometimes controversial [1-6].
2. Expansion vs. acquisitions vs. buybacks: will MC work same to project company parameters?
3. Signaling and taking advantage of Low P/E: Constant above threshold, Ratio of NI, Price falls, P/E below level, targeting EPS.
4. Projection of entire financial statements is required. Applying Stochastic Calculus in Share buyback.
5. Impact of Dark Pool Share buybacks and algorithms.

Qualitatively we can conclude that share repo strategy would have the results as shown in the table below.

Strategy	Multiple	Repo Total	Share Price	Total IRR Rank
Excess Cash	No effect	Min	No effect	4
Levered Repo	Fall	Equal to debt	Depends on risk	2
P/E Drop	Increase	MC Paths	Increase	1
Share Price Drop	Increase	MC Paths	Increase	1
Constant (% of EBTIDA)	No effect	MC Paths	Increase	3

Specification of the Proposed Model & Resource Required:

1. Carefully build MC simulation to take all proposed changes in the research methodology, with specifications:
 - A. Regression leading to alpha and beta, Random number (correlated generation normal random distributions) and use ARIMA(0,1,0) process.
 - B. De-trend and de-seasonalize data, Different stochastic process to suit different projections.
 - C. Over 20-30 VBA programs made as VBA addin, Excel file to be around 10-15 MB file with around 20-30 data tables, sheets of correlated random numbers.
 - D. Handling blanks, 0, missing data, robust data handling also installing free data pulling of financial data.
2. Impact of change in Yield Curve's needs to be taken into account in case we model levered activities.
3. Implement Share buyback Algorithms (technical Analysis can be used to get the prices where repo can be done).

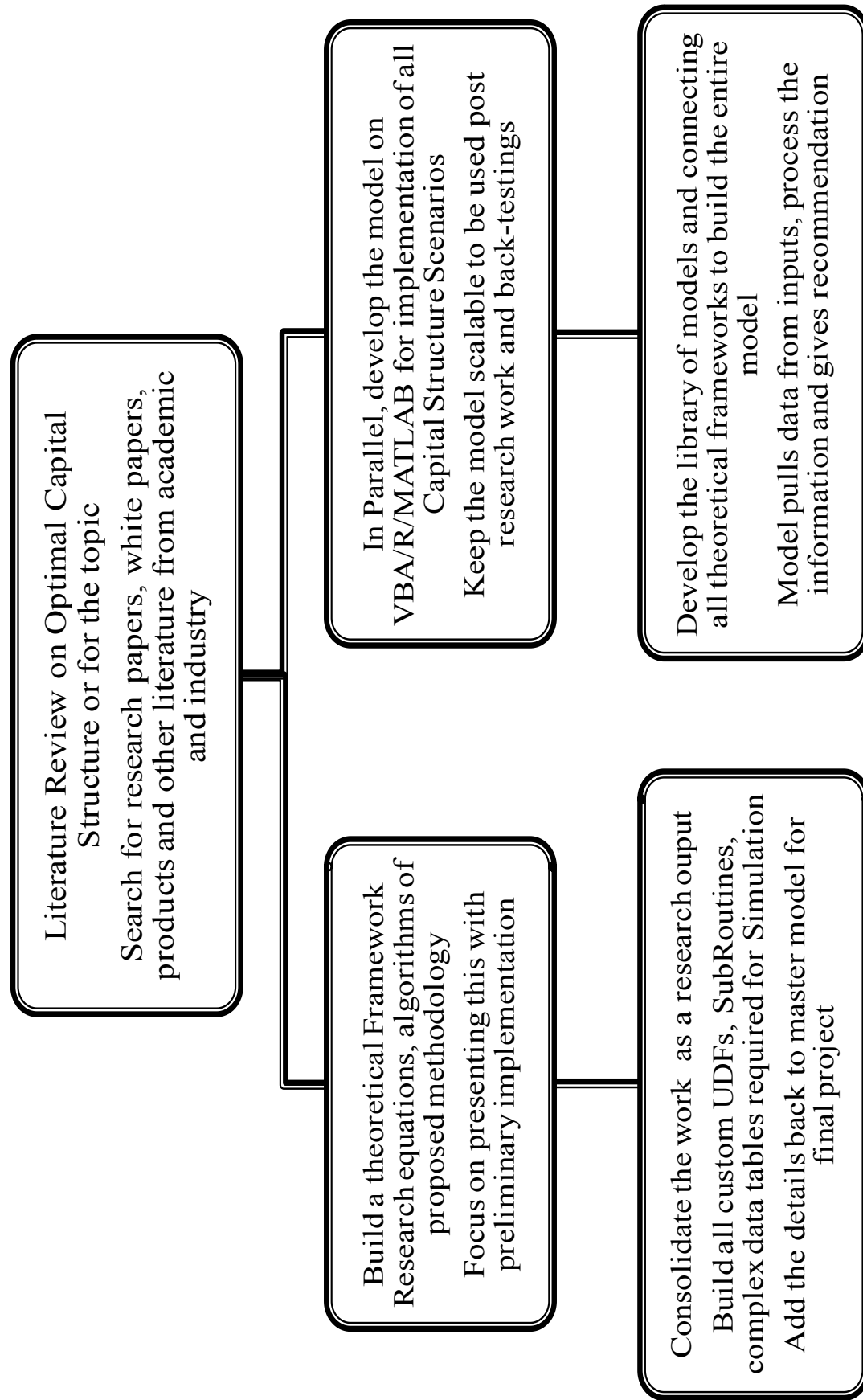


Figure 2. Delivery and Pathway for developing the model for the analysis

5. Multiple Regressions to find dependencies of EV/EBITDA with various factors

While beta is a sensitivity of company with S&P, there are a lot of things that might affect the EV value, at the same time we also need to remove all outliers and make data consistency. We would use 10–20 peers of the same sector to run our analysis. Moreover we would use the thing that is most stable: EV/EBITDA for the sector and find out which factor effects it. Troubles and challenges with regression analysis came when we got a negative sign for some parameters that we believed should have been positively correlated.

We have used the data of 3M where we have pulled the sales, margin and multiple to arrive at the MC. Multiple Regression EV/EBITDA with various multiples can help us to understand how to model the multiple which plays a crucial role in the share price calculation which is then used to calculate the IRR.

Factors used: EV/EBITDA was regressed with Margin Leverage, Growth EBITDA, Growth Revenue, Return on Assets, Capex/CFO, EPS Growth, STD stock, Cash/Assets, VIX, S&P P/E, GDP

How To Select Based On P Values / correlated residuals / correlations?

There are various strategies to get the right result, which are discussed in other parts. A general algorithm or pseudo code can be built up on that so that we select the best case. Some signs cannot be negative which we know by intuition and other have to have a good p value say around 30-40% and should not impact R-Sq-adjusted much. Keeping all these in mind we can have backward and forward selection.

Start:

Constrain on Sign – Select forward – Select Backward – Eliminate from residuals corr/ P Values/ General Correlations – Again Observe Rsq-adj for major change. Keeping don't to get the best people.

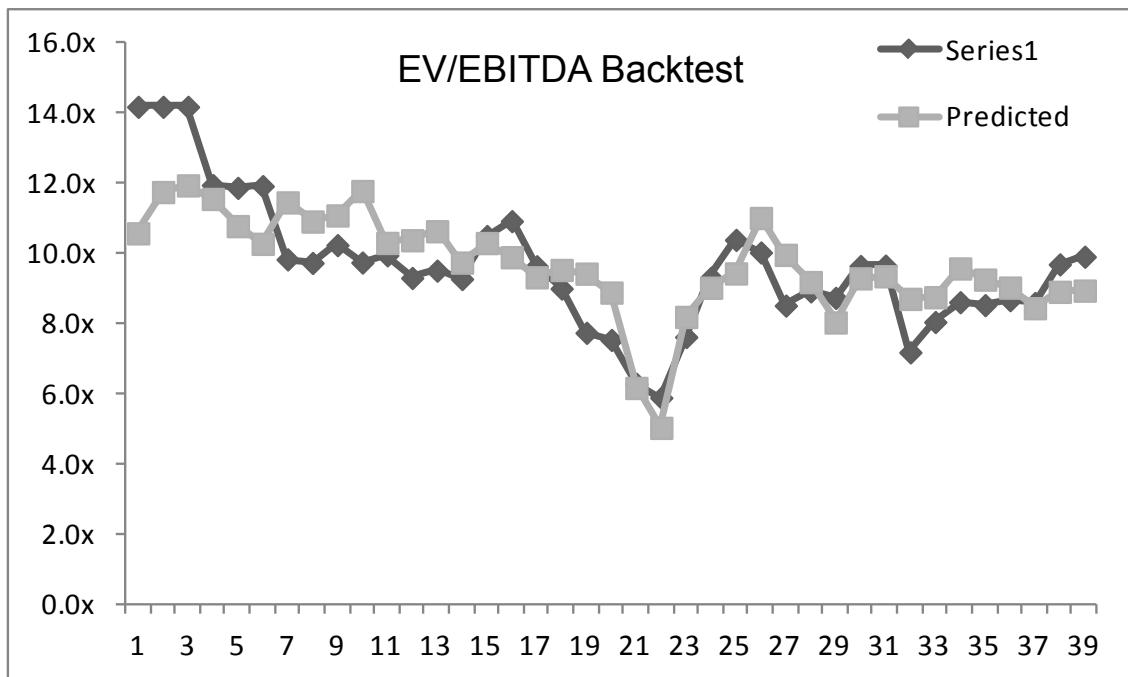


Figure 3. Back testing the multiple regressions on multiple for 3M, where Series 1 represent actual historic multiple

Intercept	8.690883
Factor	Slope
Leverage	-3.04125
Growth EBITDA	4.179901
Growth Dividend	0.035114
Return on Capital	14.38365

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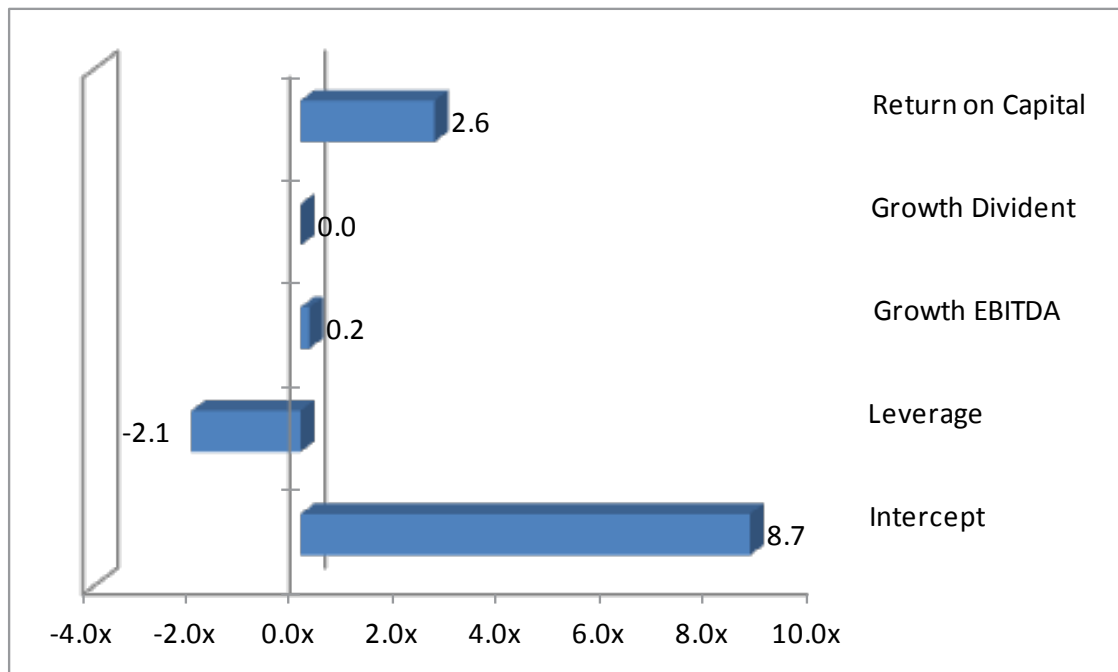


Figure 4. Contribution of various factors for EV/EBTIDA multiple for 3M for the last 40 quarters

We have selected factors with P value greater than 50% and the R-square for the regression is 56%.

Issues to consider while using multiple regression for EV multiple:

- ✓ The sector shows peculiar behavior and the company might fall into different sectors where we cannot map each sector to the company. The macro factor like GDP, VIX, S&P, and Unemployment seems to have less effect on the multiple which rallies due to its own reason. If we think that we can find directions than it again becomes tough for the reason that when EBITDA falls, EV also falls so ultimately what we get is a proxy for growth or how much we think that the pricing of high will be in spite of low EBITDA.
- ✓ On the other hand if we take intricate parameters than we get explanation of what each component brings in the valuations or the growth proxy. The basic notion should be that capex should drive growth up but there may be other factors explaining, example excess cash that will bring growth and returns down.

- ✓ We cannot take things which contribute to EV directly (MC Debt or proxies of things that are close to the multiple, hence cash by assets seems to be a better option and Cash/EV) as this would get us wrong correlations (things on left and right would be the same). Also we should avoid redundant factors like growth of sales and growth of Net Income. All of the factors should contribute well so that we get no extreme contributions of any one of them in our analysis.
- ✓ Another methodology suggests that we can take important factors from various elements like leverage, growth, profitability, and macro and explain how each factor is contributing to the multiple. Again we are searching for a balance between the statistical results and the business acumen to get the best explanation on how the multiple is behaving and what would happen if we tweak any parameters for the business. We would take the system wide data in our model from each set of companies' belonging to the same group. Creation of the group depends on the sector, growth phase, and other parameters.
- ✓ For example if a company has a multiple of 12X then its multiple can be explained in terms of growth, profitability, return methodology, macro, risks (internal external). If the direction becomes irrelevant only then we should remove the factor from the respective group. A max and min could be put so that the explanation becomes better. If we look at it there are inherent risk and growth in companies of different size as well as different sectors.
- ✓ Which market parameters might affect the share price? 10 years US Treasury bonds, Investment Grade bond returns and three months LIBOR, how much would they play a role in the future volatility of share price and past contribution to the multiple?
- ✓ Interest rate movements and use of interest rate in the model: There could be biases due to faulty assumptions and if we don't back test data or use the data from a recovery (rising period) or

not considering the entire cycle. Also we need to make sure we transform values of large inputs like sales so that when we calculate the correlated residuals we can minimize the errors.

Other Considerations While Calculating Multiple Regression Coefficients for EV/EBITDA Multiple

- ✓ For sectors where margin (we expect to) defines the valuation we might use margins, these sectors are high margin sectors like internet, others where margins are high: Gross Margin, EBITDA/Sales.
- ✓ Return method might affect the multiple depending on importance given by investors to the return quanta and methodology. For example a company which has grown (saturated) or if this is the trend in the sector we might use: ROIC, EVA, ROE.
- ✓ Cash based (in place of accrual) margins can be used: CFO/Sales, FCF/Sales, Dividend Payout Ratio, Div Yield and YoY DPS Growth.
- ✓ Growth is one thing that factors in the price in some sectors where growth sensitivities are having greater impact. We expect this in high growth or tech sector where growth defines much of the valuation.
- ✓ We can use both the combined as well as the component versions. The FGR is an arithmetic average of (NTM rev growth, NTM EBITDA growth, “long term” EPS growth), where the last is whatever the analyst’s report – typically 3y or 5y outlook.
- ✓ Whether leverage would increase or decrease a multiple cannot be said definitively, but in general a high leveraged company would have low multiple but this may not be true if debt gives a high growth sentiment. Leverage factors we can include are: Debt/Total Capital, Debt/Capital Debt (YoY Change), Adj. Debt/Total Capital.

- ✓ Risk affects all sectors but different sectors have different beta based on how they would be performing to macroeconomics sensitivities. Example, retail and Gaming Company would have more sensitivity to macro economics as compared to a health-care. Macro factors we can include are: 1yr Beta, 2yr Beta, 5yr Beta, 1yr Share Price Volatility, 5yr Share Price Volatility, VIX, 10yr Treasury Yield, 3mo LIBOR, Real GDP Growth, Unemployment Rate, S&P 500 P/E.
- ✓ Should we be using the change and not the absolute? Change should be used not absolute as change is something that makes things move up and down. This notion is important because of the change in multiple could be due to lag or the expected growth in the future. That is the reason use NTM vs. LTM. This can be understood as feedback or growth expectation driving the multiple. Similar analysis has been done in AR1.
- ✓ Not keeping redundant factors even if they are not used in the model (the factors placed there not used also convey a message that they were not good enough). We don't need to keep similar factors (or the one that forms a union of others).
- ✓ Contribution of a factor / Factor selection for unused factors: We would not take factors with the same denominator, example we will not take four capex factors or four distributions factors. In general, factors should be independent. If you have (acq+capex) as a factor, then we wouldn't want either Acq or Capex as standalone factors – this could really skew results. So we would replace all four “investment” factors with two: acq, and capex. Similarly, we will not need total distributions if we have repo and/or div factors. Start with repo/dcu, and then three dividend factors (yield, payout ratio, and then div/dcu) – we will narrow the div factors subsequently. Remember they should not overlap if at all possible. e.g. you have both 1y rev growth and growth, where the latter

Analysis of residuals

- ✓ Problems like heteroskedasticity and serial should be used to analyze the multiple regression equation. We should run correlation with residuals to see they are auto-correlated and for this you can use AR 1 method.
- ✓ Residuals vs. multiple for the company (arranged with time, this shows we can predict with more accuracy in the recent time then with the times in the past). Interpretation: We found that the variance of the residuals is decreasing with time and also they seem to be related to their past values and move in sine wave pattern. This is the same as back test results we have used where we see how the fit works for all peers. The only difference is that you can see the directional movement of residuals. If you want to increase the R-Sq in this case remove the 2003-2005 data which caused maximum noise. We can observe that the regimes with the same multiple were different in 2003-2004 boom as compared to the current boom.
- ✓ Residuals vs. multiple for the company which can be arrange with increasing of multiple. This means that when we increase the multiple we cannot be sure of (sure of what??) and same with when we talk about low values of multiple. Our analysis would work best with the range of 7.5-10.5 range of multiple.
- ✓ Multicollinearity – This should not be a problem we already remove things that are from the same group and we have changes of them being related to one another. Example: multicollinearity within the group of Macro factors.

Monte Carlo Simulation

Process	Equation	Notes
Sales	$\frac{dS}{S} = \mu dt + \sigma dW$	Brownian Motion
Margin	$\frac{dS}{S} = k(\theta - \ln X)dt + \sigma dW$	Mean reverting
Multiple (EV/EBITDA)	$d\lambda = \theta(n - \lambda)dt + \sigma\sqrt{\lambda}dW + jdN$	Mean reverting with Jumps OR regressed out of various factors
Interest Rate	$\Delta r_t = \lambda(k - r_t)\Delta t + \sigma_r \varepsilon_r$	Short long-term equations

VBA pseudo codes could be used for implementing the stochastic equations. It should be noted that all data should be matched to the assumptions of Equity reports.

Creation of “third” dimension in data tables using split join –the data table for analysis becomes important as we would like to minimize the role of VBA and keep the model open to all analysts. Hence a cell would have several values with a delimiter which can be pulled out. The calculation is done using a join function that joins all the fundamental prices for each strategy and again gets the end of period data which can be extracted through delimiter.

What questions will the research team needs to answer?

- ✓ What assumptions drive the returns for the chosen financial policy?
- ✓ What assumptions drive paths of Monte Carlo simulations?
- ✓ How to make apple to apple comparison for repo vs. acquisition?

FORECASTING SHAREHOLDER RETURNS USING MONTE CARLO SIMULATION FOR CAPITAL
STRUCTURE, SHARE REPURCHASES AND CONVERTIBLE CALLABLE BONDS

	Return IRR	Repo On	Repo Off
	84.00%	1.00	0
Mutiple	1	89.99%	84.10%
Change	0	89.92%	95.90%

Figure: Effect of using stochastic multiple and doing share repo as compared to other strategies

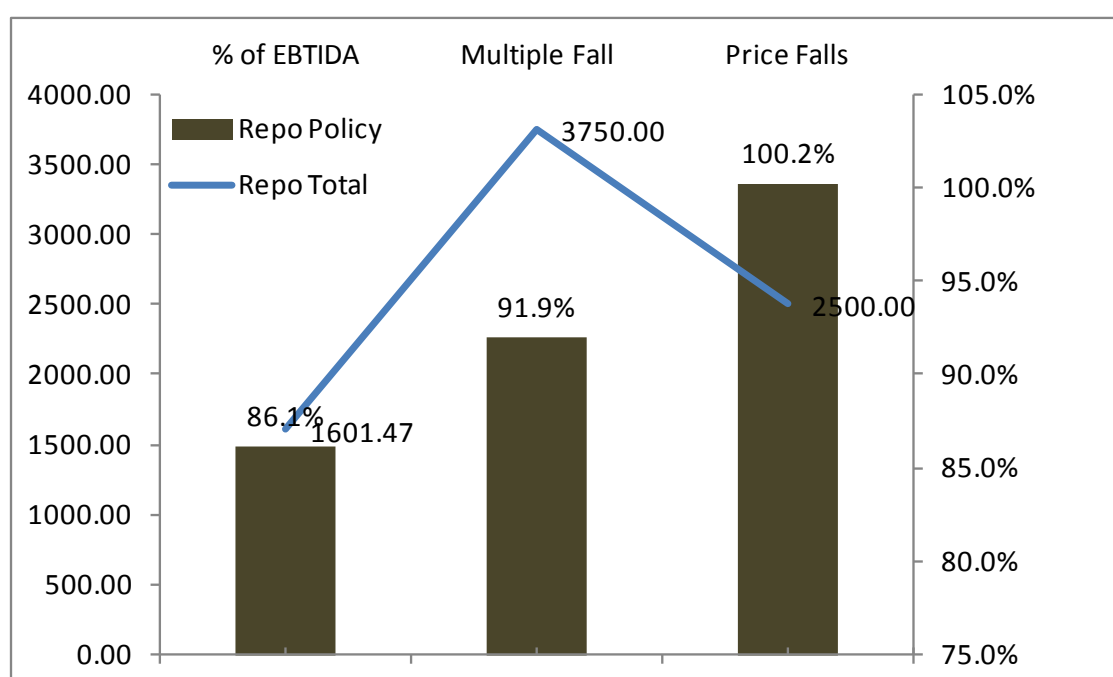
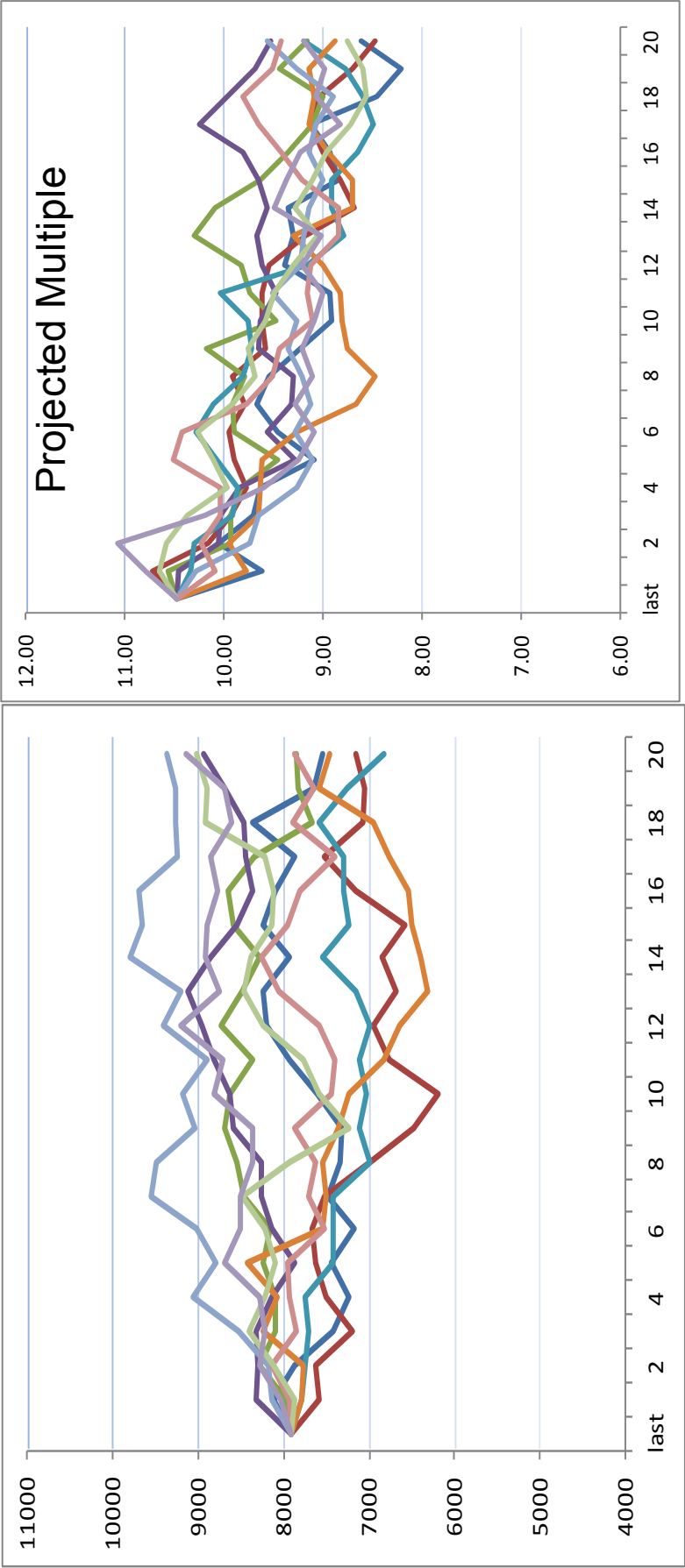


Figure 5. Repo that will occur under % of EBTIDA triggers at 5%, Multiple Fall at 9.5 and Price Falls at 24 scenarios (search for other as well constant, and also under scenario)

Ideally for an apple-to-apple comparison repo quantity should be same and we should change assumption to get the same repo quantity in all scenarios.

Sales, EBTIDA Margin, EV/EBITDA, Stock price are shown below:



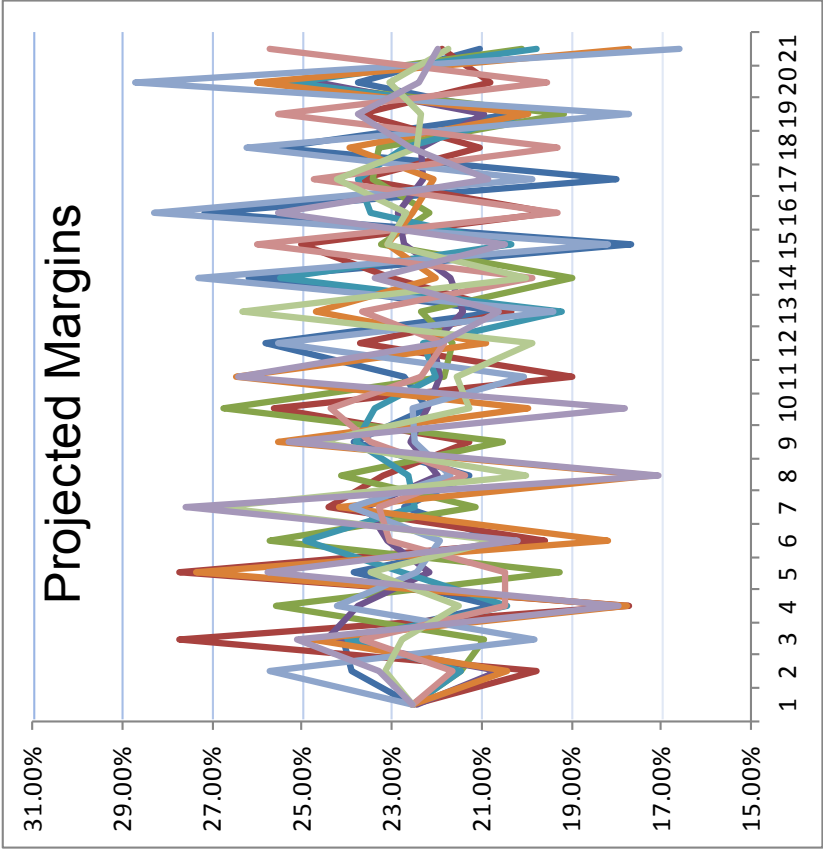


Figure 6. Expected Monte Carlo Paths consisting of six paths (get all 10 paths of stock price either by this or by general method, made by join and split)

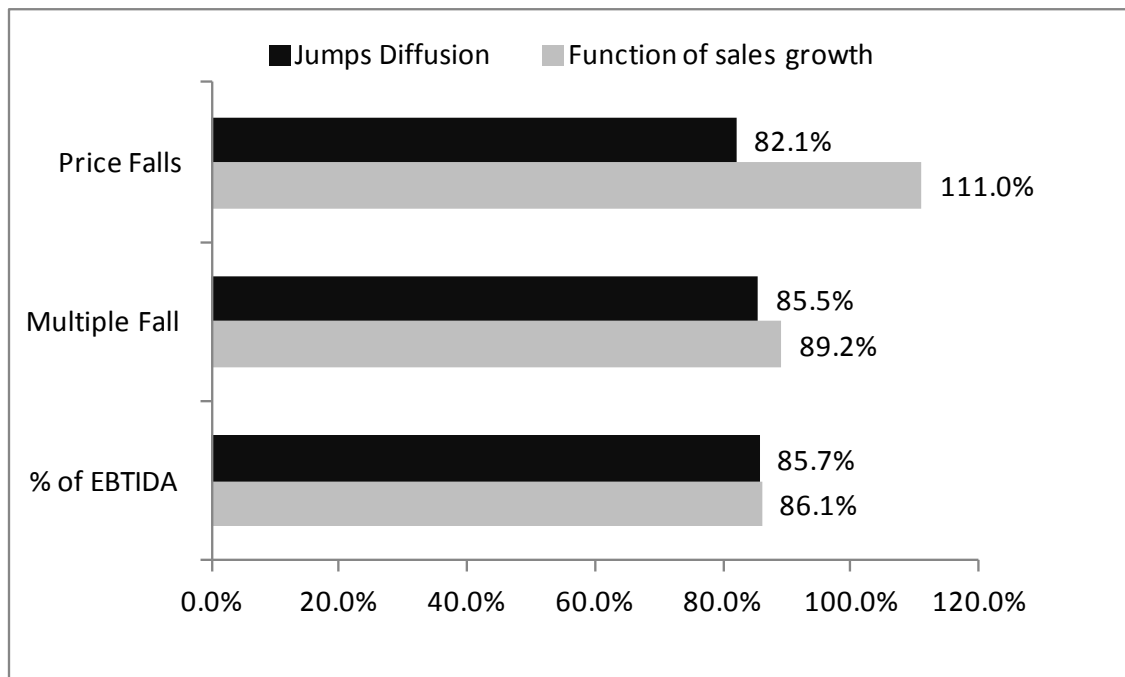


Figure 7. Returns in 3M (When assumptions for stochastic process used in simulations are changed)

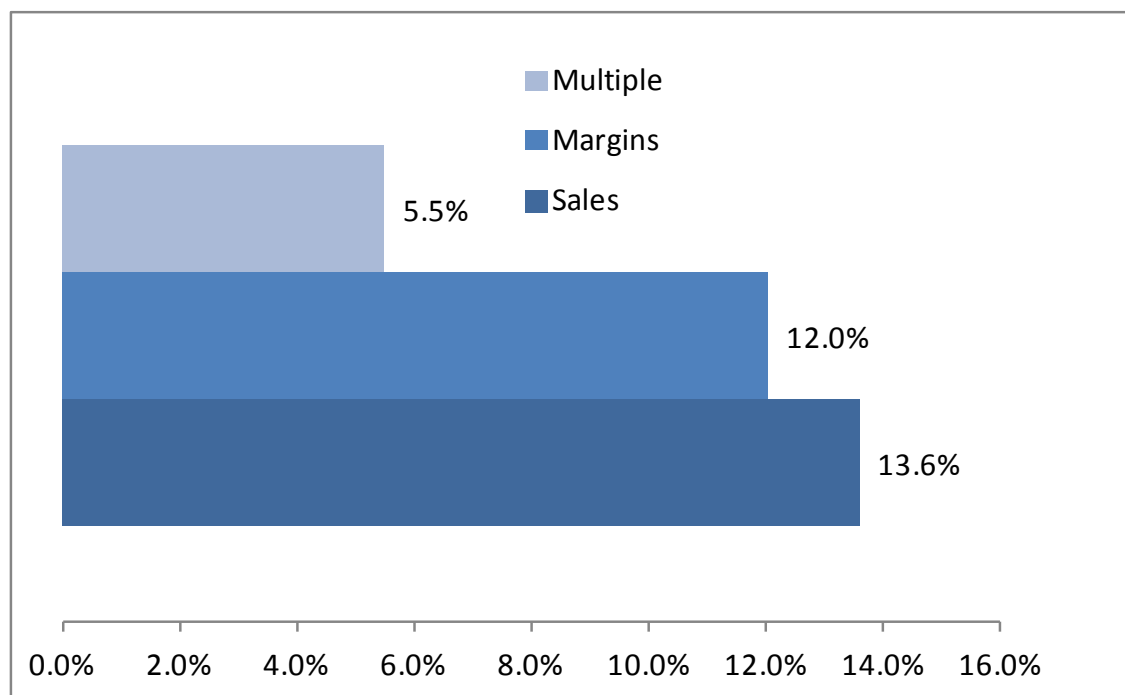


Figure 8. Share prices by changing each parameter and Risks associated on share price due to volatilities in Sales, Margin and Multiple

Increment way of depiction the contribution of volatilities of factor with respect to total volatility in the chart which is calculated by disabling all other simulations.

Direction Analysis

If we look at the results, the directional analysis still hold valid. If we keep multiple constant and don't take AR1 plus jumps then the valuation increases, or if we take margins to be AR1 we again expect the same increase. When we buy undervalued shares in repo it gives us maximum returns.

Excess Cash Projections

Excess cash projections require a lot of assumptions as compared to share price where we have used only three parameters and used different stochastic models to compare the results.

Assumptions taken are "point in time" and are made of: *CFO*, *Debt*, *CFI*, *Dividend*, *Cash*, and Number of shares. In the list only CFO remains fixed and all other changes are due to policy change in our model.

As expected the model is not as stable and the projections of excess cash is dependent on a lot too many assumptions where CFO is the toughest to project. Distribution and return of capital can be modeled using the excess cash projections where we can also tweak the amount of repo, dividend and debt. The problem of the upward biases in the consensus estimates remains the challenge to deal with as no stochastic process can be applied to any of the processes used in cash projections.

6. Results, Possible Improvements & Research Pathway

Effect of Share repo on company's total return for the projected period depends on when we buy the shares. These results would include the effect of stochastic movements in three variables: Sales, Multiple and Margins keeping all other things status quo. Model takes us to a mean path which could be also used to project 90% confidence of remaining in the range $X \pm \Delta$, etc. Factors that is most relevant for deciding Optimum Capital Structure will include expected results in all strategies and whether we can increase leverage and still keep the Multiple intact. How does idea of algorithmic share buyback effect returns as compared to traditional dividend policies are shown to in this research.

How too back test tail events for stress testing – tails of regression and correlation are compared to get the stress testing scenarios made of these tails and their probabilities. This becomes import because we cap many outliers in our analysis and including them would be the analysis comprehensive. In regression we have used large P values, removed the extreme values whereas in correlations we have used ranked correlation which again ignore the outliers. Hence we have ignored the tail events which can be worked upon using Extreme value theorem (Peaks over Threshold. Robust regression method where we can cap 200% or manual outliers thus needs to combine with stress testing.

Excel-VBA models were used to create the scenarios and but this work could be extended to R/MATLAB. Modules: Acquisition, Pension Liability, and Share repo's effect on return and the best Capital Structure depends on projections of the core elements of company drivers and are dependent on share price which makes this engine useful. Which assumptions matters the most and how to get other settings for getting realistic simulations can be judged but this research provides

a directional indication. Sometimes the very minute of basis points contribution of selected policy might be done at the cost of greater leverage that should be avoided. Into our models we have used only 10 paths that could be scaled ahead.

When we start creating excel we need to make sure most of the things are simple and intuitive and hence the regression process should run in the most simple and automated way.

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Appendix of pseudo codes:

Public Sub CorrelationRankSelection()

- ✓ This Sub would rank the correlations of factors vs peer and select the factors that are most correlated
- ✓ We are targeting to get top eight factors by this method
- ✓ After we get the required factors we can then remove the other manually on p-values
- ✓ Since we are not touching the p-values this function could be calculated with Manual mode
- ✓ An_rank range is the range with correlation rank and Use_factor is the range with flags to enable/disable factor

Dim i, n, lower, upper As Integer

n = Range("Factors_Guess").Value

lower = ((n) / 2) + 1

upper = 16 - lower + 1

Begin_Backward_Selection

Application.Calculation = xlCalculationManual

For i = 1 To 16

If Range("An_ranks")(1, i) < lower Or Range("An_ranks")(1, i) > upper Then

Range("Use_factor")(1, i).Value = True

Else

Range("Use_factor")(1, i).Value = False

End If

Next i

Application.Calculation = xlCalculationSemiautomatic

End Sub

Sub PValuesRankSelection

- ✓ This Sub would rank the P Values of factors and keep on removing the one with highest P values using rank
- ✓ After we get the requested factors we can then remove them other manually on pvalues
- ✓ Since we are touching the p values this function should be run in automatic mode
- ✓ An_rank_pvalue range is the range with p value rank, Use_factor is the range with flags to enable/disable factor
- ✓ An_pos is the range which holds the position to turn off

Begin_Backward_Selection

Dim i, j, n, lower, flag, temp As Variant

n = Range("Factors_Guess").Value

lower = n + 1

flag = 0

For j = 15 To lower Step -1

 MsgBox j

 For i = 1 To 16

 If Range("An_rank_pvalue")(1, i) > j Then

 temp = Range("An_pos")(1, i)

 Range("Use_factor")(1, temp).Value = False

```
End If
Next i
Next j
End Sub
```

Public Sub ResidualsRankSelection

- ✓ This Sub would rank the correlations of factors vs peer and select the factors whose residuals shows highest correlation
- ✓ After we get the requested factors we can then remove them manually on pvalues
- ✓ Since we are not touching the p values this function could be calculated with Manual mode
- ✓ An_residuals_rank range is the range with corr residuals rank and Use_factor is the range with flags to enable/disable factor

Begin_Backward_Selection

```
Dim i, j, n, lower, flag, temp As Variant
n = Range("Factors_Guess").Value
lower = n + 1
flag = 0
For j = 15 To lower Step -1
For i = 1 To 16
If Range("An_residuals_rank")(1, i) > j Then
temp = Range("An_pos")(1, i)
Range("Use_factor")(1, temp).Value = False
End If
Next i
Next j
End Sub
```